



YORK REGION
North Roads Operations Centre
Expansion and Storm Water Management

3525 Baseline Road
Sutton West, ON

Region of York Tender No. RFTC-1868-24-TR88179
GEC Project No.: 6016

May 23, 2025
Reissued for Tender

PROJECT MANUAL
Issued by



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Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Definitions
 - .1 Information Documents means information of any type and in any form, related to the Project and identified in this Section as such and do not include the Contract Documents.

1.3 STATUS OF INFORMATION DOCUMENTS

- .1 Information document, by their nature, cannot reveal all conditions that exist or can occur on the Site. Should conditions be found to vary substantially from the report immediately notify the Consultant in writing and await instruction.
- .2 The Contractor shall not be entitled to extra payment or extension of the Contract Time for Work which is required and which is reasonably inferable from the reports as being necessary.

1.4 USE OF AND RELIANCE UPON INFORMATION DOCUMENTS

- .1 Information Documents are made available by the Owner for the purpose of providing the Contractor with access to information available to Owner.
- .2 Information Documents shall not be considered a representation or warranty that information contained therein is accurate, complete or appropriate, and do not form a part of the Contract Documents.
- .3 Bidder shall interpret and draw its own conclusions about Information Documents and is encouraged to obtain specialist advice with respect thereto. Prime Consultant assumes no responsibility for such interpretations and conclusions.
- .4 Information contained in Information Documents may be time sensitive and dates shall be considered when interpreting Information Documents.
- .5 Bidder may rely upon the data contained in Information Documents, or parts thereof, which are specifically incorporated into Contract Documents by means of copying, transcribing or referencing, but shall draw his own conclusions from such data and shall not rely on opinions or interpretations contained therein.

1.5 INFORMATION DOCUMENTS

- .1 Information Documents, in whole or in part, consist of the following:
 - .1 Geotechnical Investigation for Modification of Ponds at 3525 Baseline Road, Sutton, Ontario dated December 6, 2024 prepared by Engtec Consulting Inc.
 - .2 Geotechnical Investigation for Maintenance Building Expansion at Roads Operations Centre at 3525 Baseline Road dated December 4, 2023 prepared by Engtec Consulting Inc.

- .3 Designated Substances and Hazardous Materials Survey dated November 20, 2020 prepared by ECHO Environmental Consulting Occupational Health
- .4 Designated Substances Survey dated July 12, 2024 prepared by LEAP Management Inc.
- .5 Stormwater Management Report dated July 26, 2024 prepared by Resilient Consulting Corporation.
- .6 LEED Energy Model Report dated May 23, 2025 prepared by MCW Consultants Ltd.
- .7 LEED v4 Overall Documentation Progress dated May 23, 2025 prepared by MCW Consultants Ltd.
- .8 Hydrogeological Assessment dated September 28, 2022 prepared by Harden Environmental Services Limited.
- .9 Soil Characterization Report dated March 11, 2025 prepared by Engtec Consulting Inc.
- .10 Soil Characterization Report: Stockpile Sampling and Delineation Samples dated April 4, 2025 prepared by Engtec Consulting Inc.
- .11 Assessment of Past Uses dated March 11, 2025 prepared by Engtec Consulting Inc.
- .12 Construction Dewatering Assessment dated November 21, 2024 prepared by Hydrogeology Consulting Services.
- .13 Summary of Salt-Impacted and Contaminated Soils dated April 14, 2025.
- .14 Soil Management Plan (SMP) - York Region North Road Operations Centre at 3525 Baseline Rd, Georgina, ON. dated April 7, 2025 prepared by Engtec Consulting Inc.
- .15 Property Services Branch Facilities Signage Guidelines dated April 24, 2023 prepared by York Region

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- .1 The Work of this Contract includes, but is not limited to, general construction of and renovations to North Roads Operations Centre, located at 3525 Baseline Road in the Town of Georgina, Ontario. The Work includes the construction of the building and related sitework.
- .2 Work specified in Specifications is divided into Divisions and Sections for reference purposes only. Except as may be otherwise specified in the Contract, division and coordination of the Work among Contractor, Subcontractors, Sub-Subcontractors and Suppliers is the Contractor's responsibility.

1.3 LEED CERTIFICATION

- .1 The Project is registered for LEED NC Version 4 certification with an anticipated certification level as indicated. The Contractor, Subcontractor, Suppliers, and manufacturers are required to participate to achieve LEED certification.
- .2 To obtain LEED Certification, the Project must meet certain LEED prerequisites and obtain certain LEED credits. A summary of prerequisites and credits for which the Project will be seeking certification are outlined in 01 35 22 – LEED NC V4 Checklist. Refer to LEED Requirements for a full description of Contractor's LEED responsibilities.
- .3 Follow special administrative procedures and submit special Submittals to assist the Owner in obtaining LEED certification. Refer to Green Product Information Submittal Forms to determine required LEED submittals.
- .4 At contract award, the Contractor shall appoint a Contractor LEED Coordinator to be responsible for all Contractor LEED responsibilities and submittals. The Contractor LEED Coordinator must either have a LEED AP designation, a LEED GA designation, or experience in all aspects of Contractor LEED responsibilities.
- .5 Where the term 'LEED' is used within these Specifications it refers to the LEED (Leadership in Energy and Environmental Design) NC Version 4 for Building Design and Construction Rating System, including detailed requirements as set out in the LEED v4 Reference Guide.

1.4 COMMUNICATION METHOD

- .1 Work of this Contract will be recorded and administered through ftp site. Contractor and Subcontractors will provide accounts, and communication will be sent back and forth through this program to allow ease of access for Owner, Consultants, Contractor, subtrades, and other permitted parties.

1.5 CONTRACT METHOD

- .1 Construct Work under single stipulated price Contract.

1.6 WORK SCHEDULE

- .1 Reach Substantial Performance of the Contract and Total Performance of the Contract by date as required in Contract.

1.7 CONTRACTOR USE OF PREMISES

- .1 Limit use of premises for Work, for storage, and for access, to allow:
 - .1 Owner occupancy.
 - .2 Partial Owner occupancy.
 - .3 Work by Other Contractors.
 - .4 Public usage.
- .2 Co-ordinate use of premises under direction of Consultant.
- .3 Obtain and pay for use of additional storage or Work areas needed for operations under this Contract.
- .4 Remove or alter existing Work to prevent injury or damage to portions of existing Work which remain.
- .5 Repair or replace portions of existing Work which have been altered during construction operations to match existing or adjoining Work, as directed by Consultant.
- .6 At completion of operations condition of existing Work: equal to or better than that which existed before new Work started.

1.8 OWNER OCCUPANCY

- .1 The Owner will occupy premises and adjacent buildings during entire construction period for execution of normal operations. Refer to Appendix H for more details.
- .2 Co-operate with the Owner in scheduling operations to minimize conflict and to facilitate Owner usage. Refer to Appendix H for more details.

1.9 DOCUMENTS REQUIRED

- .1 Maintain at job site, one copy each document as follows:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 LEED™ Documentation Binders
 - .5 Reviewed Shop Drawings.
 - .6 List of Outstanding Shop Drawings.
 - .7 Change Orders.
 - .8 Other Modifications to Contract.
 - .9 Field Test Report, System Components List complete with Commissioning Verification Forms and Check Sheets and Commissioning Issues/Resolution Log.
 - .10 Permits

- .11 Copy of Approved Work Schedule.
- .12 Health and Safety Plan and Other Safety Related Documents.
- .13 Daily weather log
- .14 Other documents as specified.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 ACCESS AND EGRESS

- .1 Design, construct and maintain temporary "access to" and "egress from" Work areas, including stairs, ramps or ladders and scaffolding, independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

1.3 USE OF SITE AND FACILITIES

- .1 Execute Work with least possible interference or disturbance to normal use of premises. Make arrangements with Owner to facilitate Work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by Work provide temporary means to maintain security.
- .4 Salt storage, garage and wash bays must be accessible and fully operational during ploughing season (Oct 1 to April 30).
- .5 Coordinate relocation of pressure washer with York Region. Provide minimum 1 week notice.
- .6 Contractor to ensure fuel station is accessible daily. Any restrictions to access of fuel station to be coordinated with York Region.
- .7 Contractor to ensure safe access to the site at all times.
- .8 Contractor to address potential conflicts between Contractor's vehicles and York Region's vehicles throughout construction.
- .9 Review Appendix E YRND – Proposed Phasing and coordinate work of that Section. Appendix E is included for general reference only; Contractor shall prepare suitable sequencing plan that achieves the intent of maintaining operations throughout construction.
- .10 Separate pedestrian and vehicle access for York Region staff and construction is preferred wherever possible. Where not possible, additional barriers, flagpersons, and safety measures will be required.
- .11 Site to remain fully operational throughout construction
- .12 Contractor to be responsible for ensuring contractor's work along with any closures, shutdowns, or disruptions are coordinated with York Region to mitigate operational impacts.
- .13 Contractor to be responsible for ensuring contractor's work does not impact safety of York Region staff

1.4 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

- .1 Execute Work with least possible interference or disturbance to building operations, occupants, public and normal use of premises. Arrange with Consultant to facilitate execution of Work.

1.5 BUILDING SMOKING ENVIRONMENT

- .1 Comply with smoking restrictions.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 SUMMARY

- .1 Related Requirements:
 - .1 General Conditions and Supplementary Conditions of the Contract.

1.3 CASH ALLOWANCES

- .1 Include in Contract Price specified cash allowances.
- .2 Cash allowances, unless otherwise specified, cover net cost to Contractor and Subcontractor of services, Products, construction machinery and equipment, freight, handling, unloading, storage, installation and other authorized expenses incurred in performing Work.
- .3 Contract Price, and not cash allowance, includes Contractor's overhead and profit in connection with such cash allowance.
- .4 Contract Price will be adjusted by written order to provide for excess or deficit to each cash allowance.
- .5 Where costs under a cash allowance exceed amount of allowance, Contractor will be compensated for excess incurred and substantiated plus allowance for overhead and profit as set out in Contract Documents.
- .6 Include progress payments on accounts of Work authorized under cash allowances in Consultant's monthly certificate for payment.
- .7 Prepare schedule jointly with Consultant and Contractor to show when items called for under cash allowances must be authorized by Consultant for ordering purposes so that progress of Work will not be delayed.
- .8 Amount of each allowance, for Work specified in specification is as follows:
 - .1 Include allowance of \$550,000.00 for excavation, transportation, removal, backfill and disposal of unsuitable and contaminated material
 - .2 Include allowance of \$35,000.00 for Hydro-Vac services to expose unforeseen underground utilities.
 - .3 Include allowance of \$40,000.00 for relocating unforeseen existing underground service lines.
 - .4 Include allowance of \$200,000.00 for Inspection and Material Testing
 - .5 Include allowance of \$25,000.00 for Bell Conduits and Incoming Fibre Service in addition to the contract requirements
 - .6 Include allowance of \$40,000.00 for Hydro Connection Charges
 - .7 Include allowance of \$330,000.00 for unforeseen pumping and disposal of groundwater
 - .8 Include allowance of \$94,000.00 for supply and installation of up to 1,000 Tons of Granular A for Soft Spot Remediation
 - .9 Include allowance of \$5,000.00 for unforeseen designated substances removal where removal cannot be fully captured in contract documents, including reference documents (in soil and existing structure)

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 ADMINISTRATIVE

- .1 Schedule and administer project meetings throughout the progress of the work and at the request of the Consultant.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting four Business Days in advance of meeting date to the Consultant.
- .4 Provide physical space and make arrangements for meetings and provide arrangements for virtual attendance (audio and video) when required by Owner or Consultant.
- .5 Preside over meetings.
- .6 Record meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7 Reproduce and distribute copies of minutes within three Business Days after meetings and transmit to meeting participants and affected parties not in attendance.
- .8 Representative of the Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.3 PRECONSTRUCTION MEETING (CONSTRUCTION PARTNERING WORKSHOP)

- .1 Promptly after award of the Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Representatives of the Owner, the Consultant, the Contractor, major Subcontractors, suppliers listed in bid form, field inspectors and supervisors shall be in attendance.
- .3 Coordinate time and location of meeting and notify parties concerned minimum 5 Business Days before meeting.
- .4 Agenda to include:
 - .1 Appointment of official representative of participants in the Work.
 - .2 Schedule of Work: in accordance with Construction Progress Schedules and long lead times.
 - .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
 - .5 Delivery schedule of specified equipment.
 - .6 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

- .7 Site requirements, coordination and restrictions in accordance with Appendix H – Site Restrictions.
- .8 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
- .9 Owner provided products and salvaged items as indicated on drawings.
- .10 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .11 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .12 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
- .13 Monthly progress claims, administrative procedures, photographs, hold backs.
- .14 Appointment of inspection and testing agencies or firms.
- .15 Insurances, transcript of policies.

1.4 PROGRESS MEETINGS

- .1 During course of Work schedule progress meetings every two weeks.
- .2 Contractor, major Subcontractors involved in Work, Consultant, and Owner are to be in attendance.
- .3 Notify parties minimum 5 Business Days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 7 Business Days after meeting.
- .5 Agenda to include the following:
 - .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Field observations, problems, conflicts.
 - .4 Problems which impede construction schedule.
 - .5 Review of off-site fabrication delivery schedules.
 - .6 Corrective measures and procedures to regain projected schedule.
 - .7 Revision to construction schedule.
 - .8 Progress schedule, during succeeding work period.
 - .9 Review submittal schedules: expedite as required.
 - .10 Maintenance of quality standards.
 - .11 Review proposed changes for affect on construction schedule and on completion date.
 - .12 Other business.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 SUMMARY

- .1 Provide an experienced photographer with appropriate equipment to take photographs, edit and deliver for viewing online.
- .2 Provide progressive sets of photographs from the same location of the same view of the building to track progress, all photos must include a measuring tape for scaling and reference of components documented.
- .3 Provide time lapse sequential photographs and video of selected construction work as it progresses. Position a camera on Site prior to commencing Work on Site, at a birds eye view approved by Owner to capture images and time lapse videos. 2 submissions to be submitted: one at 50% and one at 100%.
- .4 Provide high concentration of photos take over shorter time frame of mock-ups for testing and inspection of construction methods as determined by Owner/Consultant.

1.3 SUBMITTALS

- .1 Schedule: Identify preset intervals to be on-site (i.e. First Tuesday of month) and additional special dates Consultant to be present (i.e, milestones, mock ups, commencement or completion)
- .2 Key Plan: Submit key plan showing building site and building interior plans with identification of vantage points for locations of photographer and view directions for photo sets. Label each site as it will be identified on online views.
- .3 Submit photographs at end of project and at each month end prior to request for progress payments, as a series of photos with comments on progress and set-backs/problems/corrections, in PDF format.

1.4 COPYRIGHT PRIVILEGES

- .1 Obtain and transfer or permit Owner complete image rights for unlimited reproduction and distribution of photographic documentation.

Part 2 Products

2.1 PHOTOGRAPHY

- .1 Submit monthly collection of photos (PDF of jpeg image) with month end report to Consultant and Owner.
- .2 Digital images, 'jpeg' format produced by a digital camera with minimum size of 2.0 megapixels and an image with not less than 1936x1296 resolution and 300 dpi.

2.2 INDEXING AND NAVIGATION

- .1 For each photographer location and view direction, compile photographs in chronological order from first photo to last photo of that shot.
- .2 Assemble shots to run as slide show (power point), sequentially by date and time, which can be stopped at any image or selected individually from folder.
- .3 Name and date slides so Owner can easily find photos of the building/construction.

Part 3 Execution

3.1 PROGRESSION PHOTOGRAPHIC SETS

- .1 Site sets: from predetermined locations around the site, recording:
 - .1 Complex construction locations.
 - .2 Major underground utilities
 - .3 Soils and sediment control.
 - .4 Blindside property line excavation, reinforcing drainage and concrete wall construction.
- .2 Exterior Wall Sets: from predetermined locations around site, recording:
 - .1 Outside progression of building envelope.
 - .2 Exterior key points such as front entrances, adjacent buildings, unique details.
 - .3 Pace of construction.
- .3 Interior Sets: at predetermined locations around site, recording:
 - .1 Progress of testing, commissioning, and balancing of HVAC, Plumbing, Electrical.
 - .2 Interior wall framing and finishing as requested.
 - .3 Installation of interior finishes millwork and details as requested.

3.2 SHORT TERM PHOTOGRAPHIC IMAGES

- .1 Photos to be taken as overlapping images of systems and installations focusing on details of interest, progress of work or importance to the client (confirm location as required by Consultant).
- .2 Detail photography to permanently record actual location of these systems for operation and maintenance purposes.

END OF SECTION

1.1 General

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Submit to Consultant submittals listed for review. Submit within 10 working days and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Special submittals are required for LEED Certification. Refer to Section 01 33 01 and Section 01 61 00 for a full description of LEED reporting and submittal requirements for Contractors, Subcontractors, Suppliers and Manufacturers.
- .3 Submit to Consultant complete list of items that require warranties and their duration.
- .4 Do not proceed with Work affected by submittal until review is complete.
- .5 Present Shop Drawings, Product data, samples and mock-ups in SI Metric units.
- .6 Where items or information is not produced in SI Metric units converted values are acceptable.
- .7 Review submittals prior to submission to the Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific Project will be returned without being examined and considered rejected.
- .8 Notify the Consultant in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .9 Verify field measurements and affected adjacent Work are co-ordinated.
- .10 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.
- .11 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant review.
- .12 Keep one reviewed copy of each submission on Site.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Product Data / Shop Drawings
 - .1 The term "Shop Drawings" means Drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
 - .2 Submit Shop Drawings bearing stamp and signature of qualified professional engineer registered or licensed in Province of the Work as required. The Professional Engineer shall be responsible for reviewing the method of seismic restraint and attachment to the structure with the Consultant prior to installation. The Professional Engineer shall also provide field and certification of installation at Sub-contractor's cost.
 - .3 Particular consideration shall be given in the design of seismic restraint anchorage to areas of the structure. Attachment of seismic restraint to

the building structure must be reviewed and accepted by the Owner's Structural Consultant. The Subcontractor shall submit seismic restraint calculations upon request for review by the Consultant. Consider this article the minimum requirement. Further instruction contained in any particular Specification Section governs for that section of the Work.

- .4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design Drawings and Specifications.
- .5 Submit Shop Drawings showing details of seismic restraint of architectural systems and finishes, and mechanical, plumbing and electrical equipment and associated installations, shall include the approximate weight of the item to be restrained.
- .6 Allow 10 Working Days for Consultant's review of each submission.
- .7 Adjustments made on Shop Drawings by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.
- .8 Make changes in Shop Drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.
- .9 Accompany submissions with transmittal letter containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, Product data and sample.
 - .5 Other pertinent data.
- .10 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.

- .5 Performance characteristics.
- .6 Standards.
- .7 Operating weight.
- .8 Wiring diagrams.
- .9 Single line and schematic diagrams.
- .10 Relationship to adjacent Work.
- .11 After Consultant's review, distribute copies.
- .12 Submit electronic copy of Shop Drawings for each requirement requested in Specification Sections and as Consultant may reasonably request.
- .13 Submit electronic copies of Product data sheets or brochures for requirements requested in Specification Sections and as requested by Consultant where Shop Drawings will not be prepared due to standardized manufacture of Product.
- .14 Submit electronic copies of test reports for requirements requested in Specification Sections and as requested by Consultant.
 - .1 Report signed by authorized official of testing laboratory that material, Product or system identical to material, Product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been conducted within 3 years of date of Contract award.
- .15 Submit electronic copies of certificates for requirements requested in Specification Sections and as requested by Consultant.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of Product, system or material attesting that Product, system or material meets Specification requirements.
 - .2 Certificates must be dated after award of Project Contract complete with Project name.
- .16 Submit electronic copies of manufacturers instructions for requirements requested in Specification Sections and as requested by Consultant.
 - .1 Pre-printed material describing installation of Product, system or material, including special notices and WHMIS Safety Data Sheets concerning impedances, hazards and safety precautions.
- .17 Submit electronic copies of Manufacturer's Field Reports for requirements requested in Specification Sections and as requested by Consultant.
 - .1 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .18 Submit electronic copies of Operation and Maintenance Data for requirements requested in Specification Sections and as requested by Consultant.
- .19 Delete information not applicable to Project.
- .20 Supplement standard information to provide details applicable to Project.
- .21 If upon review by Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication

and installation of Work may proceed. If Shop Drawings are rejected, noted copy will be returned and resubmission of corrected Shop Drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.22 Samples:

- .1 Submit for review samples in duplicate as requested in respective Specification Sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Consultant's business address.
- .3 Notify Consultant in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.
- .6 Make changes in samples which Consultant may require, consistent with Contract Documents.
- .7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 QUALITY ASSURANCE

.1 Mock-Ups:

- .1 Erect mock-ups in accordance with 01 45 00 - Quality Control.

.2 Photographs: Digital Format as indicated in Section 01 32 33 – Photographic Documentation.

.3 Certificates and Transcripts:

- .1 Immediately after award of Contract, submit WSIB Certificate of Clearance.
- .1 Submit transcription of insurance immediately after award of Contract.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Section Number	Submittal Description	LEED	LEED Credit	Submittal Notes
01 57 00	EROSION AND SEDIMENT CONTROL	X		
	ESC Inspection Log	X	Construction Activity Pollution Prevention	Bi-monthly submission to LEED consultant.
	Digital Date-Stamped Photographs of installed sediment & erosion measures	X	Construction Activity Pollution Prevention	Bi-monthly submission to LEED consultant.
01 74 19	CONSTRUCTION WASTE MANAGEMENT (CWM) PLAN	X		
	Construction Waste Management (CWM) Plan	X	Construction & Demolition Waste	Identify 5 waste streams & anticipated total waste generated.
	W1: Proposed receiving facilities form	X	Construction & Demolition Waste	
	W2: Waste Tracking Worksheet	X	Construction & Demolition Waste	
	LEED MR Construction and Demolition Waste Management calculator	X	Construction & Demolition Waste	
	Final CWM Report	X	Construction & Demolition Waste	
01 81 19	INDOOR AIR QUALITY	X		
	Construction Indoor Air Quality (IAQ) Management Plan	X	Construction Indoor Air Quality Management Plan	Must meet SMACNA IAQ Guidelines and more.
	IAQ 1: MSDS, PD, Letter from Manufacturer, low-emitting material label/certificate (to inform Low-Emitting Materials Calculator)	X	Low-Emitting Materials	Need to supply VOC content and/or VOC emissions. For furniture, Furniture Emissions Evaluation. For composite wood, Formaldehyde emissions evaluation. Speak to LEED consultant for more info.
	IAQ 2: IAQ Management Inspection Form	X	Construction Indoor Air Quality Management Plan	Bi-monthly submission to LEED Consultant.
	IAQ 3: Photo Documentation Checklist	X	Construction Indoor Air Quality Management Plan	Bi-monthly submission to LEED Consultant.
	Filtration Media Documentation	X	Minimum Indoor Air Quality Performance &	MERV 11 for prerequisite, MERV 13 for credit.
03 30 00	CAST-IN-PLACE CONCRETE	X		
	Concrete Mix Designs	X	Building Life Cycle Impact Reduction	EPD must be valid during construction.
03 35 00	CONCRETE FINISHING	X		
	CRMA (Canadian Ready Mixed Concrete Association) Industry-Wide EPD (Environmental Products Declaration) for Concrete in compliance with LEED.	X	Environmental Product Declarations	EPD must be valid during construction.
	Product Data and list of products proposed for use on project	X	Multiple BPDO credits	
	Corporate sustainability reports for 100% of products contributing toward credit OR Documentation of product claims for credit requirements or other USGBC-approved	X	Sourcing of Raw Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
04 22 00	UNIT MASONRY	X		
	CMU: Product Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
05 41 00	STRUCTURAL METAL STUD FRAMING	X		
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
05 50 00	METAL FABRICATIONS	X		
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
06 40 00	ARCHITECTURAL WOODWORK	X		
	Submit products' cost or surface area as per section 01 81 19 for products applied	X	Low-Emitting Materials & Sourcing of Raw Materials	75% by cost must meet formaldehyde emissions evaluation.
	Product Certification as ultra-low-emitting formaldehyde (ULEF) product, or Certified as no added formaldehyde resins (NAF) product	X	Low-Emitting Materials	Formaldehyde emissions evaluation OR salvaged and reused materials criteria.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.

	Corporate sustainability reports for 100% of products contributing toward credit OR Documentation of product claims for credit requirements or other USGBC-approved program	X	Sourcing of Raw Materials & Material Ingredients	For criteria incl. recycled content, FSC, CSR reports, etc.
	Detailed & dimensioned shop drawings	X	EPDs, Sourcing of Raw Materials, Material Ingredients	
07 21 19	FOAM-IN-PLACE INSULATION	X		
	Manufacturer's certification for the materials compliance with the VOC Emissions Evaluation requirements as per Section 01 81 19	X	Low-Emitting Materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH)
	Submit products' cost or surface area as per section 01 81 19 for products applied	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	If applicable, certification compliance following programs to demonstrate the chemical inventory of the product to at least 0.1% (1000 ppm) (Declare label, Cradle to Cradle, HPD, etc)	X	Material Ingredients	For Chemical inventory criteria. Chemical inventory of the product to at least 0.1% (1000 ppm)
07 21 29	SPRAY APPLIED POLYURETHANE FOAM	X		
	Manufacturer's certification for the materials compliance with the VOC Emissions Evaluation requirements as per Section 01 81 19	X	Low-Emitting Materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010, using the applicable exposure scenario.
	Submit products' cost or surface area as per section 01 81 19 for products applied	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	If applicable, certification compliance following programs to demonstrate the chemical inventory of the product to at least 0.1% (1000 ppm) (Declare label, Cradle to Cradle, HPD, etc)	X	Material Ingredients	For Chemical inventory criteria. Chemical inventory of the product to at least 0.1% (1000 ppm)
07 42 00	COMPOSITE METAL PANELS	X		
	Submit products' cost or surface area as per section 01 81 19 for products applied	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	Detailed and dimensioned Shop Drawings (signed & sealed by Prof. Engr)	X	EPDs, Sourcing of Raw Materials & Low-Emitting Materials	
07 52 00	MODIFIED BITUMINOUS MEMBRANE ROOFING	X		
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
07 62 00	SHEET METAL FLASHING AND TRIM	X		
	Submit products' cost or surface area as per section 01 81 19 for products applied		Sourcing of Raw Materials	
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
07 84 00	FIRE STOPPING AND SMOKESEALS	X		
	Submit products' cost or surface area as per section 01 81 19 for products applied	X	Sourcing of Raw Materials & Low-Emitting Materials	
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	Detailed shop drawings for each condition on site	X	EPDs, Sourcing of Raw Materials & Low-Emitting Materials	
	Certification: Certified copies of test reports from accredited testing agency for VOC emissions evaluation and VOC content	X	Low Emitting Materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH)
07 92 00	SEALANTS	X		
	Submit products' cost or surface area as per section 01 81 19 for products applied	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.

	Certification: Certified copies of test reports from accredited testing agency for VOC emissions evaluation and VOC content	X	Low Emitting Materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010, using the applicable exposure scenario, and VOC content info following SCAQMD Rule 1168.
	If applicable, Material Ingredient Reporting Information (Declare label, Cradle to Cradle, H	X	Material Ingredients	Manufacturers inventory, Declare, Cradle to Cradle, HPD, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
08 11 13	STEEL DOORS AND FRAMES	X		
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or	X	Environmental Product Declarations	EPD must be valid during construction.
	Submit products' cost or surface area as per section 01 81 19 for insulation products applied	X	Low Emitting Materials & Sourcing of Raw Materials	
	Corporate sustainability reports for 100% of products contributing toward credit OR	X	Sourcing of Raw Materials	For criteria incl. recycled content, FSC,
	Certification: Certified copies of test reports from accredited testing agency for VOC	X	Low Emitting Materials	VOC Emissions evaluation in
	If applicable, Material Ingredient Reporting Information (Declare label, Cradle to Cradle, H	X	Material Ingredients	Manufacturers inventory, Declare,
08 44 13	GLAZED ALUMINUM CURTAIN WALLS	X		
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or	X	Environmental Product Declarations	EPD must be valid during construction.
	Submit Calculations certified by Prof. Engr.	X	Minimum & Optimize Energy Performance	Info to be reviewed by Energy Modeler
	Test Reports of the insulating glass units as prescribed in CAN/CGSB-12.8	X	Minimum & Optimize	Shop dwgs which tells/helps the
08 80 50	GLAZING	X		
	Submit products' cost or surface area as per section 01 81 19 for all glass products applied		Sourcing of Raw Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If applicable, Material Ingredient Reporting Information (Declare label, Cradle to Cradle, H	X	Material Ingredients	Manufacturers inventory, Declare, Cradle to Cradle, HPD, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or	X	Environmental Product Declarations	EPD must be valid during construction.
	Test Reports of the insulating glass units as prescribed in CAN/CGSB-12.8	X	Minimum & Optimize Energy Performance	Shop dwgs which tells/helps the energy modeller to calculate the R-
09 21 16	GYPSUM WALLBOARD ASSEMBLIES	X		
	LEED: with the VOC Emissions Evaluation requirements as per Section 01 81 19	X	Low-emitting materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010, using the applicable exposure scenario.
	If applicable, Material Ingredient Reporting Information (Declare label, Cradle to Cradle, H	X	Material Ingredients	Manufacturers inventory, Declare, Cradle to Cradle, HPD, etc.
	Submit products' cost or surface area as per section 01 81 19 for all the gypsum wallboard products applied on site.	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	Detailed Shop Drawings	X	Sourcing of Raw Materials & Low-Emitting Materials, Material Ingredients, EPDs	
09 30 13	TILING	X		
	Submit products' cost or surface area as per section 01 81 19 for floor products applied on site.		Sourcing of Raw Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If applicable, Material Ingredient Reporting Information (Declare label, Cradle to Cradle, H	X	Material Ingredients	Manufacturers inventory, Declare, Cradle to Cradle, HPD, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	Shop drawings (location and details of control joints)	X	EPDs, Sourcing of Raw Materials, Material Ingredients, Low Emitting Materials	
	Certification: Certified copies of test reports from accredited testing agency for VOC emissions evaluation	X	Low Emitting Materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010, using the applicable exposure scenario.
09 51 13	ACOUSTICAL PANEL CEILINGS	X		

	Manufacturer's certification for the ceiling materials compliance with the VOC Emissions Evaluation requirements as per Section 01 81 19	X	Low-emitting materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010, using the applicable exposure scenario.
	Submit products' cost or surface area as per section 01 81 19 for all ceiling materials products applied on site.	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If applicable, Material Ingredient Reporting Information (Declare label, Cradle to Cradle, H	X	Material Ingredients	Manufacturers inventory, Declare, Cradle to Cradle, HPD, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
09 65 00	RESILIENT FLOORING	X		
	Submit products' cost or surface area as per section 01 81 19 for floor products applied on site.	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	Manufacturer's certification for flooring materials showing compliance with the VOC Emissions Evaluation, requirements as per Section 01 81 19	X	Low-emitting materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH)
09 72 00	VINYL FILMS	X		
	Submit products' cost or surface area as per section 01 81 19 for products applied on site.	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	Manufacturer's certification showing compliance with the VOC Emissions Evaluation, requirements as per Section 01 81 19	X	Low-emitting materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010, using the applicable exposure scenario.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	If applicable, Material Ingredient Reporting Information (Declare label, Cradle to Cradle, H	X	Material Ingredients	Manufacturers inventory, Declare, Cradle to Cradle, HPD, etc.
09 91 00	PAINTING	X		
	Submit products' cost or surface area as per section 01 81 19 for products applied on site.	X	Sourcing of Raw Materials & Low-Emitting Materials	For criteria incl. recycled content, FSC, CSR reports, etc.
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	If applicable, Material Ingredient Reporting Information (Declare label, Cradle to Cradle, H	X	Material Ingredients	Manufacturers inventory, Declare, Cradle to Cradle, HPD, etc.
	Manufacturer's certification showing solar reflectance levels for asphalt coating	X	Heat Island Reduction	Should provide proof of initial SR value of at least 0.33.
	Manufacturer's certification for the painting materials compliance with the VOC Emissions Evaluation and VOC content limits, requirements as per Section 01 81 19.	X	Low-emitting materials	VOC Emissions evaluation in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010, using the applicable exposure scenario. VOC content limits under the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113, effective June 3, 2011.
10 28 10	TOILET AND BATH ACCESSORIES	X		
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
	Shop Drawings	X	Environmental Product Declarations	
10 51 13	METAL LOCKERS	X		
	LEED Submittals in accordance with Division 01	X	Environmental Product Declarations & Low Emitting Materials	
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.

	Manufacturer's certification showing compliance with the Furniture Emissions Evaluation, requirements as per Section 01 81 19	X	Low Emitting Materials	certification in accordance with ANSI/BIFMA Standard Method M7.1-2011 (R2016) and complies with ANSI/BIFMA e3-2014e or e3-2019e Furniture Sustainability Standard, Sections 7.6.1 OR 7.6.2, OR 7.6.2 AND 7.6.3
	Shop Drawings	X	Environmental Product Declarations & Low Emitting Materials	
11 31 00	APPLIANCES	X		
	LEED Submittals in accordance with Division 01	X	Indoor Water Use Reduction & Environmental Product Declarations	
	Energy Star Documentation for dishwashers, clothes washers, and ice machines	X	Indoor Water Use Reduction	
	If available, Product-Specific Declaration (conforming to ISO 14044), an Industry wide Type III EPD or Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930) for metal for LEED compliance	X	Environmental Product Declarations	EPD must be valid during construction.
22 40 10	PLUMBING FIXTURES AND DRAINS	X		
	Proof of WaterSense label	X	Indoor Water Use Reduction	WaterSense label required for Toilet, Urinal, Showerhead, Private Lavatory Faucet
	Shop Drawings (fixtures & trim) - dimensions, details & roughing-in dimensions.	X	Indoor Water Use Reduction	
	Sustainable Design Submittals (LEED) in accordance with Division 01	X	Indoor Water Use Reduction	
23 21 23	HVAC PUMPS	X		
	Shop Drawings (stamped and signed by Prof. Engr.)	X	Minimum & Optimize Energy Performance	Info to be reviewed by Energy Modeler
	Sustainable Design Submittals (LEED) in accordance with Division 01	X	Minimum & Optimize Energy Performance	Info to be reviewed by Energy Modeler
23 35 10	FANS AND BLOWERS	X		
	Product Data	X	Minimum & Optimize Energy Performance	Info to be reviewed by Energy Modeler
	Shop Drawings	X	Minimum & Optimize Energy Performance	Info to be reviewed by Energy Modeler
23 37 10	AIR TERMINAL CONTROL UNITS	X		
	Product Data	X	Minimum & Optimize Energy Performance	Info to be reviewed by Energy Modeler
	Shop Drawings	X	Minimum & Optimize Energy Performance	Info to be reviewed by Energy Modeler
23 40 10	AIR FILTERS	X		
	Product Data	X	Minimum Indoor Air Quality Performance & Enhanced Indoor Air Quality Performance	MERV 11 for prerequisite, MERV 13 for credit.
	Shop Drawings	X	Minimum Indoor Air Quality Performance & Enhanced Indoor Air Quality Performance	
23 81 26	SPLIT SYSTEM AIR CONDITIONING UNITS	X		
	Product Data	X	Minimum & Optimize Energy Performance	Info to be reviewed by Energy Modeler
	Shop Drawings	X	Minimum & Optimize Energy Performance	
23 81 29	VARIABLE REFRIGERANT FLOW SYSTEMS	X		
	Product Data	X	Minimum & Optimize Energy Performance; Enhanced Refrigerant Management	Info to be reviewed by Energy Modeler
	Shop Drawings	X	Minimum & Optimize Energy Performance	
26 50 00	LIGHTING LUMINAIRES	X		
	Shop Drawings (dimension detailed drawings)	X	Light Pollution Reduction, Purchasing Lamps	

Product Data (information of each lamp type)		X	Light Pollution Reduction, Report BUG rating Purchasing Lamps
32 13 13	CONCRETE PAVING, SIDEWALKS, CURBS, AND GUTTERS	X	
	Samples of specified precast concrete unit pavers	X	Heat Island Reduction & Rainwater Management
	Product data	X	Heat Island Reduction & Rainwater Management Report solar reflectance value (initial and three-year aged if available). Retention levels if permeable
32 93 10	TREES, SHRUBS, AND GROUND COVER PLANTING	X	
	List of specified landscaping species	X	Outdoor Water Use Reduction

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 INTENT

- .1 The intent of Delegated Design Submittals required by this Section is to account for professional engineering responsibility for design, review and acceptance of components of Work forming a part of permanent Work in accordance with the Ontario Building Code, and that has been assigned to a design entity other than Consultant including, but not limited to, the following:
 - .1 Design requiring structural analysis of load bearing components and connections and seismic requirements.
 - .2 Design requiring compliance with fire safety regulations.
 - .3 Design requiring compliance with life or health safety regulations.
 - .4 Materials and systems located in sections as indicated below.
- .2 This Section provides standard forms for submittal of Letter of Commitment and Letter of Compliance required complying with requirements of Building Code and design delegated to a Professional Engineer within technical specification Sections.
- .3 Delegated Design Submittals are not required for components of Work requiring engineering for temporary Work (i.e.: crane hoisting, engineered lifts, false Work, shoring, concrete formwork) that would normally form a part of Contractor's scope of Work.
- .4 The requirements of this section are in general conformance with recommended Practice Guidelines and Guideline to Professional Practice and Code of Ethics published by Professional Engineers Ontario (PEO), with regards to duties of specialty professionals appointed during construction period.
- .5 The requirements of this Section do not diminish responsibilities of Consultant's role as Registered Professional of Record; submittals will be used by Consultant to establish that Work is substantially performed in accordance with Building Code.

1.3 RELATED REQUIREMENTS

- .1 Technical Sections as indicated.
- .2 Divisions 21 through 28 - Coordinate with disciplines for items requiring delegated design submittals.
- .3 Coordinate additional items with disciplines for items requiring delegated design submittals.

1.4 DELEGATED DESIGN

- .1 Performance and Design Criteria: Provide products and systems complying with specific performance and design criteria indicated where professional design services or certifications by a design professional are specifically required of Contractor by Contract Documents.

- .2 If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Consultant.
- .3 Delegated design will be required for elements designed by a specialty professional, which may include:
 - .1 Elements normally fabricated off-site
 - .2 Elements that require specialized fabrication equipment or a proprietary fabrication process not usually available at job Site (i.e.: guardrails, handrails, open web steel joists, wood trusses, combination wood and metal or plywood joists, prefabricated wood or metal buildings, noise and vibration isolation devices, elevators).
 - .3 Elements requiring civil engineering, not normally a part of scope of services performed by architectural; structural; mechanical; electrical; or geotechnical disciplines of Consultant.

Part 2 Products

2.1 CERTIFICATE OF AUTHORIZATION

- .1 The PEO Certificate of Authorization allows individual professional engineers acting as independent contractors or companies to offer or provide professional engineering services directly to the public. Certificate of Authorization holders must stamp their work to indicate their responsibility for the services provided. For Professional Engineers acting as independent contractors or companies, Submit Certificate of Authorization at same time as submission of Letter of Commitment.

2.2 LETTER OF COMMITMENT

- .1 Submit a signed and sealed Letter of Commitment on company letterhead addressed to Consultant in accordance with format in Appendix A attached to the end of this Section prior to starting Work requiring design and seal of a professional engineer.

2.3 LETTER OF COMPLIANCE

- .1 Submit a signed and sealed Letter of Compliance on company letterhead addressed to Consultant in accordance with format in Appendix B attached to the end of this Section on completion of Work requiring design and seal of a professional engineer.

Part 3 Execution

3.1 IMPLEMENTATION

- .1 Include summary of Work described in technical specification Section as a part of the required Letter of Commitment.
- .2 Prepare required submittals and present to Consultant within sufficient time to allow for Consultant's detailed review and acceptance.

3.2 SUPPLEMENTS

- .1 The documents listed below, attached following "END OF SECTION", form part of this Specification Section:
 - .1 Appendix A – Letter of Commitment
 - .2 Appendix B - Letter of Compliance
 - .3 Section 01 35 22 100% DD LEED Scorecard

END OF SECTION

APPENDIX A

LETTER OF COMMITMENT

Submit a signed and sealed letter of commitment on company letterhead in the form as follows:

[Date]

[Consultant]

[Consultant's Address]

Attention: [Consultant's Registered Professional of Record]

Re: Letter of Commitment for Delegated Design of [System of Component of Work]
[Name of Project]
[Project Number]
[City, Province]

As the retained registered professional engineer for design and field review of the above named component of Work and project, I hereby give assurance I am qualified to perform the following Work as required by Contract Documents:

1. [List appropriate design services for System or Component of Work];
2. Preparation of shop and erection documents;
3. Review fabrication of [structural] [fire rated] [life and health safety] components;
4. Review erection of [structural] [fire rated] [life and health safety] components.
5. [Modify list to suit System of Component of Work.]

I hereby give assurance that I will be responsible for above noted Work as described in Project Manual, including requirements of addenda, change orders and change directives.

I also undertake to be responsible for field review of fabrication and erection of [structural] [fire rated] [life and health safety] components as required to ascertain substantial compliance with the Building Code and Contract Documents.

I will notify you in writing if my responsibility is terminated at any time during the course of Work covered by this Letter of Commitment.

Retained Professional Engineer

Signature

Date

(Apply seal)

APPENDIX B

LETTER OF COMPLIANCE

[Date]

[Consultant]

[Consultant's Address]

Attention: [Consultant's Registered Professional of Record]

Re: Letter of Compliance for Delegated Design of [System of Component of Work]
[Name of Project]
[Project Number]
[City, Province]

I hereby give assurance that I have fulfilled my obligations for field review as outlined by previously submitted Letter of Commitment.

I hereby give assurance that aspects of [structural] [life and health safety] Work as defined by previously submitted Letter of Commitment substantially comply with Contract Documents and Building Code.

Retained Professional Engineer

Signature

Date

(Apply seal)

York Region - North Roads Operation Centre - LEED NC v4 CHECKLIST

CURRENT TARGET = SILVER



C T P NP C - Completed; T - Targeted; P - Pending; NP - Not Pursued

0	1	0	0	Integrative Process	POSSIBLE POINTS: 1	RESPONSIBLE
	1		0	Integrative Process	1	

0	2	0	14	LT - Location and Transportation	POSSIBLE POINTS: 16	RESPONSIBLE
			16	LEED for Neighborhood Development Location	16	
	1		0	Sensitive Land Protection	1	Arch
			2	High Priority Site	2	
			5	Surrounding Density and Diverse Uses	5	
			5	Access to Quality Transit	5	
			1	Bicycle Facilities	1	
			1	Reduced Parking Footprint	1	
	1		0	LEED v4.1 Electric Vehicles	1	Arch/MCW

0	4	1	5	SS - SUSTAINABLE SITES	POSSIBLE POINTS: 10	RESPONSIBLE
				Required	Required	Civil/GC
	1		0	Site Assessment	1	
		1	1	Site Development - Protect or Restore Habitat	2	
			1	Open Space	1	
			3	LEED v4.1 Rainwater Management	3	
	2		0	Heat Island Reduction	2	
	1		0	Light Pollution Reduction	1	

0	7	2	2	WE - WATER EFFICIENCY	POSSIBLE POINTS: 11	RESPONSIBLE
				Required	Required	Landscape
				Required	Required	Mech/GC
				Required	Required	Mech/Owner
	2		0	Outdoor Water Use Reduction	2	Landscape
	4	2	0	Indoor Water Use Reduction	6	Mech/GC
			2	Cooling Tower Water Use	2	
	1		0	Water Metering	1	Mech/GC

0	20	5	8	EA - ENERGY & ATMOSPHERE	POSSIBLE POINTS: 33	RESPONSIBLE
				Required	Required	CxA
				Required	Required	Energy Modeller
				Required	Required	Mech/Owner
				Required	Required	Mech/GC
	4	2	0	Enhanced Commissioning	6	CxA
	12		6	Optimize Energy Performance	18	Energy Modeller
	1		0	Advanced Energy Metering	1	Mech
			2	Demand Response	2	
		3	0	Renewable Energy Production	3	
	1		0	Enhanced Refrigerant Management	1	Mech/GC
	2		0	Green Power and Carbon Offsets	2	

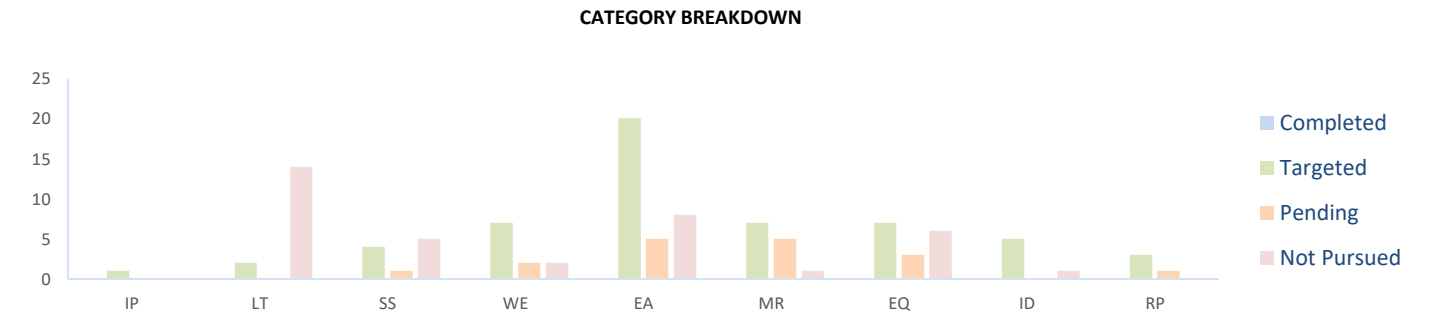
0	7	5	1	MR - Materials and Resources	POSSIBLE POINTS: 13	RESPONSIBLE
				Required	Required	Arch
				Required	Required	GC
	3	1	1	LEED v4.1 Building Life-Cycle Impact Reduction	5	
	1	1	0	LEED v4.1 BPDO - Environmental Product Declarations	2	GC
		2	0	LEED v4.1 BPDO - Sourcing of Raw Materials	2	
	1	1	0	LEED v4.1 BPDO - Material Ingredients	2	GC
	2		0	LEED v4.1 Construction and Demolition Waste Management	2	GC

0	7	3	6	EQ - INDOOR ENVIRONMENTAL QUALITY	POSSIBLE POINTS: 16	RESPONSIBLE
				Required	Required	Mech
				Required	Required	Owner
	2		0	Enhanced Indoor Air Quality Strategies	2	Mech
	1	2	0	LEED v4.1 Low-Emitting Materials	3	GC
	1		0	Construction Indoor Air Quality Management Plan	1	GC
	1	1	0	Indoor Air Quality Assessment	2	GC
	1		0	Thermal Comfort	1	Mech
	1		1	Interior Lighting	2	Electrical
			3	Daylight	3	
			1	Quality Views	1	
			1	Acoustic Performance	1	

0	5	0	1	ID - INNOVATION & DESIGN	POSSIBLE POINTS: 6	RESPONSIBLE
	1		0	Innovation in Design: Bird Collision Deterrence	1	MCW
	1		0	Innovation in Design: Reduced Mercury Lamps	1	GC/Owner
	1		0	Innovation in Design: Occupant Comfort Survey	1	Owner
			1	Innovation in Design: Heat Island Mitigation Cool Walls	1	
	1			Pilot Credit: Passive Survivability and Back-up Power During Disruptions	1	Arch/MCW
	1		0	IDc2 - LEED Accredited Professional	1	MCW

0	3	1	0	RP - REGIONAL PRIORITY	POSSIBLE POINTS: 4	RESPONSIBLE
	1		0	Regional Priority : Optimized Energy Performance (10 pts min)	1	MCW
	1		0	Regional Priority : Building Life Cycle Impact Reduction (3 pts min)	1	MCW
		1		Regional Priority: Heat Island Reduction (2 pts min)	1	
	1		0	Regional Priority: Indoor Water Use Reduction (4 pts min)	1	MCW

0	56	17	37	ESTIMATED POINT TOTALS (Certified: 40-49 Silver: 50-59 Gold: 60-79 Platinum: 80+)
56				CURRENT TARGET = SILVER



Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations, most current edition
 - .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Safety Data Sheets (SDS).
 - .3 Province of Ontario:
 - .1 Ontario Occupational Health and Safety Act and Regulations, most current edition

1.3 ACTIVE SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 Submittal Procedures.
- .2 Submit Site Specific Health and Safety Plan: Within 7 days after date of Notice to Commence the Work and prior to commencement of the Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in Work plan.
- .3 Submit 2 copies of Contractor's authorized representative's Work site health and safety inspection reports to Consultant and Authority Having Jurisdiction, weekly.
- .4 Submit copies of reports or directions issued by Federal and Provincial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit WHMIS SDS - Safety Data Sheets.
- .7 Consultant will review Contractor's Site Specific Health and Safety Plan and provide comments to Contractor within 7 days after receipt of plan. Revise plan as appropriate and resubmit plan to Consultant within 7 days after receipt of comments from Consultant.
- .8 Consultant's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Consultant.

- .10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.4 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.

1.5 SAFETY REQUIREMENTS

- .1 Contractor shall verify that emergency procedures including appropriate First Aid facilities and First Aid personnel are in place at the Work Site.
- .2 Contractor shall also have access to the Owner's First Aid Facilities. Conditions for use will be reviewed at the Project Start-up Meeting.
- .3 Contractor shall employ a full time, on-site Construction Safety Officer (CSO) who is responsible for the following:
 - .1 Providing new employee orientation
 - .2 Overseeing site activities
 - .3 Providing appropriate training on personal protective equipment and Workplace Hazardous Materials Information System (WHMIS)
 - .4 Conducting and documenting accident investigations as required
 - .5 Conducting daily Work site inspections
 - .6 Conducting weekly site safety meetings, train new employees and verifying that Subcontractors, Sub-Subcontractors, Suppliers and others working on the site are aware of safety requirements
 - .7 Requirement for a full time, on-site CSO may be waived where it can be shown that the site superintendent is certified and trained to act as the Safety Officer or the number of workers is below the requirement for a CSO.
 - .8 CSO shall be certified by a training program recognized by the Ontario Construction Safety Association.
- .4 Maintain on site sufficient quantities of PPE, including but not limited to: hard hats, safety glasses, hearing protection and other items of clothing or special equipment as necessary to verify that visitors to the site, the Consultant and the Owner's representative are adequately protected.
- .5 Provide training and instruction to occupants of adjacent buildings being added to or renovated, and forming a part of the Work of this Contract, about the dangers involved with entering the Work site prior to working on site:
 - .1 Provide educational materials, brochures or pamphlets as a part of the training session.
 - .2 Provide training sessions prior to the start of Work, to verify that knowledge of construction site hazards is reinforced and maintained.
- .6 Verify that all Contractor's employees, Subcontractors, Sub-Subcontractors, Suppliers and others working on the site, meet clothing requirements in accordance with all applicable occupational health and safety laws and requirements.

1.6 MEETINGS

- .1 Schedule and administer health and safety meeting with Consultant and Owner prior to commencement of Work.

1.7 REGULATORY REQUIREMENTS

- .1 Perform Work in accordance with Section 01 41 00 Regulatory Requirements.

1.8 GENERAL REQUIREMENTS

- .1 Develop written Site Specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address Project Specifications.
- .2 Consultant may respond in writing, where deficiencies or concerns are noted and may request resubmission with correction of deficiencies or concerns.

1.9 RESPONSIBILITY

- .1 Be responsible for health and safety of persons on Site, safety of property on Site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with Site-Specific Health and Safety Plan.

1.10 COMPLIANCE REQUIREMENTS

- .1 Comply with Ontario Occupational Health and Safety Act and Regulations.
- .2 York Region Health and Safety Guide for Construction Contractors

1.11 UNFORESEEN HAZARDS

- .1 When unforeseen or peculiar safety related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Authorities Having Jurisdiction and advise the Consultant verbally and in writing. Refer to 00 30 00 Information Documents listing applicable reports:
 - .1 Designated Substances and Hazardous Materials Survey dated November 2, 2020, prepared by ECOH Environmental Consulting Occupational Health

1.12 DESIGNATED SUBSTANCES SURVEY DATED JULY 12, 2024, PREPARED BY LEAP MANAGEMENT INC.CONSTRUCTOR

- .1 The Contractor shall, for the purposes of the *Occupational Health and Safety Act*, and for the duration of the Work of this Contract:
 - .1 Be the "Constructor " for the "Work Site", and
 - .2 Meet all requirements of the *Occupational Health and Safety Act* and Regulations, Workers Compensation Board legislation, the Fire Code legislation and all other applicable laws that govern Workplace safety.

- .3 The Contractor shall direct all Subcontractors, Sub-Subcontractors, Other Contractors, employees, Suppliers, workers and any other persons at the "Work Site" on safety related matters, to the extent required to fulfill its "Constructor" responsibilities pursuant to the Act, regardless of:
 - .1 Whether or not any contractual relationship exists between the Contractor and any of these entities, and
 - .2 Whether or not such entities have been specifically identified in this Contract.
- .4 Safety Certification: Safety certification is a condition of Contract award; Contractor is required to comply with GC 9.8 Certificate of Recognition (COR™) Safety Program for the duration of the Work of this Contract.

1.13 POSTING OF DOCUMENTS

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province having jurisdiction, and in consultation with Consultant.

1.14 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by Authority Having Jurisdiction or by Consultant.
- .2 Provide Consultant with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Consultant may stop Work if non-compliance of health and safety regulations is not corrected.

1.15 BLASTING

- .1 Blasting or other use of explosives is not permitted without prior receipt of written instruction by Authority Having Jurisdiction.

1.16 POWDER ACTUATED DEVICES

- .1 Use powder actuated devices only after receipt of written permission from Authority Having Jurisdiction.

1.17 WORK STOPPAGE

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Definitions:
 - .1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade environment aesthetically, culturally and/or historically.
 - .2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prior to commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review by Consultant Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.
- .3 Address topics at level of detail commensurate with environmental issue and required construction tasks.
- .4 Environmental protection plan, include:
 - .1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.
 - .2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
 - .3 Names and qualifications of persons responsible for training site personnel.
 - .4 Descriptions of environmental protection personnel training program.
 - .5 Erosion and sediment control plan as per LEED requirements.
 - .6 Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.
 - .7 Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plans include measures to minimize amount of mud transported onto paved public roads by vehicles or runoff.

- .8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use. Plan to include measures for marking limits of use areas including methods for protection of features to be preserved within authorized Work areas.
- .9 Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
- .10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.
- .11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off Project site.
- .12 Contaminant prevention plan that: identifies potentially hazardous substances to be used on job site; identifies intended actions to prevent introduction of such materials into air, water, or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
- .13 Wastewater management plan that identifies methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.

1.4 FIRES

- .1 Fires and burning of rubbish on site not permitted.

1.5 DISPOSAL OF WASTES

- .1 Strictly adhere to requirements of Section 01 74 19 - Construction Waste Management. Do not bury rubbish and waste materials on site unless approved by Consultant.
- .2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

1.6 DRAINAGE

- .1 Provide erosion and sediment control plan that identifies type and locations of erosion and sediment controls to be provided. Plan: include monitoring and reporting requirements to assure that control measure are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.
- .2 Storm Water Pollution Prevention Plan (SWPPP) to be substituted for erosion and sedimentations control plan.
- .3 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.
- .4 Do not pump water containing suspended materials into waterways or drainage systems. Migration to water retention pond is allowed.
- .5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

1.7 SITE CLEARING AND PLANT PROTECTION

- .1 Protect trees and plants on site and adjacent properties where indicated on Drawings and in Specifications.
- .2 Wrap in burlap, trees and shrubs adjacent to construction Work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of 2 m.
- .3 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.
- .4 Minimize stripping of topsoil and vegetation.
- .5 Restrict tree removal to areas indicated or designated by Consultant.

1.8 WORK ADJACENT TO WATERWAYS

- .1 Do not operate Construction Equipment in waterways.
- .2 Do not use waterway beds for borrow material.
- .3 Do not dump excavated fill, waste material or debris in waterways.
- .4 Design and construct temporary crossings to minimize erosion to waterways.
- .5 Do not skid logs or construction materials across waterways.
- .6 Avoid indicated spawning beds when constructing temporary crossings of waterways.
- .7 Do not blast under water or within 100 m of indicated spawning beds.

1.9 POLLUTION CONTROL

- .1 Maintain temporary erosion and pollution control features installed under this Contract.
- .2 Control emissions from equipment and plant to local authorities' emission requirements.
- .3 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area, by providing temporary enclosures.
- .4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

1.10 NOTIFICATION

- .1 Consultant will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.
- .2 Contractor: after receipt of such notice, inform Consultant of proposed corrective action and take such action for review by Consultant.
- .3 Consultant will issue stop order of work until satisfactory corrective action has been taken.
- .4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Related Requirements:

.1 Meet or exceed requirements of:

.1 Contract Documents.

.2 Specified standards, codes and referenced documents.

1.2 REFERENCES

.1 Reference Standards:

.1 Ontario Building Code 2024

.2 Canadian Standards Association (CSA Group):

.1 CSA B651:23, Accessible Design for the Built Environment
including amendments up to tender closing date and other codes
of provincial or local application. In case of conflict or discrepancy,
more stringent requirements apply.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 GENERAL REQUIRMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Canadian Construction Documents Committee (CCDC)
 - .1 CCDC 2 -2020, Stipulated Price Contract as amended in the Contract Documents.
- .2 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S1001-11, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems

1.3 INSPECTION/FIELD REVIEW

- .1 Refer to CCDC 2 -2020, Stipulated Price Contract, as amended in the Contract Documents.
- .2 Allow Consultant access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .3 Give minimum 8 Days prior notice requesting inspection if Work is designated for special tests, inspections or approvals by Contract Documents, Consultant's instructions, or law of Place of Work.
- .4 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .5 Consultant will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Owner shall pay cost of examination and replacement.

1.4 INDEPENDENT INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies will be engaged by the Consultant for purpose of inspecting and/or testing portions of Work. Cost of such services will be paid through Cash Allowance Item CA4.
- .2 Where individual sections specifically indicate that certain inspections, tests and other quality control services are the Owner's responsibility, the Owner will employ and pay a qualified independent inspection/testing agency to perform those services.
- .3 Contractor shall provide inspections, tests and other quality control services, specified in the Contract Documents or required by the Authorities Having Jurisdiction unless otherwise indicated in the Contract Documents as the responsibility of the Owner. Employ and pay for a qualified independent inspection/testing agency to perform quality control services.

- .4 Provide notification to the Owner 5 Business Days prior to requiring Owner employed inspections or tests. The Owner will arrange for the inspection or testing agency to complete quality control services as required by specification sections. Owner will provide prior notice of 2 Business Days to the Contractor of dates inspections and tests are to be completed.
- .5 The Owner shall provide the Contractor a list of Owner employed inspection and testing agencies. The Contractor will arrange inspections and testing directly with independent agencies as required to conform to the construction schedule. Contractor will provide prior notice of 2 Business Days to the Owner of dates inspections and tests are to be completed.
- .6 Provide equipment required for executing inspection and testing by appointed agencies.
- .7 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .8 If defects are revealed during inspection or testing, appointed agency will request additional inspection or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Consultant at no cost to Owner. Pay costs for retesting and reinspection.

1.5 ACCESS TO WORK

- .1 Allow inspection/testing agencies access to Work, off Site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

1.6 PROCEDURES

- .1 Notify appropriate agency in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples or materials required for testing, as specifically requested in Specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on Site. Provide sufficient space to store and cure test samples.

1.7 REJECTED WORK

- .1 Refer to CCDC 2 CCDC 2-2020, Stipulated Price Contract, as amended in the Contract Documents.
- .2 Remove defective Work, whether result of poor workmanship, use of defective Products or damage and whether incorporated in Work or not, which has been rejected by Consultant as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .3 Make good other Contractor's work damaged by such removals or replacements promptly.
- .4 If, in the Consultant's sole opinion, it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called

for by Contract Documents, amount of which will be determined by the Owner acting reasonably.

1.8 REPORTS

- .1 Submit electronic copies of inspection and test reports to Consultant.
- .2 Provide copies to Subcontractor of work being inspected or tested and manufacturer or fabricator of material being inspected or tested.

1.9 TESTS AND MIX DESIGNS

- .1 Furnish test results and mix designs as requested.
- .2 Cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work will be appraised by Consultant and may be authorized as recoverable.

1.10 MOCK-UPS

- .1 Prepare mock-ups for Work specifically requested in Specifications. Include for Work of Sections required to provide mock-ups.
- .2 Construct in locations acceptable to Consultant or as specified in specific Section.
- .3 Prepare mock-ups for Consultant's review with reasonable promptness and in orderly sequence, to not cause delays in Work.
- .4 Failure to prepare mock-ups in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .5 If requested, Consultant will assist in preparing schedule fixing dates for preparation.
- .6 Applicable Specification Sections identify whether mock-up may remain as part of Work or if it must be removed and when.

1.11 MILL TESTS

- .1 Submit mill test certificates as requested or required by applicable Specification Sections.

1.12 EQUIPMENT AND SYSTEMS

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.
- .2 Submit integrated systems testing reports and verification letter to confirm integrated systems testing for fire protection and life safety systems has been successfully completed in accordance with CAN/ULC-S1001.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 GENERAL

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 RELATED DOCUMENTS

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section. Coordinate work in this Section with Section 01 14 00 – Work Restrictions and Site Restrictions Plan.

1.3 SUMMARY

- .1 This Section includes requirements for temporary utilities, support facilities, and security and protection facilities for Project construction operations.
- .2 Contractor must maintain the existing garage's operation during construction.
- .3 Owners will have Contractors working on site in the 'Contractors trailers'. Relocation of the trailers to be coordinated with the owner and must be complete between April 30th and October 1st Contractors trailers to be fully operational in winter periods within the contract, October 1st- April 30th.
- .4 Access to be maintained to all on site buildings throughout construction. See Appendix H - Site Restrictions and Proposed Phasing Plan.
- .5 Staff are to be moved back in to building from temporary trailers upon substantial completion. Refer to Appendix E.
- .6 Contractor to provide temporary office trailers, temporary power, data, heating, cooling, and washroom facilities for staff as per the requirements outlined in section 2.2 – Equipment.
- .7 Existing garage and washbay to be fully operational during winter operations (from October 1 to April 30).
- .8 All work within the garage shall be coordinated with the Owner to maintain business continuity. No work to be planned in the garage area between October 1 to April 30.
- .9 Refer to Section 20 05 15 Mechanical Work in Existing Buildings and 26 05 14 Working in Existing Facility for mechanical and electrical systems operational requirements in the existing garage during construction.
- .10 Related Sections:
 - .1 Section 01 10 00 - Summary for work restrictions and limitations on utility interruptions.
 - .2 Section 01 74 21 - Construction Waste Management and Disposal for provision of on-site construction waste and recycling facilities.
 - .3 Section 32 12 16 - Asphalt Paving for construction and maintenance of asphalt pavement for temporary roads and paved areas.

1.4 DEFINITIONS

- .1 Permanent Enclosure: As determined by Consultant, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and

weathertight; and all openings are closed with permanent construction or substantial temporary closures.

1.5 USE CHARGES

- .1 General: Use charges for temporary construction facilities and services are not chargeable to the Owner or Contractor and shall be included in the Contract Sum for this Project. Allow other entities to use temporary services and facilities without cost, including, but not limited to, the following:
 - .1 Owner's construction forces.
 - .2 Occupants of Project.
 - .3 Consultant.
 - .4 Testing agencies.
 - .5 Personnel of authorities having jurisdiction.

1.6 SUBMITTALS

- .1 Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- .2 Temporary Utility Reports: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.
- .3 Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- .4 Implementation and Termination Schedule: Within fifteen (15) days of date established for submittal of Contractor's Construction Schedule, submit a schedule indicating implementation and termination of each temporary utility.
- .5 Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
 - .1 Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 - .2 Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 - .3 Indicate sequencing of work that requires water and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
- .6 Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
 - .1 Locations of dust-control partitions at each phase of work.
 - .2 HVAC system isolation schematic drawing.
 - .3 Location of proposed air-filtration system discharge.
 - .4 Waste handling procedures.

- .5 Other dust-control measures.

1.7 QUALITY ASSURANCE

- .1 Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.
- .2 Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- .3 Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- .4 Accessible Temporary Egress: For addition and renovation work that affects egress from occupied portions of the facility.

1.8 PROJECT CONDITIONS

- .1 Temporary Utilities: At earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of permanent service.
 - .1 Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.
 - .2 Coordinate with each utility company for providing and terminating temporary utilities required during the construction contract time. The Owner makes no claims and shall not be held responsible for when permanent utilities will be available to the project site other than as described in these specifications and no later than the date of Substantial Completion. If conditions occur which require the Owner's involvement (obtaining easements or right-of-way), notify the Consultant and the Owner in a timely manner to allow for the procedures required to allow the permanent power to be brought to the site.
- .2 Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
 - .1 Keep temporary services and facilities clean and neat.
 - .2 Relocate temporary services and facilities as required by progress of the Work.

Part 2 PRODUCTS

2.1 MATERIALS

- .1 General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Consultant. Provide materials suitable for use intended.
- .2 Lumber and Plywood: Comply with requirements in Section 06 10 00.
- .3 Tarpaulins: Fire-resistive labeled with flame-spread rating of 15 or less.
- .4 Water: Potable.

2.2 EQUIPMENT:

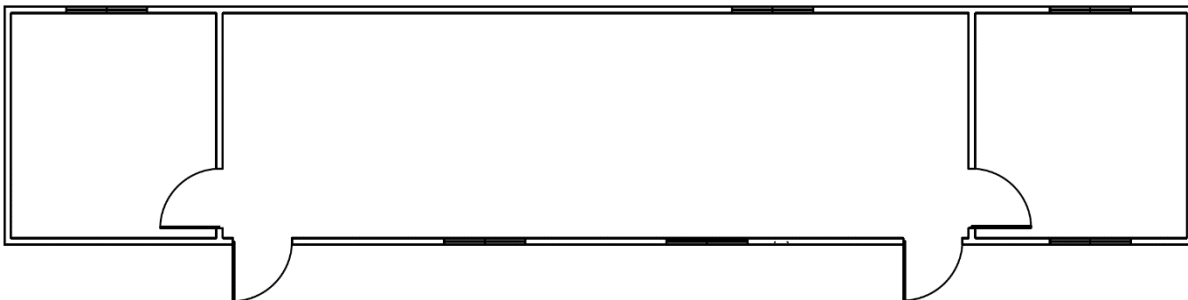
.1: Field Offices:

All office furniture to be supplied and installed by the Region.

All other items, as described below, to be provided by the Contractor.

Temporary mobile office to include Min. Qty of (3) three spaces separated by a solid partition, with doors leading into the main office space.

- (1) one room (min dimension to be 11'-0" Wx12'-0" D)
to be outfitted with (3) three metal shelving units (to be supplied and installed by the Region and / or an installer specified by the Region).
This room to be used as storage for outdoor clothing and gear and to be used as a temporary changing area for staff.
- (1) one room (min dimension to be 11'-0" Wx12'-0" D)
To be outfitted with a 42" square or circular lunchroom table and (4) four chairs, (2) mobile tables for small appliances and a mini fridge (to be supplied and installed by the Region and / or an installer specified by the Region).
This room to be used as private meeting space for confidential conversations, as well as a break room / lunch area for staff.
- (1) one room (min dimension to be 37'-0" Wx12'-0" D)
To be used as office/ admin space.
Will be outfitted with Teknion TOS panel system making up (8) eight benching style workstations

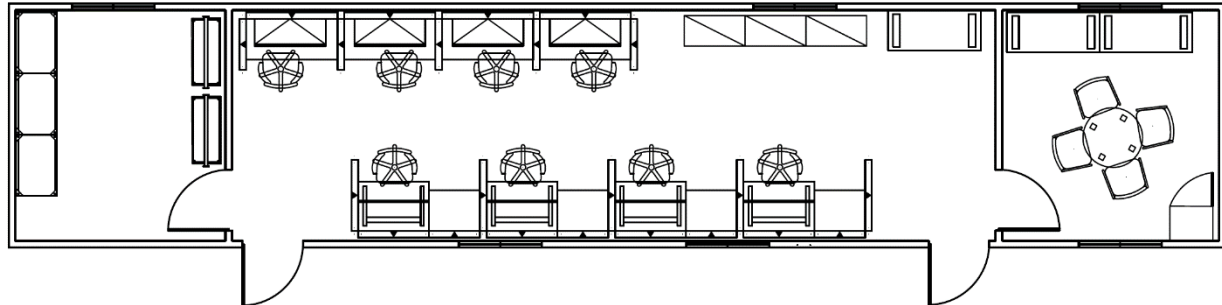


- Min. Qty of (3) three spaces separated by solid partitions
Room 1: to be 48" W x 12" D
- Room 2: to be 11'-0" Wx12'-0" D
- Room 3: to be 48" W x 12" D

.1 Number of Desks:

- Temporary mobile office to be outfitted with Region owned systems furniture.
- To be installed by the Region and / or an installer specified by the Region and certified to install Teknion TOS systems furniture.
- Office / Admin room to be outfitted with (8) eight benching style workstations complete with (8) eight task chairs:
 - (4) four workstations to be 72" W x 42" D
 - (4) four workstations to be 54" W 42" D

- Min of 4'-5" of space required as pathway between workstations.
- Min of 3'-0" space required beside exit door before furniture can be installed



.2: Power and Data Requirements:

Power

- Approx. (16) Sixteen Duplex power outlets required.
- One Duplex power outlet required for each workstation.
- Each station requires 8T wiring system using a 1,2,3 circuit.
- All workstations to be powered using plug in base feed. Plug from electrical harness in panels directly inserted into duplex outlet.
- Workstations can also be hardwired into outlet if required

wiring system/receptacles

	Wiring System			
	8T	8K	7T	7K
Regular Ground Receptacles	1, 2, 3	1, 2	1, 2	1, 2, A, B
Isolated Ground Receptacles	5	5, 6	n/a	n/a

wiring system/related circuit

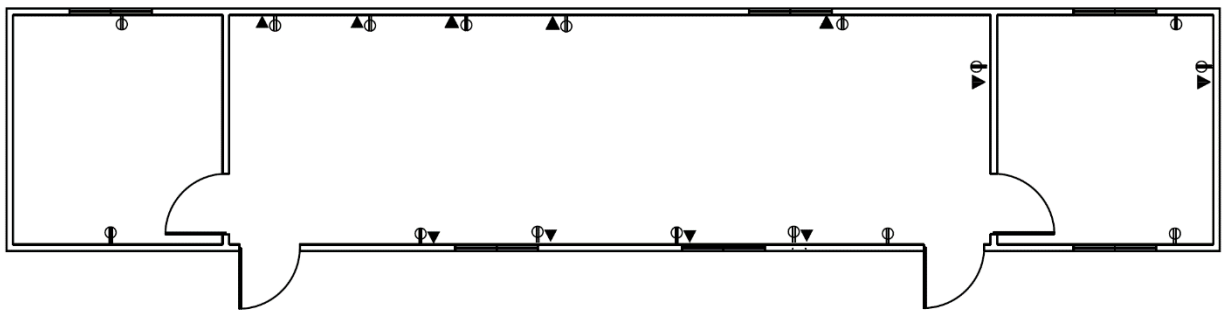
	Wiring System			
	8T	8K	7T	7K
Regular Circuit 1 Receptacle	✓	✓	✓	✓
Regular Circuit 2 Receptacle	✓	✓	✓	✓
Regular Circuit 3 Receptacle	✓		✓	
Isolated Circuit 5 IG Receptacle	✓	✓		
Isolated Circuit 6 IG Receptacle		✓		
Regular Circuit A Receptacle			✓	✓
Regular Circuit B Receptacle				✓

✓ Applicable

- one additional Duplex power outlet required for desktop Printer
- (6) six additional Duplex power outlet required as convenience outlets for vacuuming, charging
- Phones, tablets, and other equipment

Data

- Approx. (10) ten Data /ethernet ports required.
- One Data /ethernet port required for each workstation
- One Additional data port required for convenience
- Surge protectors to be provided by the contractor
- Contractor to provide a wall mounted 5RU shelf inside trailed to house temporary distribution equipment in the trailer



.3: Lighting Specifications:

Windows

- Temporary mobile office to be outfitted with Min of (5) five large windows to be placed as follows:
- Min (1) one window in storage and change room (Room 1)
- Min (3) three windows in Main office / admin area Room (2)
- Min (1) one window in Meeting/ break room (Room 3)

Lighting

- Recommend installing one recessed light for every 4-5 square feet in a room.
- Room 1: storage and change room requires approx. 1,000-2,000 lumens, approx. (2-4) LED recessed lights
- Room 2: Main office / admin requires approx. 3,600 and 7,200 lumens approx. (10-12) LED recessed lights
- Room 3: Meeting/ break room requires approx. 1,000-2,000 lumens, approx. (2-4) LED recessed lights

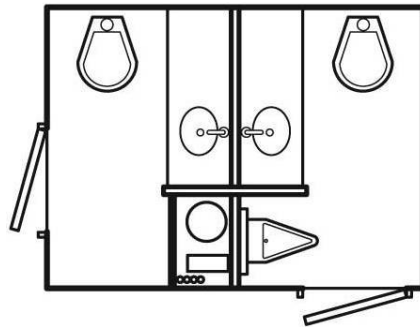
*Please note: Final placement of supervisor desks to be determined by the mobile trailer that is delivered to site – Door, window and electrical outlet placement will determine the final layout. It is noted that supervisors should be placed near windows as they need to be able to view gate at all times.

.4: Portable Washroom

- Washroom must have a minimum of (2) two Toilets c/w sink
- Washroom must include lighting, ventilation, HVAC – heating and cooling
- Must 1:1 ratio of sink to toilet stall

- Must have running water
- Regular service and cleaning to be included
- Must include off-site waste disposal
- Soap and water and/or anti-bacterial hand cleansers,
- Individual hand towels, air blowers or clean individual sections of continuous toweling,
- Trash cans for disposal of hand towels and feminine hygiene products.

*Please note that there are no on-site water or waste facilities available



.5: Temperature Control:

- The temporary mobile office and washroom must be equipped with climate control features, including heating for the winter months and cooling for the summer months, to ensure a comfortable working environment year-round in all parts/ rooms in the trailer
- Heating Equipment: Unless Owner authorizes use of permanent heating system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
- Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
- Heating Units: Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use for type of fuel being consumed

.6. Storage Solutions:

- Temporary mobile office to be outfitted with Region owned systems furniture and storage units.
- To be installed by the Region and / or an installer specified by the Region and certified to install Teknion TOS systems furniture.

.7. Safety and Security:

- The temporary mobile office and washrooms shall be in accordance with the Ontario Building Code requirements
Ensure that the condition of the temporary mobile office unit and the temporary washroom unit is exemplary and free from any signs of wear or damage.
- Should the client express dissatisfaction with the condition of either unit upon delivery, it is the contractor's obligation to replace the unit to fulfill the client's requirements for satisfaction.
- Temporary mobile office to be outfitted with the following:
 - First aid kit

- Mobile eye-wash station
- Fire extinguishing : Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.
 - Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.
- Health and safety Board: to be posted in a conspicuous place and kept posted while work is being completed
 - Board must include the constructor's name and if the constructor carries on business in a different name, the business name;
 - Must include the address and telephone number of the constructor's head office or principal place of business in Ontario; and
 - Must include the address and telephone number of the nearest office of the Ministry
 - Must include the address and telephone number of nearest hospital
- PPE Mandatory: A worker shall wear such protective clothing and use such personal protective equipment or devices as are necessary to protect the worker against the hazards to which the worker may be exposed

.8. Accessibility:

- Trailer must include stairs and a landing platform
- Stairs shall be securely fastened and supported wooden handrail on the open sides of each flight, and a guardrail on the open side of each landing.
- Stairs and landings shall be designed, constructed and maintained to support a live load of 4.8 kilonewtons per square meter without exceeding the allowable unit stresses for each material used.
- Ramps should be available if required at any time

.9: Drinking-Water Fixtures:

Provide drinking-water fountains or containerized, tap-dispenser, bottled-water drinking-water units, including paper cup supply.

Part 3 EXECUTION

3.1 INSTALLATION, GENERAL

- .1 Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- .2 Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities

3.2 TEMPORARY UTILITY INSTALLATION

- .1 General: Engage appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.
 - .1 Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
 - .2 Provide adequate capacity at each stage of construction. Before temporary utility is available, provide trucked-in services.
 - .3 Obtain easements to bring temporary utilities to the Project site where Owner's easements cannot be used for that purpose.
- .2 Sewers and Drainage: If sewers are available, provide temporary connections to remove effluent that can be discharged lawfully. If sewers are not available or cannot be used, provide drainage ditches, dry wells, stabilization ponds, and similar facilities. If neither sewers nor drainage facilities can be lawfully used for discharge of effluent, provide containers to remove and dispose of effluent off-site in a lawful manner.
 - .1 Filter out excessive soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
 - .2 Connect temporary sewers to municipal system as directed by sewer department officials.
 - .3 Maintain temporary sewers and drainage facilities in a clean, sanitary condition. After heavy use, restore normal conditions promptly.
- .3 Water Service: Install water service and distribution piping in sizes and pressures adequate for construction until permanent water service is in use. Sterilize temporary water piping before use.
 - .1 Provide rubber hoses as necessary to serve the Project site.
 - .2 As soon as water is required at each level, extend service to form a temporary water- and fire-protection standpipe. Provide distribution piping. Space outlets so water can be reached with a 100-foot (30-m) hose. Provide one hose at each outlet.
 - .3 Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
 - .4 If water pressure is inadequate, provide pumps to supply a minimum static pressure suitable for construction needs. Provide pumps to supply a minimum of static pressure at highest point. Equip pumps with surge and storage tanks and automatic controls to supply water uniformly at reasonable pressures.
- .4 Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.
 - .1 Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for the facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.

- .2 Toilets: Install self-contained toilet units. Shield toilets to ensure privacy. Provide separate facilities for male and female personnel.
- .3 Drinking-Water: Provide bottled-water, drinking-water units or drinking water fountains connected to permanent or temporary potable water source.
- .5 Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed.
 - .1 Maintain a minimum temperature of 50 deg F in permanently enclosed portions of building for normal construction activities, and 65 deg F for finishing activities and areas where finished Work has been installed.
 - .2 Provide measures and equipment to meet warranty requirements of interior woodwork and casework.
- .6 Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
 - .1 Provide measures and equipment to meet warranty requirements of interior woodwork and casework.
- .7 Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnecting means, automatic ground-fault interrupters, and main distribution switchgear.
 - .1 Install electric power service underground, unless overhead service must be used.
 - .2 Install power distribution wiring overhead and rise vertically where least exposed to damage.
- .8 Electric Distribution: Provide data lines to temporary trailers as required, in advance of relocating staff. Provide receptacle outlets adequate for connection of power tools and equipment.
 - .1 Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
- .9 Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions.
 - .1 Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 - .2 Install exterior-yard site lighting that will provide adequate illumination for construction operations, traffic conditions, and signage visibility when the Work is being performed.

3.3 SUPPORT FACILITIES INSTALLATION

- .1 General: Comply with the following:
 - .1 Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
 - .2 Provide non-combustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
 - .3 Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- .2 Temporary Roads and Areas: Construct and maintain temporary roads and areas adequate to support loads and to withstand exposure to traffic during construction period. Locate temporary roads and areas as indicated on Drawings. Maintain temporary roads for duration of construction period. Do not construct or utilize permanent roads for construction without written permission of Owner.
- .3 Dewatering Facilities and Drains: Comply with requirements in applicable Division 31 for temporary drainage and dewatering facilities and operations not directly associated with construction activities included in individual Sections. Where feasible, use same facilities. Maintain the Project site, excavations, and construction free of water.
 - .1 Dispose of rainwater in a lawful manner that will not result in flooding the Project or adjoining property nor endanger permanent Work or temporary facilities.
 - .2 Before connection and operation of permanent drainage piping system, provide temporary drainage where roofing or similar waterproof deck construction is completed.
 - .3 Remove snow and ice as required to minimize accumulations.
- .4 Construction Waste Disposal and Recycling Facilities: Comply with the requirements specified in Section 01 74 19 - Construction Waste Management and Disposal. Open burning of construction waste is not permitted on the Project Site.
- .5 Common-Use Field Offices: Provide an insulated, weathertight, air-conditioned field office for use as a common facility by all personnel engaged in construction activities; of sufficient size to accommodate required office personnel and meetings of persons at the Project site. Keep offices clean and orderly.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- .1 Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near the Project site.

- .2 Stormwater Control: Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of stormwater from heavy rains. Finish grading must produce surface drainage adequate to prevent standing water or wet areas, and to ensure that all storm water flows to inlets or other points of discharge.
- .3 Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights.
- .4 Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
- .5 Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
- .6 Vertical Openings: Close openings of 25 sq. ft. or less with plywood or similar materials.
- .7 Horizontal Openings: Close openings in floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
- .8 Install tarpaulins securely using fire-retardant-treated wood framing and other materials.
- .9 Where temporary wood or plywood enclosure exceeds 100 sq. ft. in area, use fire-retardant-treated material for framing and main sheathing.
- .10 Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
 - .1 Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above.
 - .1 Other Locations: Class ABC dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for exposures.
 - .2 Locate fire extinguishers where convenient and effective for their intended purpose; provide not less than one extinguisher on each floor at or near each usable stairwell.
 - .2 Store combustible materials in containers in fire-safe locations.
 - .3 Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for firefighting. Exterior access routes shall be in accordance with International Fire Code, Section 315.0. Prohibit smoking in hazardous fire-exposure areas.
 - .4 Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

- .5 Permanent Fire Protection: At earliest feasible date in each area of the Project, complete installation of permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.
- .6 Develop and supervise an overall fire-prevention and first-aid fire-protection program for personnel at the Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
- .7 Provide hoses for fire protection of sufficient length to reach construction areas. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 OPERATION, TERMINATION, AND REMOVAL

- .1 Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- .2 Maintenance: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements.
- .3 Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- .4 Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- .5 Temporary Facility Changeover: Except for using permanent fire protections as soon as available, do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- .6 Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - .1 Materials and facilities that constitute temporary facilities are the property of Contractor. Owner reserves right to take possession of Project identification signs.
 - .2 Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
- .7 At Project Substantial Performance, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements in Section 01 77 00 - Closeout Procedures.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C), Interior Design + Construction (ID+C).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 LEED Submittals: provide LEED submittals in accordance with Section 01 33 01 – LEED V4 Submittal List.

1.4 INSTALLATION AND REMOVAL

- .1 Provide temporary utilities controls in order to execute Work expeditiously.
- .2 Remove from site all such Work after use.

1.5 DEWATERING

- .1 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.
- .2 Refer to Section 00 30 00 – Information Documents “Construction Dewatering Assessment dated November 21, 2024, prepared by Hydrogeology Consulting Services” for dewatering rates and construction dewatering monitoring program. Provide test results as required by the Consultant.

1.6 WATER SUPPLY

- .1 Provide continuous supply of potable water for construction use.
- .2 Arrange for connection with appropriate utility company and pay costs for installation, maintenance and removal.
- .3 Pay for utility charges at prevailing rates.

1.7 TEMPORARY HEATING AND VENTILATION

- .1 Refer to Section 01 81 19 - Indoor Air Quality and follow requirements for implementation of Indoor Air Quality Management Plan.
- .2 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
- .3 Construction heaters used inside building must be vented to outside or be flameless type. Solid fuel salamanders are not permitted.
- .4 Provide temporary heat and ventilation in enclosed areas as required to:
 - .1 Facilitate progress of Work.

- .2 Protect Work and Products against dampness and cold.
- .3 Prevent moisture condensation on surfaces.
- .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
- .5 Provide adequate ventilation to meet health regulations for safe working environment.
- .5 Maintain temperatures of minimum 10 degrees Celsius in areas where construction is in progress.
- .6 Ventilating:
 - .1 Meet requirements of Section 01 81 19 - Indoor Air Quality.
 - .2 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
 - .3 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
 - .4 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
 - .5 Ventilate storage spaces containing hazardous or volatile materials.
 - .6 Ventilate temporary sanitary facilities.
 - .7 Continue operation of ventilation and exhaust system for time after cessation of Work process to ensure removal of harmful contaminants.
- .7 Permanent heating system of building, to be used when available. Be responsible for damage to heating system if use is permitted.
- .8 On completion of Work for which permanent heating system is used, replace filters, replace bearing, and thoroughly clean permanent equipment used during construction.
- .9 Ensure Date of Substantial Performance and Warranties for heating system do not commence until entire system is in as near original condition as possible and is certified by Consultant.
- .10 Pay costs for maintaining temporary heat, when using permanent heating system.
- .11 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
 - .1 Meet requirements of Section 01 81 19 - Indoor Air Quality.
 - .2 Conform with applicable codes and standards.
 - .3 Enforce safe practices.
 - .4 Prevent abuse of services.
 - .5 Prevent damage to finishes.
 - .6 Vent direct-fired combustion units to outside.
- .12 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.8 TEMPORARY POWER AND LIGHT

- .1 Provide and pay for temporary power during construction for temporary lighting and operating of power tools.
- .2 Arrange for connection with appropriate utility company. Pay costs for installation, maintenance and removal.
- .3 Provide and maintain temporary lighting throughout Project. Ensure level of illumination on all floors and stairs is not less than 162 lx.
- .4 Electrical power and lighting systems installed under this Contract may be used for construction requirements only with prior approval of Consultant provided that guarantees are not affected. Make good damage to electrical system caused by use under this Contract. Replace lamps which have been used for more than 3 months.

1.9 TEMPORARY COMMUNICATION FACILITIES

- .1 Provide and pay for temporary telephone and data (Wi-Fi) hook up, lines and equipment necessary for own use.

1.10 FIRE PROTECTION

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.
- .2 Burning rubbish and construction waste materials is not permitted on Site.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Canadian Construction Documents Committee (CCDC)
 - .1 CCDC 2-2020, Stipulated Price Contract as amended in the Contract Documents.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete, Includes Updates through No. 3 August 2006.
 - .2 CSA-O121-17), Douglas Fir Plywood.
 - .3 CAN/CSA-S269.2-16, Access Scaffolding for Construction Purposes.
 - .4 CAN/CSA-Z321-96 (R2006) - Signs and Symbols for the Workplace
- .3 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 2017 U.S. EPA Construction General Permit.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.4 INSTALLATION AND REMOVAL

- .1 Prepare site staging plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation, trailer location, material storage, material delivery and pick up, garbage disposal as well as in-house and Contractor parking.
- .2 Identify areas which have to be gravelled to prevent tracking of mud.
- .3 Indicate use of supplemental or other staging area.
- .4 Provide construction facilities in order to execute work expeditiously.
- .5 Remove from Site all such work after use.

1.5 SCAFFOLDING

- .1 Scaffolding in accordance with CAN/CSA-S269.2.
- .2 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms and temporary stairs.

1.6 HOISTING

- .1 Provide, operate and maintain hoists cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.

- .2 Hoists cranes to be operated by qualified operator.

1.7 SITE STORAGE/LOADING

- .1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.
- .2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

1.8 CONSTRUCTION PARKING

- .1 Parking will not be permitted on Site.
- .2 Provide and maintain adequate access to project Site.

1.9 SECURITY

- .1 Provide fencing and additional security as deemed necessary by Contractor.

1.10 OFFICES

- .1 Provide office heated to 22 degrees C, lighted 750 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table.
- .2 Provide marked and fully stocked first-aid case in a readily available location.
- .3 Subcontractors to provide their own offices as necessary. Direct location of these offices as directed by Owner.

1.11 EQUIPMENT, TOOL AND MATERIALS STORAGE

- .1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on Site in manner to cause least interference with work activities.

1.12 SANITARY FACILITIES

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Provide separate facilities for staff through as indicated in Section 01 50 00 – Temporary Facilities and Controls.
- .3 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.13 CONSTRUCTION SIGNAGE

- .1 Provide and erect project sign, prior to the start of construction, in a location designated by the Consultant and approved by the Owner. Signage design shall be provided by the Consultant.
- .2 No other signs or advertisements, other than warning signs, are permitted on Site.

- .3 Locate project identification sign as directed by Consultant and construct as follows:
 - .1 Build concrete foundation, erect framework, and attach signboard to framing.
 - .2 Paint surfaces of signboard and framing with one coat primer and two coats enamel. Colour white on signboard face, black on other surfaces.
 - .3 Apply vinyl sign face overlay to painted signboard face in accordance with installation instruction supplied.
- .4 Maintain approved signs and notices in good condition for duration of the Contract, and dispose of off site upon Total Performance of the Contract or earlier if directed by the Consultant.

1.14 PROTECTION AND MAINTENANCE OF TRAFFIC

- .1 Provide access as necessary to maintain traffic. Refer to Supplementary Conditions and no standing vehicles can block York Regional Police egress and access to Baseline Road.
- .2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Consultant.
- .3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs
- .4 Protect travelling public, York Region Staff and Regional contractors from damage to person and property.
- .5 Contractor's traffic on roads selected for hauling material to and from Site to interfere as little as possible with public traffic.
- .6 Verify adequacy of existing roads and allowable load limit on these roads. Contractor is responsible for repair of damage to roads caused by construction operations.
- .7 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.
- .8 Dust control: adequate to ensure safe operation at all times.
- .9 Location, grade, width, and alignment of construction and hauling roads: subject to approval by Consultant.
- .10 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.
- .11 Provide snow removal during period of Work.
- .12 Remove, upon completion of work, haul roads designated by Consultant.

1.15 CLEAN-UP

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways at intervals appropriate to keep roads and driveway free from dust and debris.

- .3 Store materials resulting from demolition activities that are salvageable.
- .4 Stack stored new or salvaged material not in construction facilities.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of Authorities Having Jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-O121-17 Douglas Fir Plywood.

1.3 INSTALLATION AND REMOVAL

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from Site all such work after use.

1.4 HOARDING

- .1 Erect temporary Site enclosure using purpose made, prefabricated interlocking metal fence panels 2.1 m high.
- .2 Provide one lockable truck entrance gate and at least one pedestrian door as directed and conforming to applicable traffic restrictions on adjacent streets. Equip gates with locks and keys.
- .3 Erect and maintain pedestrian walkways including roof and side covers, complete with signs and electrical lighting as required by Authorities Having Jurisdiction.
- .4 Provide barriers around trees and plants designated to remain. Protect from damage by equipment and construction procedures.

1.5 GUARD RAILS AND BARRICADES

- .1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs.
- .2 Provide as required by governing authorities.

1.6 WEATHER ENCLOSURES

- .1 Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
- .2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.
- .3 Design enclosures to withstand wind pressure and snow loading.

1.7 DUST TIGHT SCREENS

- .1 Provide dust tight screens or insulated partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.
- .2 Maintain and relocate protection until such work is complete.

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1.8 ACCESS TO SITE

- .1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.

1.9 PUBLIC TRAFFIC FLOW

- .1 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect public.

1.10 FIRE ROUTES

- .1 Maintain access to property including overhead clearances for use by emergency response vehicles.

1.11 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY

- .1 Protect surrounding private and public property from damage during performance of Work.
- .2 Be responsible for damage incurred.

1.12 PROTECTION OF BUILDING FINISHES

- .1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.
- .2 Provide necessary screens, covers, and hoardings.
- .3 Confirm with Consultant locations and installation schedule 3 days prior to installation.
- .4 Be responsible for damage incurred due to lack of or improper protection.

1.13 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

PART 1– GENERAL

1.1 GENERAL REQUIREMENTS.

- .1 Comply with Division 1 requirements and documents referred to herein.

1.2 RELATED SECTIONS

- .1 Section 01 81 13 General LEED® Requirements.

1.3 REFERENCES

- .1 LEED® v4 Reference Guide for Green Building Design and Construction (LEED® USGBC BD&C 2013), United States Building Council
- .2 LEED® Online v4 BD+C USGBC Forms
- .3 U.S. Environmental Protection Agency (EPA) Construction General Permit, 2012

1.4 DEFINITIONS

- .1 Temporary erosion controls shall include, but shall not be limited to: sodding, mulching, watering, coir blankets, seeding, reseeding, berms, interceptor ditches, and/or other best management practices (BMPs) which will ensure that erosion during construction will be either eliminated or minimized.
- .2 Temporary sedimentation controls shall include, but shall not be limited to: silt fences, Silt Soxx, sediment traps, barriers, and/or other BMPs to control soil erosion.

1.5 DESCRIPTION OF WORK

- .1 Prevent the loss of soil from the construction site resulting from storm water runoff, wind erosion, and construction activities. This includes protecting topsoil by stockpiling for reuse.
- .2 Prevent sedimentation of receiving storm sewer and roadway
- .3 Prevent air pollution caused by dust and particulate matter.
- .4 Meet and/or exceed the requirements of LEED® v4 BD&C Sustainable Sites Prerequisite: Construction Activity and Pollution Prevention, which specifies compliance with EPA Construction General Permit 2012, OR local erosion and sedimentation control standards and codes, whichever is more stringent.

1.6 QUALITY ASSURANCE

- .1 Provide erosion control methods in accordance with LEED® v4 BD&C Sustainable Sites Prerequisite 1: Construction Activity and Pollution Prevention and/or requirements of authorities having jurisdiction. The Contractor shall comply with all applicable rules and regulations in terms of both installation and maintenance during construction.
- .2 The site superintendent (or other individual designated by the Contractor) shall be responsible for all aspects of LEED® coordination related to erosion and sedimentation control. This individual will be responsible for:

- .1 Implementing erosion and sedimentation control measures shown on the drawings and described in the Erosion and Sedimentation Control Plan and this section in accordance with manufacturer instructions and the prescribed installation procedures in the referenced EPA document and herein. Control measures shall be updated and managed in accordance with the work on site. No additional charges will be permitted for additional measures required to manage the sequencing and methods of the work.
- .2 Conducting erosion and sedimentation control measure inspections and making necessary repairs
- .3 Maintaining an erosion and sedimentation control inspection log to document observations, deficiencies and corrective actions. This includes taking photographs.
- .4 Preparing erosion and sedimentation control documentation and submittals required for LEED® certification as detailed herein.
- .5 Reporting erosion and sedimentation control progress to the Consultant.
- .6 Participating in the LEED® Kick-Off meeting as described in Section 01 81 13 General LEED® Requirements.

1.7 SUBMITTALS

- .1 Erosion and Sedimentation Control Plan aligning with LEED v4 BD&C Sustainable Sites Prerequisite 1: Construction Activity and Pollution Prevention. Refer to LEED Consultant to confirm Plan's compliance.
- .2 Submit the following in accordance with conditions of contract and general conditions sections:
 - .1 Product data for silt barriers and netting.
 - .2 The Contractor has the option to submit additional control measures in the form of shop drawings.
- .3 ESC Inspection Log (to be completed by the Contractor)
 - .1 Inspections of the installed erosion and sediment control measures shall be carried out on a weekly basis or following any storm event greater than 10mm of precipitation. These inspections will be recorded and compiled in a summary log.
 - .2 Submit completed ESC Inspection Logs to the Consultant on a monthly basis as part of the ongoing Monthly LEED® Reports required in Section 01 81 13 – General LEED Requirements.
 - .3 Inspection log shall contain the following as a minimum:
 - .1 General Project Information
 - .2 Individual responsible for inspections
 - .3 Date of each inspection
 - .4 Weather conditions
 - .5 Deficiencies observed
 - .6 Corrective actions taken to restore deficiencies, date these repairs were completed and photographs of damaged and repaired areas/control measures
 - .7 Signature of party responsible for inspection and corrective actions/repairs

-
- .4 Digital Date-Stamped Photographs of installed sediment and erosion control measures
 - .1 Each erosion and sediment control measure shall be photographed by the Contractor:
 - .1 Immediately after installation
 - .2 Each week and following a significant storm event
 - .3 If damage is discovered and following repair of said damage
 - .2 These photographs will be submitted to the Consultant monthly with an annotation describing each photograph as part of the ongoing Monthly LEED® Reports required in Section 01 81 13. – General LEED Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

- .1 Erosion control devices as shown on the plans are the minimum required based upon the finished grades for the site. The Contractor is responsible to provide additional devices for erosion protection at the Contractor's expense to minimize erosion during all phases of activity.
- .2 The Contractor shall maintain temporary construction entrances and remove all mud and debris from public roads on a daily basis, or more often if needed.
- .3 Erosion and sedimentation control measures shall be maintained and inspected until the next phase of building construction commences.

PART 4 SUPPLEMENTS

- 1. The document listed below, attached following "END OF SECTION", forms part of this Specification Section:
 - 1. ESC Report Review Checklist

END OF SECTION

ESC: REPORT REVIEW CHECKLIST

Project Name:		Completed By:	
Project Location:		Weather Conditions:	

Observations	
Deficiencies Noted	
Correction Actions Taken	
Date of Completion	

ESC Measure	Date:		
	Yes	No	Comments
Are photos taken?	<input type="checkbox"/>	<input type="checkbox"/>	
Are entrances installed according to the approved plans, and best practices? (Check for material/ debris on street, run off diversion)	<input type="checkbox"/>	<input type="checkbox"/>	
Are basins installed according to the approved plans, and best practices? (Check for runoff directed to basin, down slope areas stabilized riser pipe wrapped with wire fence/filter, fabric, emergency overflow, accumulated sediment more than 40% of volume, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	
Are silt fences installed according to the approved plans, and best practices? (Check for fabrics trenched in, follow contour, turned up slope at ends, silt accumulated, broken stakes, areas where sediment could leave the site.)	<input type="checkbox"/>	<input type="checkbox"/>	
Are all inlet protection measures installed according to plans? (Check for runoff ponding, in good shape, silt accumulated, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	
Are all disturbed areas that will lay dormant for 21 days or more stabilized with seed, sod, or mulch? (Stockpile, hillsides, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	
Are all stabilized areas in good condition and not eroding?	<input type="checkbox"/>	<input type="checkbox"/>	
Have all areas that have achieved final grade within the past 7 days been stabilized?	<input type="checkbox"/>	<input type="checkbox"/>	
Is there evidence of material leaving the site in the form of dust? (Required action: apply water and calcium chloride to gravel roads.)	<input type="checkbox"/>	<input type="checkbox"/>	
Have the appropriate retaining walls indicated on grading plans been constructed to stabilize soil on steep slopes?	<input type="checkbox"/>	<input type="checkbox"/>	
Additional Comments:			

I hereby certify that the information provided above is complete and correct:

Signature of Authorized Official

Position

Date

PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Comply with Division 1 requirements and documents referred to herein.

1.2 SUMMARY

- .1 Provide LEED® product requirements including but not limited to following:
 - .1 Minimize ecological footprint of the building by specifically selecting materials that conserve raw and non-renewable resources.
 - .2 Minimize amount of energy expended in transportation of materials to Site through intentional sourcing of regional materials.
 - .3 To document for the purpose of LEED® Certification under the United States Building Council LEED®- v4.1 Building Design and Construction.
 - .4 Source and select materials that meet sustainability criteria detailed herein.
 - .5 Provide documentation to Consultant as detailed within this Section to certify materials meet criteria prior to ordering of Products or materials.

1.3 RELATED SECTIONS

- .1 Section 01 81 13 General LEED® Requirements
- .2 Division 03, Concrete
- .3 Division 04, Masonry
- .4 Division 05, Metals
- .5 Division 06, Wood, Plastics, and Composites
- .6 Division 07, Thermal and Moisture Protection
- .7 Division 08, Openings
- .8 Division 09, Finishes
- .9 Division 10, Specialties
- .10 Division 31, Earthwork
- .11 Division 32, Exterior Improvements

1.4 REFERENCES

- .1 LEED® v4.1 Reference Guide for Green Building Design and Construction, Canada Green Building Council (CaGBC).

1.5 DEFINITIONS

- .1 Recycled Content: is percentage by weight of recycled material that is in a product or material brought onto site.
- .2 Post-Consumer Recycled Content: amount by weight of recycled material derived from previously used consumer products (e.g., aluminum and steel cans, glass and plastic bottles, asphalt from parking lots, gypsum from drywall etc.).

- .3 Pre-Consumer Recycled Content: amount by weight of recycled material derived from outside industrial sources (i.e., in-house process recycling of production scrap is not included). Some examples of this are: sawmill dust used in MDF board, blast furnace slag used in mineral wool insulation, and coal fly ash used in concrete mixes.
- .4 In-House Process Recycled Content: trimmings, cut-offs and scrap returned to the production process as a part of internal housekeeping.
- .5 Manufacturing Location: is last point of processing or assembly (e.g., A sawmill that turns harvested trees into framing lumber which is then used on-site).
- .6 Extraction Location: is origin of material inputs that are transported to Manufacturing Location (e.g. location of forests where trees for framing lumber were harvested from).
- .7 Rapidly Renewable Materials: Agriculture products, both fiber and animal, that take 10 years or less to grow or raise and can be harvested in a sustainable fashion.
- .8 Environmental Product Declaration (EPD): a statement that the product meets the environmental requirements of ISO 14021-1999 and ISO 14044-2006.
- .9 Life Cycle Assessment (LCA): an evaluation of a product that studies the environmental impacts from cradle to grave, as defined by ISO 14040-2006 and ISO 14044-2006.
- .10 Health Product Declaration (HPD): a statement that provides full disclosure of the potential chemicals of concern in products.
- .11 Corporate Social Responsibility (CSR): voluntary activities undertaken by a company to operate in an economically, socially, and environmentally sustainable manner.
- .12 Low-Carbon Concrete: concrete which, when compared with conventional concrete materials, performs well in a series of six climate parameters that LEED requires to be measured in LCA work.

1.6 DESCRIPTION OF WORK

- .1 Site superintendent (or other individual designated by Contractor) is responsible for coordinating activities associated with LEED® Product requirements.
- .2 LEED® Product requirement responsibilities include:
 - .1 Providing the total construction cost for materials within Divisions 03 – 10, 31 and 32 to the LEED Consultant for material credit calculations.
 - .2 Provide an estimate of total concrete material amounts (by mix) on the project to the LEED Consultant for LCA calculations.
 - .3 Providing a final itemized list of materials within Divisions 03 – 10, 31 and 32 to the LEED Consultant such as the shop drawing log.
 - .4 Coordinating with subcontractors to select products and materials that meet requirements specified herein.
 - .5 Providing product and material documentation submittals as detailed herein prior to the ordering of product or material.
 - .6 Providing final material costs (sub-contractor cost excluding labour and equipment) to the Consultant for material credit calculations
 - .7 Reporting products and materials selection progress to Consultant.
 - .8 Participating in the LEED® Kick-Off meeting as described in Section 01 81 13 General LEED® Requirements.

1.7 SUBMITTALS

- .1 Building Product Disclosure and Optimization Calculator (appended to this Section)
 - .1 Complete schedule and collect supporting documentation (Product literature, manufacturer information, EPDs, HPDs, etc.) for products and materials listed in Part 2 of this Section.
 - .2 Complete schedule by providing individual material costs (excluding labour and equipment) for all building products and materials in Divisions 03 – 10, 31 and 32 that contribute to meeting LEED® requirements specified in this Section.
 - .3 Only materials that are permanently installed in the project are applicable. Temporary construction applications such as bracing, concrete form work and pedestrian barriers shall not be included.

PART 2 - PRODUCTS

2.1 ENVIRONMENTAL PRODUCT DECLARATIONS

- .1 Select products/materials with Environmental Product Declarations and fall within Divisions 03 – 10, 31 and 32.
- .2 Products and materials chosen must have either a Product-Specific Declaration (conforming to ISO 14044), an Industry-Wide Type III EPD, or a Product-Specific Type III EPD (conforming to ISO 14025, and EN 15804 or ISO 21930).
- .3 Ensure the products and materials listed below have available EPDs that are compliant with ISO standards and have a corresponding Product Category Rule (PCR):
 - .1 Asphalt
 - .2 Concrete
 - .3 Concrete Reinforcement
 - .4 Precast Concrete
 - .5 Masonry
 - .6 Structural Steel
 - .7 Steel Deck, Roofing and Siding
 - .8 Steel Deck, Roofing and Siding
 - .9 Sheet Metal Flashing
 - .10 Light Steel Framing (Steel Studs)
 - .11 Composite Wood (MDF, Particle Board, Plywood)
 - .12 Fiberglass Insulation
 - .13 Mineral Wool Insulation
 - .14 Metal Wall Panels
 - .15 Metal Doors
 - .16 Gypsum
 - .17 Ceramic Tile
 - .18 Acoustic Tiles

- .19 Suspended Ceiling T-Grid
- .20 Resilient Flooring
- .21 Carpet
- .22 Wood doors
- .23 Finish Carpentry
- .24 Wood Flooring
- .25 Acoustical Wood Ceilings

2.2 MATERIAL INGREDIENT REPORTING AND OPTIMIZATION

- .1 Select products/materials from manufacturers that have published the chemical inventory of their products/materials to at least 0.1% (1000ppm). Applicable publication programs include:
 - .1 Manufacturer report providing an inventory of all ingredients identified by the name and Chemical Abstract Service Registration Number (CASRN);
 - .2 Products with a published, complete Health Product Declaration;
 - .3 Products has a Material Health Certificate or is Cradle to Cradle certified under v3 or later at the Bronze level or higher.
 - .4 Products with a Declare product label; Declare labels designated as Red List Free or LBC Compliant that demonstrate content inventory to 1000 ppm.
- .2 Select products/materials from manufacturers that document their material optimization using one of the following options:
 - .1 Manufacturer Ingredient Screening report that has screened the product to at least 1000 ppm and has a publicly available inventory and a detailed action plan to reduce known hazards using the principles of green chemistry.
 - .2 Material Inventory of Health Product Declaration of the product, demonstrating a chemical inventory of at least 100 ppm. The HPD or Manufacturer Inventory must be third party verified.
 - .3 REACH Optimization.
- .3 Materials fall within Divisions 03 – 10, 31 and 32.
- .4 At a minimum, the following materials shall be included:
 - .1 Asphalt
 - .2 Concrete
 - .3 Concrete Reinforcement
 - .4 Precast Concrete
 - .5 Masonry
 - .6 Structural Steel
 - .7 Steel Deck, Roofing and Siding
 - .8 Steel Deck, Roofing and Siding
 - .9 Sheet Metal Flashing
 - .10 Light Steel Framing (Steel Studs)

- .11 Composite Wood (MDF, Particle Board, Plywood)
- .12 Fiberglass Insulation
- .13 Mineral Wool Insulation
- .14 Metal Wall Panels
- .15 Metal Doors
- .16 Gypsum
- .17 Ceramic Tile
- .18 Acoustic Tiles
- .19 Suspended Ceiling T-Grid
- .20 Resilient Flooring
- .21 Carpet
- .22 Wood doors
- .23 Finish Carpentry
- .24 Wood Flooring
- .25 Acoustical Wood Ceilings

2.3 REGIONAL CONTENT

- .1 Select products/materials that are extracted, manufactured, and purchased within 160 km of the project site and that fall within Divisions 03 – 10, 31 and 32.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 SUMMARY

- .1 Section Includes:
 - .1 This Section indicates the criteria for use of optional Products listed in the Specification and provision for proposing changes to acceptable materials listed during the Bid Period and during the course of construction.
 - .2 LEED Requirements: Materials and Products have been selected to comply with requirements of the Leadership in Energy and Environmental Design (LEED) program. Substituted materials and Products must meet or exceed LEED requirements for targeted credits.
 - .3 Substitution requests must be accompanied by a LEED Materials Submittal Form and a LEED Emissions Submittal Form for each substituted Product. LEED Materials Submittal Form and LEED Emissions Submittal Form are to be downloaded from www.usgbc.org/resources.
- .2 Related Requirements:
 - .1 Specification Sections referencing this Section.

1.3 REFERENCES

- .1 Definitions:
 - .1 Acceptable Materials: The term Acceptable Materials is used to specify Products by trade name, manufacturer, catalogue number, model number, or similar reference, and is used within the Project Manual as follows:
 - .1 Acceptable Materials listings are based on Consultant's determination that materials meet specified requirements and opinion of applicability to the Project requirements.
 - .2 Acceptable Materials listings are deemed to establish the standard of acceptance that Consultant will consider appropriate for the Work.
 - .3 Any Product listed in the Acceptable Materials listing may be used to establish the Bid Price.
 - .2 Basis-of-Design Materials: The term Basis-of-Design Materials is used to specify a specific material name, manufacturer, catalogue number, model number or similar reference and is used as follows:
 - .1 Basis-of-Design Materials are used to establish Consultant's preference for a single source Product listing based on performance, appearance or configuration.
 - .2 Use the Basis-of-Design Material to establish the Bid Price, unless an Addendum is issued adding additional Acceptable Materials.

- .3 Basis-of-Design Materials designation does not limit the Contractor's ability to submit Proposed Substitutions in accordance with Substitutions requirements of this Section and specific performance requirements listed in Technical Specification Sections.
- .3 Non-proprietary Specification means a Specification which includes descriptive, reference standard or performance requirements, or any combination thereof, but does **not** include proprietary names of Products or manufacturers.
- .4 Substitution means a proposal from a Contractor to provide a Product, material, or item of equipment not specified in the Contract documents but functionally equivalent and readily exchangeable to a specified item; for consideration by Consultant and Owner.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 When the Contractor wants to propose a substitute product or when requested by the Consultant, the Contractor is to submit complete data substantiating compliance of a Product with requirements of Contract Documents. Include the following:
 - .1 Product identification, including manufacturer's name and address.
 - .2 Written verification that the substitute Products can be obtained, meet the performance required for the Project, and meet requirements of the Building Code.
 - .3 Manufacturer's literature providing Product description, applicable reference standards, and performance and test data.
 - .4 Samples, as applicable.
 - .5 Name and address of Projects on which Product has been used and date of each installation.
 - .6 For substitutions and requests for changes to accepted Products, include in addition to the above, the following:
 - .1 Itemized comparison of substitution with named Product(s). List significant variations.
 - .2 Designation of availability of maintenance services and sources of replacement materials.

1.5 PRODUCT OPTIONS

- .1 For Products specified by non-proprietary Specification:
 - .1 Select any Product, assembly or material that meets or exceeds the specified standards for Products specified only by referenced standards and performance criteria.
- .2 Acceptable Materials: Select any named Product, assembly or material contained in the listing of Acceptable Materials.
- .3 Basis-of-Design Materials: Use the named Product contained in the Basis-of-Design Material listing, unless an addendum is issued indicating acceptance of additional Acceptable Materials.

1.6 SUBSTITUTIONS

- .1 Contractor will assemble requests for substitutions requested by Subcontractors and submit to Consultant for review.
- .2 Consultant will review proposed substitute Products for acceptability only when submitted by Contractor; Consultant will not review requests submitted independently by Subcontractors.
- .3 No substitutions will be permitted without Consultant's written acceptance; Contractor will be required to remove Products and replace with specified materials or provide a credit to the value of the Contract at Consultant's discretion where substitutions are found in the Work that have not been formally accepted by Consultant and Owner.
- .4 Consultant is not obliged to accept any Proposed Substitution offered by Contractor and reserves the right to dismiss any item with no further explanation.
- .5 Substitute Products: Where substitute Products are permitted, unnamed Products may be accepted by Consultant, subject to the following:
 - .1 Substitute Products shall be the same type as, be capable of performing the same functions as, and meet or exceed the standards of quality and performance of the named Product(s). Substitutions shall not require revisions to Contract Documents nor to Contract Price or Work of Other Contractors.
 - .2 Substitute products life cycle cost shall remain consistent or decrease.
- .6 Substitute Manufacturers: Where substitute manufacturers are permitted, unnamed manufacturers may be accepted by Consultant, subject to the following:
 - .1 Substitute manufacturers shall have capabilities comparable to those of the named manufacturer(s). Substitutions shall not require revisions to Contract Documents nor to Work of Other Contractors.
- .7 In making a proposal for substitution, the Contractor represents:
 - .1 That they have personally investigated the proposal and (unless the proposal explicitly states otherwise) determined that it performs in a similar way or is superior to the Product or method specified.
 - .2 That the same guaranty will be furnished as for the originally specified Product or construction method.
 - .3 That they will coordinate installation of the accepted substitute into the Work, making such changes in the Work as may be required to accommodate the change.
 - .4 That they will bear costs and waives claims for additional compensation for costs and time that subsequently become apparent arising out of the substitution.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Contract Number: RFTC-1868-24-TR88179

Request No: _____ Dated: _____
Project Name: _____
Project Location: _____
Project No.: _____ Contract No.: _____

References: Specifications(s): _____ Section(s): _____ Paragraph(s): _____
Drawings(s): Drawing No(s): _____ Detail No(s): _____

Contractually Specified Product _____
Contractor Proposed Product _____

Proposed Product is: Alternate ☐ Substitute ☐

*See attached data for both specified and proposed Products as required by Section 01 62 00
– Product Options and Substitutions.*

Data Attached: Drawings: ☐ Product Data: ☐ Reports: ☐ Samples: ☐
Tests: ☐ Other: _____

Reason(s) for not providing the Specified Product:

Similar Installation:

Project: _____
Address: _____
Consultant: _____ Owner: _____
Date Installed: _____

Post-Tender:

Will proposed substitution impact other parts of the Work? No ☐ Yes ☐

Will proposed substitution increase Contract Time? No ☐ Yes ☐

If Yes attached explanation by number of Days. _____

Actual Dollar Savings if substitution is accepted: \$ _____

Contract Number: RFTC-1868-24-TR88179

The undersigned Certified that the proposed Request for an Alternate or Substitute conforms to all the requirements of Division 01 – General Requirements, Section 01 62 00 – *Product Options and Substitutions*.

Request Submitted by General Contractor _____
(Firm's Name)

By: _____ Title: _____
(Print Name) (Title)

(Signature) (Date)

Request Received on (Date): _____

Owner's Representative Review – This Substitution is:

- ☐ Approved.
(Submittals in accordance with Section 01 62 00 – *Product Options and Substitutions*.)
- ☐ Approved as Noted.
(Submittals in accordance with Section 01 62 00 – *Product Options and Substitutions*.)
- ☐ Rejected.
(Use Specified Materials)
- ☐ Rejected:
(Request Not Received Within Specified Time Period – Use Specified Materials)

Review Issued By: _____
(Print Name) (Signature)

(Date)

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Contractor shall coordinate Owner supplied Products with the Construction Schedule for delivery dates.
- .2 Contractor shall coordinate with the Owner for installation of Owner installed items, blocking and servicing requirements and confirm dimensional requirements for items being built-in or attached to Contractor's Work.
- .3 Contractor shall coordinate Owner supplied Products, installed by the Contractor for installation requirements, blocking and servicing requirements and confirm dimensional requirements for items being built-in or attached to Contractor's Work.
- .4 Contractor is responsible for Owner supplied items once delivered to Site.

Part 2 Products

2.1 PRE-PURCHASED MATERIALS

- .1 The Owner has ordered and purchased, the following listed items of equipment, to be delivered to the Work site by the equipment manufacturer/vendor. The Contractor shall install the equipment. List as follows:
 - .1 feminine disposal bins,
 - .2 furniture,
 - .3 IT switches,
 - .4 Wireless Access Points (WAPS)
 - .1 Wi-Fi system and wireless access points shall be supplied by Owner. Contractor shall provide two data cable drops for wireless access points and coordinate installations as directed by Owner, see Drawing E4-01 for proposed locations and quantities, see Drawing E7-01 for installation details.
 - .2 Provide horizontal cables for Owner provided wireless access points inside the temporary staff trailer. Contractor

shall provide two data drops for wireless access points
and coordinate installations with Owner.

- .5 1 Number - Dual Head EV Charger (CPF 50)
- .6 1 Number - Dual Head EV Chargers (CT 4000)
- .7 3 Number of Fly Lights
- .8 1 Number – Storage Cabinet for First Aid Room

Part 3 Execution

3.1 PREPARATION

- .1 Contractor shall provide all necessary framing, support and blocking built into walls (or ceiling) to receive pre-purchased equipment and furniture, all services roughing in, in accordance with reviewed Shop Drawings which will be later supplied by the Owner.
- .2 Owner Supplied, Contractor Installed Materials: Contractor shall receive and unload each item, transport it to its designated place of installation and unpack, assemble and install, and connect to building services, and as follows:
 - .1 Owner's Responsibilities:
 - .1 Arrange for delivery of Shop Drawings, Product data, samples, manufacturer's instructions, and certificates to Contractor.
 - .2 Deliver Supplier's bill of materials to Contractor.
 - .3 Arrange and pay for delivery to site in accordance with Progress Schedule.
 - .4 Inspect deliveries jointly with Contractor.
 - .5 Submit claims for transportation damage.
 - .6 Arrange for replacement of damaged, defective or missing items.
 - .7 Arrange for manufacturer's field services; arrange for and deliver manufacturer's warranties and bonds to Contractor.
 - .2 Contractor's Responsibilities:
 - .1 Designate submittals and delivery date for each Product in progress schedule.
 - .2 Review Shop Drawings, Product data, samples, and other submittals. Submit to Consultant notification of any observed discrepancies or problems anticipated due to non-conformance with Contract Documents.
 - .3 Receive and unload Products at site.

- .4 Inspect deliveries jointly with Owner; record shortages, and damaged or defective items.
- .5 Handle Products at site including un-crating and storage.
- .6 Protect Products from damage, and from exposure to elements.
- .7 Assemble, install, connect, adjust, and finish Products.
- .8 Provide installation inspections required by public authorities.
- .9 Repair or replace items damaged by Contractor or Subcontractor on Site (under their control).

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Reference Standards:
 - .1 Owner's identification of existing survey control points and property limits.

1.2 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit name and address of Surveyor to the Consultant.
- .2 On request of the Consultant, submit documentation to verify accuracy of field engineering Work.
- .3 Submit certificate signed by surveyor certifying and noting those elevations and locations of completed Work that conform and do not conform with Contract Documents.

1.3 QUALITY ASSURANCE

- .1 Qualifications of Surveyor
 - .1 Qualified registered land surveyor, licensed to practice in Place of Work, acceptable to the Consultant.

1.4 SURVEY REFERENCE POINTS

- .1 Existing base horizontal and vertical control points are designated on Drawings.
- .2 Locate, confirm and protect control points prior to starting site Work. Preserve permanent reference points during construction.
- .3 Make no changes or relocations without prior written notice to the Consultant.
- .4 Report to Consultant when reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
- .5 Require surveyor to replace control points in accordance with original survey control.

1.5 SURVEY REQUIREMENTS

- .1 Establish two permanent bench marks on site, referenced to established bench marks by survey control points. Record locations, with horizontal and vertical data in Project Record Documents.
- .2 Establish lines and levels, locate and lay out, by instrumentation.
- .3 Stake for grading, fill and topsoil placement and landscaping features.
- .4 Stake slopes and berms.
- .5 Establish pipe invert elevations.
- .6 Stake batter boards for foundations.
- .7 Establish foundation column locations and floor elevations.
- .8 Establish lines and levels for mechanical and electrical Work.

1.6 EXISTING SERVICES

- .1 Before commencing Work, establish location and extent of service lines in area of Work and notify the Consultant of findings.
- .2 Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by the Consultant.

1.7 LOCATION OF EQUIPMENT AND FIXTURES

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform the Consultant of impending installation and obtain approval for actual location.
- .4 Submit field Drawings to indicate relative position of various services and equipment when required by the Consultant.

1.8 RECORDS

- .1 Maintain a complete, accurate log of control and survey Work as it progresses.
- .2 On completion of foundations and major site improvements, prepare a certified survey showing dimensions, locations, angles and elevations of Work.
- .3 Record locations of maintained, re-routed and abandoned service lines.

1.9 SUBSURFACE CONDITIONS

- .1 Promptly notify Consultant in writing if subsurface conditions at Place of Work differ materially from those indicated in Contract Documents, or a reasonable assumption of probable conditions based thereon.
- .2 After prompt investigation, should Consultant determine that conditions do differ materially, instructions will be issued for changes in Work as provided in Changes and Change Orders.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Canadian Construction Documents Committee (CCDC)
 - .1 CCDC 2-2020, Stipulated Price Contract as amended in Contract Documents.

1.3 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or Other Contractors.
- .2 Remove waste materials from Site at daily regularly scheduled times or dispose of as directed by Consultant. Do not burn waste materials on Site.
- .3 Clear snow and ice from access to building, bank/pile snow in designated areas only.
- .4 Make arrangements with and obtain permits from Authorities Having Jurisdiction for disposal of waste and debris.
- .5 Provide on-Site containers for collection of waste materials and debris.
- .6 Provide and use marked separate bins for recycling. Refer to Section 01 74 19 – Construction Waste Management.
- .7 Dispose of waste materials and debris off Site.
- .8 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .9 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .10 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .11 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .12 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.4 FINAL CLEANING

- .1 Clean work prior to final review by Consultant.
- .2 When Substantial Performance of the Contract has been achieved, remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .3 Remove waste in accordance with Section 01 74 19 – Construction Waste Management.

- .4 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .5 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .6 Remove waste products and debris including that caused by Owner or Other Contractors.
- .7 Remove waste materials from Site at regularly scheduled times or dispose of as directed by Consultant. Do not burn waste materials on Site, unless approved by Consultant.
- .8 Make arrangements with and obtain permits from Authorities Having Jurisdiction for disposal of waste and debris.
- .9 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .10 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.
- .11 Clean lighting reflectors, lenses, and other lighting surfaces.
- .12 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .13 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .14 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .15 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .16 Remove dirt and other disfiguration from exterior surfaces.
- .17 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .18 Sweep and wash clean paved areas.
- .19 Clean equipment and fixtures to sanitary condition.
- .20 Clean mechanical equipment including replacement of filters.
- .21 Clean roofs, downspouts, and drainage systems.
- .22 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .23 Remove snow and ice from access to building.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Comply with Division 1 requirements and documents referred to herein.

1.2 SUMMARY

- .1 Provide waste management and disposal including but not limited to following:
 - .1 Minimize the amount of solid waste generated by construction, renovation and demolition activities.
 - .2 Of the inevitable solid waste that is generated by CRD activities, identify at least five (5) materials (both structural and non-structural) targeted for diversion; divert a minimum of 75% from landfill (through reuse and recycling).
 - .3 Meet requirements to achieve LEED® v4 BD+C Materials and Resources prerequisite (Construction and Demolition Waste Management Planning) and credit (Construction and Demolition Waste Management).
 - .4 Comply with applicable Environmental Protection Act of Ontario regulations relating to construction waste management including Ontario Regulation 102/94 and Ontario Regulation 103/94.

1.3 RELATED SECTIONS

- .1 Section 01 81 13 General LEED® Requirements.

1.4 REFERENCES

- .1 Ontario Environmental Protection Act. Ontario Regulation 102/94: Waste Audits and Waste Reduction Workplans.
- .2 Ontario Ministry of the Environment, Conservation and Parks (MECP). A Guide to Waste Audits and Reduction Workplans for Construction and Demolition Projects as Required Under Ontario Regulation 102/94.
- .3 Ontario Environmental Protection Act. Ontario Regulation 103/94: Industrial, Commercial and Institutional Source Separation Programs.
- .4 Ontario Ministry of the Environment, Conservation and Parks (MECP). A Guide to Source Separation of Recyclable Materials for Industrial, Commercial and Institutional Sectors and Multi-Unit Residential Buildings as Required Under Ontario Regulation 103/94.
- .5 Canadian Construction Association. Standard Construction Document CCA 27-1997: A Guide on Construction Environmental Management Planning.
- .6 Canadian Construction Association. Standard Construction Document CCA 81-2001: A Best Guide to Solid Waste Reduction.
- .7 Public Works and Government Services Canada. 2002 National Construction, Renovation, and Demolition Non-Hazardous Solid Waste Management Protocol.
- .8 LEED® v4 Reference Guide for Green Building Design and Construction, United States Green Building Council.

1.5 DEFINITIONS

- .1 Solid Waste: Any waste material that is sent from the project site to another location for disposal.
- .2 Land-Clearing Debris: Waste materials resulting from land-clearing that include pre-existing development materials and plant matter, but do not include soil.
- .3 Reused Waste: Waste materials that are sent to a location off-site (e.g. another construction project or product supplier) where they are used in their original form (i.e. without additional processing).
- .4 Recycled Waste: Waste materials that are sent off-site to a recycling facility where they are used to displace virgin materials as feedstock for manufacturing processes that create new products.
- .5 Landfill Waste: Waste materials that are sent to a landfill site for disposal.

1.6 DESCRIPTION OF WORK

- .1 The site superintendent (or other individual designated by Contractor) shall be responsible for all aspects of the Construction Waste Management and Disposal.
- .2 Implement a waste reduction strategy based on the 3R hierarchy: reduce the generation of waste materials at the project site, reuse materials on other construction sites where feasible, and recycle waste materials as feedstock for manufacturing processes that create new products.
- .3 Waste Management responsibilities include:
 - .1 Arranging waste management service agreements with waste haulers and waste receiving facilities.
 - .2 Supervising on-site waste management activities on a daily basis.
 - .3 Coordinating waste management tasks with Subcontractors to ensure timely and orderly progress of the work.
 - .4 Preparing waste management documentation and submittals as described in 3.1 of this section
 - .5 Reporting waste management progress to Consultant.
 - .6 Participating in the LEED® Kick-Off meeting as described in Section 01 81 13 General LEED® Requirements.

1.7 SUBMITTALS

- .1 Construction Waste Management (CWM) Plan
 - .1 The CWM Plan will be site specific, and developed and finalized before the start of any excavation, demolition, or construction activities. The LEED Consultant will provide guidance to ensure compliance. It will include the overall project waste diversion goals, at least 5 kinds of material streams to be diverted, the methods of diversion to be implemented for each of the 5 selected material streams, and the approximate amount of waste of each.
- .2 W1: Proposed Receiving Facilities Form

-
- .1 List the proposed receiving facilities for each in addition to material sent to landfill. Indicate the materials that will be accepted at each facility and the end use of the material (reuse, recycle or landfill).
 - .2 Submit completed schedule to consultant within 14 days of site mobilization.
 - .3 A sample copy of this form has been attached as a supplement at the end of this Section.
 - .3 W2: Waste Tracking Worksheet
 - .1 Obtain waybills, invoices, letters and other documentation that clearly indicates the receiving facility, end use (reused recycled or landfill) and quantity of waste for each shipment using the Waste Tracking Worksheet.
 - .2 Submit completed Waste Tracking Worksheet to the Consultant on a monthly basis as part of the ongoing Monthly LEED Reports required in General LEED Section 01 81 13.
 - .3 A sample copy of this document has been attached as a supplement at the end of this Section.
 - .4 Final CWM Report
 - .1 The final waste report will detail the total construction and demolition waste produced by the project, the types of waste material and quantity of each material, and the total waste diverted and diversion rate. This report should be completed and sent to the LEED consultant subsequent to the completion of all construction activities that may produce waste.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PROCEDURES

- .1 Waste Reduction:
 - .1 Invite suppliers to retrieve/retain packaging after delivery (for reuse).
 - .2 Prevent damage of materials due to mishandling, improper storage and contamination
 - .3 Use prefabricated assemblies built at a central facility (when possible) to avoid waste generation at site.
- .2 Waste Diversion:
 - .1 Contact local salvaging/recycling facilities and arrange for recycling services. At a minimum, proposed facilities must recycle/reuse following waste materials generated throughout construction:
 - .1 Land clearing debris
 - .2 Asphalt
 - .3 Portland cement concrete/masonry/stone
 - .4 Steel and other metals
 - .5 Wood (see note below)
 - .6 Gypsum

-
- .7 Cardboard
 - .8 Plastic
 - .9 Blue box waste
 - .2 Incineration of wood waste for power generation is not considered as recycling or reuse. Recommended measures for recycling/reusing wood include encouraging suppliers to reuse wood pallets, sending wood pallets to pallet recycling companies and converting waste wood into landscaping mulch.
 - .3 Provide Consultant with a list of proposed salvaging/recycling facilities within 14 Days of site mobilization. List must indicate materials accepted by each facility and whether materials will be reused, recycled or sent to landfill.
 - .4 Designate a central Waste Collection Area onsite dedicated to separation and storage of waste generated during construction.
 - .5 Provide containers in Waste Collection Area sized to accommodate separation and storage of expected waste types and quantities. Provide separate containers for each of following material types:
 - .1 Land clearing debris
 - .2 Asphalt
 - .3 Portland cement concrete/masonry/stone
 - .4 Steel and other metals
 - .5 Wood
 - .6 Gypsum
 - .7 Cardboard
 - .8 Plastic
 - .9 Blue box waste
 - .10 Mixed waste
 - .11 Other types
 - .6 Clearly indicate material type being stored in each container using appropriate signage.
 - .7 Ensure Subcontractors use containers provided in Waste Collection Area.
 - .8 In the event a Subcontractor is unable to use these containers, or wishes to use a waste material on future project (e.g. rubble for road base), Subcontractor must provide waybills, invoices, letters and other documentation clearly indicating receiving facility, end use (reused, recycled or landfill) and quantity of waste in each shipment.
 - .9 Follow salvaging/recycling facilities' material acceptance requirements to ensure materials are properly sorted, grouped and package for collection.
 - .10 Provide blue box recycling bins near construction trailer for recycling waste generated by site workers and visitors. Waste deposited in these bins include:
 - .1 Aluminum food or beverage cans
 - .2 Glass bottles and jars for food or beverage
 - .3 PET bottles for food or beverages

.4 Steel food or beverage cans

.5 Cardboard and paper products

.3 Waste Tracking:

.1 Coordinate delivery of separated materials to approved salvage or recycling facilities.

.2 Retain waybills for inclusion in final Waste Diversion Report.

3.2 INSPECTIONS & MAINTENANCE

.1 Conduct daily inspections of material separation bins to check for and remedy cross-contamination.

.2 Promptly transport containers to receiving facilities when containers are full.

.3 Ensure material type is clearly labeled on each container

3.3 SUPPLEMENTS

.1 The documents listed below, attached following "END OF SECTION", form part of this Specification Section:

.1 Proposed Receiving Facilities Form

.2 Waste Tracking Worksheet

END OF SECTION

W1: PROPOSED WASTE RECEIVING FACILITIES FORM

(Submit to the Consultant within 14 days after site mobilization)

Project Name:		Completed By:	
Project Location:		Company:	

At a minimum, proposed facilities must recycle/reuse the waste materials identified in Section 01 74 19 Waste Management and Disposal:

Material Type	Proposed Receiving Facility		
	Name	Material End Use	Phone Number
Wood Formwork	Wood Diversion Inc. (London, Ontario)	<input checked="" type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	519-555-5555
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	
		<input type="checkbox"/> Recycled/Reused <input type="checkbox"/> Sent to Landfill	

Signature of Authorized Official

Position

Date

W2: WASTE TRACKING WORKSHEET

Project Name:		Completed By:	
Project Location:		Company:	

For the purpose of LEED® documentation, I certify the following information for waste tracking on this Project:

Material Type Legend		
Land Clearing Debris	Asphalt	Concrete/Masonry/Stone
Steel and Other Metals	Wood	Gypsum
Cardboard	Plastic	"Blue Box" Waste
Mixed Waste	Other types as required	

#	Shipment Date	Material Type	Amount of Material (metric tonnes)		Receiving Facility Name	Waybill Number
			Reused or Recycled	Landfill		
EX	2010-06-25	Gypsum	7.0	0.0	Drywall Recycling Inc.	09-1234

I hereby certify that the information provided above is complete and correct:

_____ Signature of Authorized Official	_____ Position	_____ Date
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Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Underwriters' Laboratories of Canada (ULC):
 - .1 ULC 1001-11, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems (CAN/ULC S1001-11)

1.3 INSPECTION AND DECLARATION

- .1 Contractor's Inspection: Contractor and Subcontractors: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .1 Notify Consultant in writing of satisfactory completion of Contractor's inspection and that corrections have been made.
 - .2 Request Consultant's review.
 - .3 Consultant's Review: Consultant and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor to correct Work accordingly.
- .2 Completion: submit written certificate that following have been performed:
 - .1 Work has been completed and inspected for compliance with Contract Documents.
 - .2 Defects have been corrected and deficiencies have been completed.
 - .3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
 - .4 Certificates required by Technical Standards Safety Authority (TSSA), Electrical Safety Authority (ESA), Fire Commissioner and Utility companies have been submitted.
 - .5 Certification letter required to confirm integrated systems testing for fire protection and life safety systems has been successfully completed in accordance with ULC-1001.
 - .6 Operation of systems have been demonstrated to Owner's personnel.
 - .7 Work is complete and ready for final inspection.
- .3 Final Review: when items noted above are completed, request final inspection of Work by Owner, Consultant, and Contractor. If Work is deemed incomplete by Owner and Consultant, complete outstanding items and request reinspection.
- .4 Declaration of Substantial Performance of the Contract: when Owner and Consultant consider deficiencies and defects have been corrected and it appears requirements of Contract have been substantially performed, make application for certificate of Substantial Performance of the Contract. Refer to General Conditions and Supplementary Conditions for specifics to application.
- .5 Commencement of Warranty Periods: refer to A-13 Articles of Agreement.

- .6 Final Payment: when Owner and Consultant consider final deficiencies and defects have been corrected and it appears requirements of Contract have been totally performed, make application for final payment. If Work is deemed incomplete by Owner and Consultant, complete outstanding items and request reinspection.
- .7 Payment of Holdback: Payment of holdback shall be in accordance with the requirements of the *Construction Act* and processes set out in the General Conditions of the Contract.

1.4 CLEANING

- .1 In accordance with Section 01 74 11 – Cleaning.
- .2 Remove waste and surplus materials, rubbish and construction facilities from the site in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 Submittal Procedures.
- .2 Provide list of building system assets for each component including equipment type, manufacturer, model number, and condition (for existing equipment). Example of spreadsheet attached at end of this section.
- .3 Prepare instructions and data using personnel experienced in maintenance and operation of described Products.
- .4 Copy will be returned after final review, with Consultant's comments.
- .5 Revise content of documents as required prior to final submittal.
- .6 A minimum of 10 Business Days prior to Substantial Performance of the Contract, submit to the Consultant two final copies of operating and maintenance manuals in English along with pdf version on a flash drive in English.
- .7 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as Products provided in Work.
- .8 Furnish evidence, if requested, for type, source and quality of Products provided.
- .9 Defective Products will be rejected, regardless of previous inspections. Replace Products at own expense.
- .10 Pay costs of transportation.
- .11 Submit `redline` marked up construction drawings to the Consultant within 30 Days of Substantial Performance of the Contract and prior to Total Performance of the Contract.

1.3 FORMAT

- .1 Organize data as instructional manual.
- .2 Binders: hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of Project and identify subject matter of contents.
- .5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate Product and system, with typed description of Product and major component parts of equipment.
- .7 Text: manufacturer's printed data, or typewritten data.

- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.4 CONTENTS EACH VOLUME

- .1 Table of Contents: provide title of project;
 - .1 Date of submission; names.
 - .2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.
 - .3 Schedule of Products and systems, indexed to content of volume.
- .2 For each Product or system:
 - .1 List names, addresses and telephone numbers of Subcontractors and Suppliers, including local source of supplies and replacement parts.
 - .2 Include a summary list of all warranties that apply to the project complete with dates
- .3 Product Data: mark each sheet to identify specific Products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement Product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement Product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 Quality Control.
- .6 Training: refer to Section 01 79 00 Demonstration and Training.

1.5 AS-BUILTS AND SAMPLES

- .1 Maintain, in addition to requirements in General Conditions, at site for Consultant one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed Shop Drawings, Product data, and samples.
 - .6 Field Test Report, System Components List Complete With Commissioning Verification Forms and Check Sheets and Commissioning Issues/Resolution Log.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.

- .5 Keep record documents and samples available for inspection by Consultant.

1.6 RECORDING ACTUAL SITE CONDITIONS

- .1 Record information on set of Drawings, and in copy of Project Manual, provided by Consultant.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and Shop Drawings: mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by Change Orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related Shop Drawings and modifications.
- .5 Specifications: mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each Product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and Change Orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications Sections.

1.7 FINAL SURVEY

- .1 Submit final site survey certificate in accordance with Section 01 71 00 Examination and Preparation, certifying that elevations and locations of completed Work are in conformance, or nonconformance with Contract Documents.

1.8 REAL PROPERTY CERTIFICATE

- .1 Supply to the Consultant, as soon as construction of foundations and basic ground floor levels are completed, a survey plan from a registered Ontario Land Surveyor.
- .2 Plan shall show dimensioned building plan at ground level, distance from property lines, and elevation of the floor used as datum.
- .3 This includes all buildings in Contract.

1.9 EQUIPMENT AND SYSTEMS

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include startup, breakin, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and 01 91 13 General Commissioning (CX) Requirements.
- .15 Include integrated systems testing reports as specified in Section 01 45 00 - Quality Control and 01 91 13 General Commissioning (CX) Requirements.
- .16 Additional requirements: as specified in individual specification Sections.

1.10 MATERIALS AND FINISHES

- .1 Building Products, Applied Materials, and Finishes: include Product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured Products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture Protection and Weather Exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

- .4 Additional Requirements: as specified in individual specifications Sections.

1.11 SPARE PARTS

- .1 Provide spare parts, in quantities specified in individual specification Sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver spare parts to the Site, place and store spare parts in location at the Site as required by the Consultant.
- .4 Receive and catalogue items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered Products and submit prior to final payment.

1.12 MAINTENANCE MATERIALS

- .1 Provide maintenance and extra materials, in quantities specified in individual specification Sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver maintenance materials to Site, place and store maintenance materials in a location as required by the Consultant.
- .4 Receive and catalogue items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered Products and submit to Consultant prior to final payment.

1.13 EXITING SIGNAGE

- .1 Provide computer generated signage for emergency passage exiting of building. Provide minimum 305 x 305 mm size signs to include at locations as required by Authority having Jurisdiction for building exiting.
- .2 Prepare fire safety plan in accordance with Fire Code and local fire bylaw unless specified otherwise by the Owner. Locate in Fire Safety Plan Box. Provide fire key cylinder at location on exterior of building for Entrance by Fire Station Personnel. Provide and coordinate type of storage and location with local Fire Station and Authority Having Jurisdiction.

1.14 SPECIAL TOOLS

- .1 Provide special tools, in quantities specified in individual specification Section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver special tools to Site, place and store special tools in a location as required by the Consultant.
- .4 Receive and catalogue items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual.

1.15 STORAGE, HANDLING AND PROTECTION

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged Products at own expense and to satisfaction of Consultant.

1.16 WARRANTIES AND BONDS

- .1 Develop warranty management plan to contain information relevant to warranties.
- .2 Submit warranty management plan, 30 Days before planned pre-warranty conference, to Consultant for approval.
- .3 Warranty management plan to include required actions and documents to ensure that Owner receives warranties to which it is entitled.
- .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
- .5 Submit, warranty information made available during construction phase, to Consultant for approval prior to each monthly pay estimate.
- .6 Assemble approved information in binder and submit upon acceptance of work. Organize binder as follows:
 - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
 - .2 List Subcontractor, Supplier, and manufacturer, with name, address, and telephone number of responsible principal.
 - .3 Obtain warranties and bonds, executed in duplicate by Subcontractors, Suppliers, and manufacturers, within ten days after completion of applicable item of work.
 - .4 Verify that documents are in proper form, contain full information, and are notarized.
 - .5 Co-execute submittals when required.
 - .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance of the Contract is determined.
- .8 Conduct joint 9 month and 18 month warranty inspection, measured from time of acceptance, by Consultant.
- .9 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, Subcontractors, manufacturers or Suppliers involved.
 - .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors,

- transformers, and commissioned systems such as fire protection, alarm systems, sprinkler systems, lightning protection systems.
- .3 Provide list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of manufacturers or suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.
 - .4 Contractor's plans for attendance at 9 month and 18 month post-construction warranty inspections.
 - .5 Procedure and status of tagging of equipment covered by extended warranties.
 - .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
 - .10 Respond in a timely manner to oral or written notification of required construction warranty repair work.
 - .11 Written verification will follow oral instructions. Failure to respond will be cause for the Consultant to proceed with action against Contractor.

1.17 PRE-WARRANTY CONFERENCE

- .1 Meet with Consultant, to develop understanding of requirements of this Section. Schedule meeting prior to contract completion, and at time designated by Consultant.
- .2 Consultant will establish communication procedures for:
 - .1 Notification of construction warranty defects.
 - .2 Determine priorities for type of defect.
 - .3 Determine reasonable time for response.
- .3 Provide name, telephone number and address of licensed and bonded company that is authorized to initiate and pursue construction warranty work action.

- .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.18 WARRANTY TAGS

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Consultant.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.
- .4 Indicate following information on tag:
 - .1 Type of Product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Contract number.
 - .5 Warranty period.
 - .6 Inspector's signature.
 - .7 Construction Contractor.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 This Section includes administrative and procedural requirements for instructing and training the Owner's personnel, including the following:
 - .1 Demonstration of operation of systems, subsystems, and equipment.
 - .2 Training in operation and maintenance of systems, subsystems, and equipment.
 - .3 Demonstration and training videos.
 - .2 Related Requirements:
 - .1 Section 01 77 00 - Closeout Procedures, for Substantial Completion and Ready for Takeover procedures, warranties, and final cleaning.
 - .2 Section 01 78 00 – Closeout Submittals, Operation and Maintenance Data, for operation and maintenance manual requirements.
 - .3 Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordinate instruction and training schedule with the Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
 - .2 Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
 - .3 Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the Consultant, Contractor, and Commissioning Authority.
 - .4 Coordinate with requirements specified in Section 01 91 13 - General Commissioning (CX) Requirements.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - .1 Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and Products in lieu of recording of live instructional module.
- .2 Qualification Data: For facilitator, instructor, and videographer.
- .3 Attendance Record: For each training module, submit list of participants and length of instruction time.

- .4 Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

- .1 Demonstration and Training Recordings: Submit two copies within seven days of end of each training module.
 - .1 Identification: On each copy, provide an applied label with the following information:
 - .1 Name of the Owner.
 - .2 Name of Project.
 - .3 Name and address of videographer.
 - .4 Name of Contractor.
 - .5 Date of recording.
 - .2 Transcript: Prepared and bound in format matching operation and maintenance manual. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding recording. Include name of Project and date of recording on each page.
 - .3 At completion of training, submit complete training manual(s) for Owner's use, prepared and bound in format matching operation and maintenance manual.

1.5 QUALITY ASSURANCE

- .1 Facilitator Qualifications: A firm or individual experienced in instructing maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose Work has resulted in training or education with an established record of successful learning performances.
- .2 Instructor Qualifications: A manufacturer's factory-authorized technical service representative, complying with requirements in Section 01 45 00 - Quality Control, and experienced in operation and maintenance procedures and training.
- .3 Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- .4 Pre-Instruction Conference: Conduct conference at Project site to comply with requirements specified in Section 01 31 13 – Mechanical and Electrical Project Coordination. Review methods and procedures related to demonstration and training including, but not limited to, the following:
 - .1 Inspect and discuss locations and other facilities required for instruction and training.
 - .2 Review and finalize instruction and training schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 - .3 Review required content of instruction and training.
 - .4 For instruction and training that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

Part 2 Products

2.1 INSTRUCTION PROGRAM

- .1 Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections in Division 2 through Division 33.
- .2 Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
- .3 Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - .1 System, subsystem, and equipment descriptions.
 - .2 Performance and design criteria if Contractor is delegated design responsibility.
 - .3 Operating standards.
 - .4 Regulatory requirements.
 - .5 Equipment function.
 - .6 Operating characteristics.
 - .7 Limiting conditions.
 - .8 Performance curves.
- .4 Documentation: Review the following items in detail:
 - .1 Emergency manuals.
 - .2 Operations manuals.
 - .3 Maintenance manuals.
 - .4 Project Record Documents.
 - .5 Identification systems.
 - .6 Warranties and bonds.
 - .7 Maintenance service agreements and similar continuing commitments.
- .5 Emergencies: Include the following, as applicable:
 - .1 Instructions on meaning of warnings, trouble indications, and error messages.
 - .2 Instructions on stopping.
 - .3 Shutdown instructions for each type of emergency.
 - .4 Operating instructions for conditions outside of normal operating limits.
 - .5 Sequences for electric or electronic systems.
 - .6 Special operating instructions and procedures.
- .6 Operations: Include the following, as applicable:
 - .1 Startup procedures.
 - .2 Equipment or system break-in procedures.
 - .3 Routine and normal operating instructions.
 - .4 Regulation and control procedures.
 - .5 Control sequences.

- .6 Safety procedures.
- .7 Instructions on stopping.
- .8 Normal shutdown instructions.
- .9 Operating procedures for emergencies.
- .10 Operating procedures for system, subsystem, or equipment failure.
- .11 Seasonal and weekend operating instructions.
- .12 Required sequences for electric or electronic systems.
- .13 Special operating instructions and procedures.
- .7 Adjustments: Include the following:
 - .1 Alignments.
 - .2 Checking adjustments.
 - .3 Noise and vibration adjustments.
 - .4 Economy and efficiency adjustments.
- .8 Troubleshooting: Include the following:
 - .1 Diagnostic instructions.
 - .2 Test and inspection procedures.
- .9 Maintenance: Include the following:
 - .1 Inspection procedures.
 - .2 Types of cleaning agents to be used and methods of cleaning.
 - .3 List of cleaning agents and methods of cleaning detrimental to Product.
 - .4 Procedures for routine cleaning
 - .5 Procedures for preventive maintenance.
 - .6 Procedures for routine maintenance.
 - .7 Instruction on use of special tools.
- .10 Repairs: Include the following:
 - .1 Diagnosis instructions.
 - .2 Repair instructions.
 - .3 Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - .4 Instructions for identifying parts and components.
 - .5 Review of spare parts needed for operation and maintenance.

Part 3 Execution

3.1 PREPARATION

- .1 Assemble educational materials necessary for instruction, including documentation and training modules. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 00 – Closeout Submittals.
- .2 Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- .1 Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- .2 Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, equipment, and components not part of a system.
 - .1 The Owner will furnish Contractor with names and positions of participants.
- .3 Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - .1 Schedule training with the Owner, through Contractor, with at least seven (7) days' advance notice.
- .4 Training Location and Reference Materials: Conduct training on-site in the completed and fully operational facility using the actual systems, subsystems, and equipment in-place. Conduct training using final operation and maintenance manual submittals and additional reference materials as necessary to support the educational objectives.
- .5 Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written and performance-based test.
- .6 Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial demonstration and training use.

3.3 DEMONSTRATION AND TRAINING VIDEOS

- .1 General: Engage a qualified commercial videographer to record demonstration and training videos. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 - .1 At beginning of each training module, record each chart containing educational objectives and lesson outline.
- .2 Format: Provide typical resolution converted to format file type acceptable to the Owner, on portable USB flash drive
- .3 Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
- .4 Lighting Levels: Verify ambient lighting levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording. Furnish additional portable lighting equipment as necessary to provide adequate lighting levels.
- .5 Narration: Describe scenes on video by audio narration by microphone while video is recorded. Include verbal descriptions of items being viewed. Repeat recording procedures where audio is unintelligible.

- .6 Transcript: Provide a printed transcript of the narration. Display images and running time captured from video opposite the corresponding narration segments.
- .7 Pre-Produced Recordings: Provide recordings used as a component of training modules in same format as recordings of live training sessions.

END OF SECTION

PART 1 – General

1.1 GENERAL INSTRUCTIONS

- .1 Comply with Division 1 requirements and documents referred to herein.

1.2 SUMMARY

- .1 Work included: Provide general LEED® requirements including but not limited to following:
 - .1 Construct a building that uses land, water, energy, and material resources appropriately and efficiently and provides a safe, comfortable and productive indoor environment for building occupants in accordance with LEED® requirements.
 - .2 Provide documentation to Consultant as needed to demonstrate LEED® requirements have been met.
 - .3 Achieve certification under LEED® v4 Green Building Design and Construction Rating System administered by the United States Green Building Council.
 - .4 Take reasonable steps to ensure that the building is eligible to be LEED® Silver certified, where the minimum of 50 credits shall be achieved.

1.3 RELATED SECTIONS

- .1 Section 01 91 13 General Commissioning Requirements
- .2 Section 01 61 00 LEED® Product Requirements
- .3 Section 01 74 19 Construction Waste Management
- .4 Section 01 81 19 Indoor Air Quality
- .5 Section 01 57 00 Erosion and Sedimentation Control

1.4 REFERENCES

- .1 LEED® v4 Reference Guide for Green Building Design and Construction, United States Green Building Council.

1.5 DEFINITIONS

- .1 LEED®: Leadership in Energy and Environmental Design is a voluntary, consensus-based, market-responsive set of criteria that evaluate project performance from a whole-building perspective.
- .2 USGBC: United States Green Building Council is a broad-based inclusive coalition of representatives from different segments of the design and building industry. The Council works to change industry standards, develop best design practices and guidelines; advocate for green buildings, and develop educational tools to support its members in implementing sustainable design and construction practices.

1.6 DESCRIPTION OF WORK

- .1 Designate an individual responsible for LEED® coordination during construction.

- .2 LEED® Construction responsibilities include:
 - .1 Coordinating with trades and ensuring successful implementation of LEED® strategies, programs and plans.
 - .2 Reporting construction activity progress to Consultant as it relates to LEED® features in the Project.
 - .3 Supplying the LEED® documentation and submittals outlined within this specification and related sections to the Consultant to demonstrate that LEED® requirements have been met.
- .3 The LEED® Construction Coordinator is to be regularly on-site during construction.

1.7 LEED® KICK-OFF MEETING

- .1 Prior to the start of construction, Contractor shall hold a kick-off meeting with Consultant to review LEED® requirements. This meeting includes a review of:
 - .1 LEED® certification and performance objectives.
 - .2 LEED® requirements and procedures.
 - .3 LEED® postings and submittals.
- .2 The Contractor shall ensure that all appropriate Sub-Contractors attend the meeting as requested by the Consultant.

1.8 SUBMITTALS

- .1 Monthly LEED Reports:
 - .1 Within 10 working days after the end of each month, the Contractor shall submit a Monthly LEED® Report to the Consultant. The report shall include the following items:
 - .1 Erosion and Sedimentation Control Inspection Logs and photographs as required in Section 01 57 00
 - .2 Waste Tracking Worksheet as required in Section 01 74 19.
 - .3 IAQ Management Inspection Forms as required in Section 01 81 19 (after the building reaches close-in).
- .2 Photographs:
 - .1 Ensure photos taken for LEED® documentation purposes conform to following requirements:
 - .1 Resolution: High resolution digital images (1280 x 1024 or higher).
 - .2 Date Stamp: Standard indicating YYYY-MM-DD.
- .3 Provide submittals as outlined in Sections relating to LEED®. Submit these schedules to Consultant for approval.
- .4 Consultant will complete and provide Contractor with LEED® Letter Templates required for LEED® submission package. Contractor will then review and sign LEED® Letter Templates provided and submit to Consultant.

1.9 CREDIT SUMMARY TABLE

- .1 The project shall meet the requirements of the following LEED® credits:
- .2 Prerequisites have been identified.
- .3 The “Pursued” column indicates the credits and number of points that the project currently includes within the scope of works.
- .4 The “Pending” column indicates the credits and number of points that the project is very likely to Pursue and should be included within the scope of works.
- .5 The “Not Pursued” column indicates the credits and number of points that the project is not pursuing and should not to be included within the scope of works.

56				
56	17	37	110	ESTIMATED POINT TOTALS (40-49: Certified; 50-59: Silver; 60-79: Gold; 80+: Platinum)

Current Rating = Gold

Pursued	Pending	Not Pursued	Possible Points	Credits
1			1	Integrative Process
2	0	14	16	LOCATION AND TRANSPORTATION – (16 possible)
1			1	Sensitive Land Protection
		2	2	High Priority Site
		5	5	Surrounding Density and Diverse Uses
		5	5	Access to Quality Transit
		1	1	Bicycle Facilities
		1	1	Reduced Parking Footprint
1			1	Green Vehicles
4	1	5	10	SUSTAINABLE SITES – (10 possible)
Required				Construction Activity Pollution Prevention
1		0	1	Site Assessment
	1	1	2	Site Development – Protect or Restore Habitat
		1	1	Open Space
		3	3	Rainwater Management
2		0	2	Heat Island Reduction
1			1	Light Pollution Reduction
7	2	2	11	WATER EFFICIENCY - (11 possible)
Required				Outdoor Water Use Reduction

Required				Indoor Water Use Reduction
Required				Building-Level Water Metering
2			2	Outdoor Water Use Reduction
4	2		6	Indoor Water Use Reduction
		2	2	Cooling Tower Water Use
1			1	Water Metering
20	5	8	33	ENERGY AND ATMOSPHERE - (33 possible)
Required				Fundamental Commissioning and Verification
Required				Minimum Energy Performance
Required				Building-level Energy Metering
Required				Fundamental Refrigerant Management
4	2		6	Enhanced Commissioning
12		6	18	Optimize Energy Performance
1			1	Advanced Energy Metering
		2	2	Demand Response
	3		3	Renewable Energy Production
1			1	Enhanced Refrigerant Management
2			2	Green Power and Carbon Offsets
7	5	1	13	MATERIALS AND RESOURCES - (13 possible)
Required				Storage & Collection of Recyclables
Required				Construction and Demolition Waste Management Planning
3	1	1	5	Building Life-Cycle Impact Reduction
1	1		2	Building Product Disclosure and Optimization - Environmental Product Declarations
	2		2	Building Product Disclosure and Optimization - Sourcing of Raw Materials
1	1		2	Building Product Disclosure and Optimization - Material Ingredients
2			2	Construction and Demolition Waste Management
7	3	6	16	INDOOR ENVIRONMENTAL QUALITY - (16 possible)
Required				Minimum Indoor Air Quality Performance
Required				Environmental Tobacco Smoke (ETS) Control
2			2	Enhanced Indoor Air Quality Strategies
1	2		3	Low-Emitting Materials
1			1	Construction Indoor Air Quality Management Plan
1	1		2	Indoor Air Quality Assessment

1			1	Thermal Comfort
1		1	2	Interior Lighting
		3	3	Daylight
		1	1	Quality Views
		1	1	Acoustic Performance

5	0	1	6	INNOVATION - (6 possible)
1			1	Innovation; Bird Collision Deterrence
1			1	Innovation: Reduced Mercury Lamps
1			1	Innovation: Occupant Comfort Survey
1			1	Pilot: Passive Survivability and Backup Power Systems
		1	1	Innovation
1			1	LEED Accredited Professional

3	1	0	4	REGIONAL PRIORITY - (4 possible)
3	1	0	4	Regional Priority

END OF SECTION

PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Comply with Division 1 requirements and documents referred to herein.

1.2 SUMMARY

- .1 Provide indoor air quality requirements including but not limited to following:
 - .1 Meet or exceed recommended Design Approaches of the Sheet Metal and Air Conditioning Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition, 2007, Chapter 3.
 - .2 Protect construction workers and future building occupants from indoor air quality problems resulting from construction activities and building materials.
 - .3 Reduce production and circulation of pollutants during construction.
 - .4 Protect equipment and absorptive materials stored and installed on-site from moisture, dust and dirt accumulation during construction.
 - .5 Prohibit the use of tobacco products inside the building and within 25 feet (7.5 metres) of the building entrance during construction.
 - .6 Prepare building for occupancy following construction.

1.3 RELATED SECTIONS

- .1 Section 01 81 13 General LEED® Requirements.

1.4 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition 2007, Chapter 3
- .2 EPA Protocol for Environmental Requirements, Testing for Indoor Quality Baseline IAQ
- .3 ANSI/ASHRAE 52.2-2007: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- .4 California Department of Public Health (CDPH) Standard Method v1.2-2017
- .5 SCAQMD #1168: State of California South Coast Air Quality Management District Rule 1168. July 2005 (as amended)
- .6 SCAQMD #1113: State of California South Coast Air Quality Management District Rule 1113. June 2011 (as amended)
- .7 California Air Resources Board (CARB), 2007, Suggested Control Measure (SCM) for Architectural Coatings
- .8 California Air Resources Board (CARB) 93120 Airborne Toxic Control Measure (ATCM)
- .9 Canadian VOC Concentration Limits for Architectural Coatings

- .10 LEED® v4 Reference Guide for Green Building Design and Construction 2013, United States Green Building Council
- .11 LEED® Online v4 BD+C USGBC Forms

1.5 DEFINITIONS

- .1 Volatile Organic Compounds (VOCs): Organic chemicals that produce vapors readily at room temperature and normal atmospheric pressure (e.g. gasoline, solvents, etc.). VOCs react with sunlight and nitrogen to form ground-level ozone, a chemical that has detrimental effect on human health, agricultural crops, forests, soil, groundwater and ecosystems.
- .2 Composite Wood and Agrifiber Products: Defined as particle board, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates and door cores.

1.6 DESCRIPTION OF WORK

- .1 The Site Superintendent (or other person designated by Contractor) is responsible for LEED® coordination (during construction) related to indoor air quality management.
- .2 Indoor air quality management activities include:
 - .1 Identifying, implementing and documenting measures to achieve indoor air quality management objectives.
 - .2 Supervising on-site indoor air quality management activities on a daily basis.
 - .3 Coordinating indoor air quality management tasks with Subcontractors to ensure timely and orderly progress of the work.
 - .4 Conducting indoor air quality management inspections and making necessary repairs.
 - .5 Maintaining an indoor air quality inspection log to document observations, deficiencies and corrective actions.
 - .6 Preparing indoor air quality management documentation and submittals as detailed herein.
 - .7 Selecting Products/materials meeting requirements specified herein.
 - .8 Providing product and material documentation and submittals to Consultant as detailed herein prior to ordering a Product or material.
 - .9 Reporting indoor air quality management progress to Consultant.
 - .10 Coordination and scheduling of Indoor Air Quality Testing as required for LEED as outlined in part 3.9 of this section
 - .11 Participating in the LEED® Kick-Off meeting as described in Section 01 81 13 General LEED® Requirements.

1.7 SUBMITTALS

- .1 Construction Indoor Air Quality (IAQ) Management Plan:

- .1 No less than one week prior to the LEED® Coordination Meeting, prepare and submit a Construction Indoor Air Quality (IAQ) Management Plan for review by the Consultant. Revise and resubmit the plan as required by the Consultant.
- .2 The Construction IAQ Management Plan shall address the following:
 - .1 Describe how the project will meet the requirements of this Section and recommended design approaches of the SMACNA IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition, 2007, Chapter 3.
 - .2 Address the non-smoking policy during construction.
 - .3 Describe how the project will achieve compliance with the LEED® Construction Indoor Air Quality Management Plan credit and meet the post-construction, pre-occupancy IAQ requirements described in this Section.
- .2 IAQ 1: Low-Emitting Materials Calculator (appended to this Section):
 - .1 Complete the calculator and collect supporting documentation (SDS, Product data sheets, letter from manufacturers, general emissions evaluation, etc.) to document emission rates for adhesives, sealants, paints, coatings, flooring systems, composite wood products, and ceilings, walls, thermal, and acoustic insulation applied on-site that fall within the building weather barrier.
 - .2 Complete form to document quantities of adhesives, sealants, paints, coatings, flooring systems, and composite wood products applied on-site that fall within the building weather barrier.
 - .3 Submit completed forms and supporting product literature to Consultant for review at least 14 Days prior to ordering.
 - .4 Ensure Contractor and/or Subcontractor verifies specified products forming part of their work meet the requirements of this Section. Report conflicts between these requirements and specified Products to Consultant immediately.
- .3 IAQ 2: IAQ Management Inspection Form (appended to this Section):
 - .1 Contractor (or other person(s) delegated by Contractor) must complete the inspection form on a bi-weekly basis. Commence inspections when building ductwork is being installed and building is enclosed and carry through to building turnover. Submit completed IAQ Management Inspection Forms to the Consultant on a monthly basis as part of the ongoing Monthly LEED Reports required in Section 01 81 13 – General LEED Requirements.
 - .2 Submit a final copy of all completed inspection forms to Consultant after construction and prior to Contractor demobilization.
- .4 IAQ 3: Photo Documentation Checklist (appended to this Section):
 - .1 Ensure Contractor (or other person(s) delegated by Contractor) provides photographs as specified in checklist.
 - .2 Photographs must be included for each bi-weekly IAQ Inspection during construction to demonstrate continuous compliance.
 - .3 Photographs must be accompanied by date taken and a description of indoor air quality management measure depicted.

.5 Filtration Media Documentation:

- .1 In the event that permanent HVAC equipment is operated during construction, the Contractor shall submit documentation to the Consultant for review and approval prior to installation of filtration media. Documentation must demonstrate that all filtration media used over return air grills or ducts has a Minimum Efficiency Reporting Value (MERV) of 8. The Contractor shall not use any filtration media for this use until receiving approval from the Consultant.

PART 2 PRODUCTS

2.1 ALL PRODUCTS

- .1 All building products and materials that must be considered for the LEED® Low Emitting Materials credit are divided into seven categories:
- .1 Interior paints and coatings applied on site
 - .2 Interior adhesives and sealants applied on site (including flooring adhesive)
 - .3 Flooring
 - .4 Composite wood
 - .5 Ceilings, walls, thermal, and acoustic insulation
 - .6 Furniture (only included if part of scope of work)
 - .7 Exterior applied products (only applicable to healthcare and school projects)
- .2 All building products that fall into categories 1 to 5, as listed above, must meet the specific emissions and content requirements described herein.

2.2 INTERIOR PAINTS AND COATINGS

- .1 Interior paints and coatings applied on-site and within the building weather barrier must have a General Emissions Evaluation completed; these products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017.
- .2 Interior paints and coatings applied on site and within the building weather barrier must also must meet the applicable VOC limits of the South Coast Air Quality Management District (SCAQMD) Rule 1113.
- .3 VOC content limits of SCAQMD Rule 1113 are as follows:

Coatings	
Category	VOC Limit (grams/litre)
Clear Wood Finish, Lacquer	550
Clear Wood Finish, Sanding Sealer	350

Clear Wood Finish, Varnish	350
Clear Brushing Lacquer	680
Floor Coatings	100
Sealers and Undercoaters	200
Shellac: Clear	730
Shellac: Pigmented	550
Stain	250
Concrete-Curing Compounds	350
Japans/Faux Finishing Coatings	350
Magnesite Cement Coatings	450
Pigmented Lacquer	550
Waterproofing Sealers	250
Waterproofing Concrete/Masonry Sealers	400
Wood Preservatives	350
Low Solids Coatings	120 (incl. water)

- .4 Submit supporting documentation for all interior paints and coatings applied onsite and within the building weather barrier.

2.3 INTERIOR ADHESIVES AND SEALANTS

- .1 Interior adhesives and sealants applied on-site and within the building weather barrier must have a General Emissions Evaluation completed; these products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017.
- .2 Interior adhesives and sealants applied on site and within the building weather barrier must also must meet the applicable VOC limits of the South Coast Air Quality Management District (SCAQMD) Rule 1168.
- .3 VOC content limits of SCAQMD Rule 1168 are as follows:

Architectural Adhesives

Category	VOC Limit (grams/litre)
Indoor Carpet Adhesive	50
Carpet Pad Adhesive	50

Wood Flooring Adhesive	100
Rubber Floor Adhesive	60
Subfloor Adhesive	50
Ceramic Tile Adhesive	65
VCT and Asphalt Tile Adhesive	50
Drywall and Panel Adhesive	50
Cove Base Adhesive	50
Multipurpose Construction Adhesive	70
Structural Glazing Adhesive	100

Specialty Adhesives

Category	VOC Limit (grams/litre)
PVC Welding	510
CPVC Welding	490
ABS Welding	325
Plastic Cement Welding Adhesive	250
Adhesive Primer for Plastic	550
Contact Adhesive	80
Special Purpose Contact Adhesive	250
Structural Wood Member Adhesive	140
Sheet Applied Rubber Lining Operations	850
Top and Trim Adhesive	250

Substrate Specific Adhesives

Category	VOC Limit (grams/litre)
Metal to Metal Adhesive	30

Plastic Foam Adhesive	50
Porous Material (except wood) Adhesive	50
Wood Adhesive	30
Fibreglass Adhesive	80

Sealants

Category	VOC Limit (grams/litre)
Architectural Sealant	250
Non-membrane Roof Sealant	300
Roadway Sealant	250
Single-Ply Roof Membrane Sealant	450
Other Sealant	420

Sealant Primers

Category	VOC Limit (grams/litre)
Architectural, Non-Porous Sealant Primer	250
Architectural, Porous Sealant Primer	775
Other Sealant Primer	750

- .4 Submit supporting documentation for all adhesives and sealants applied onsite and within the building weather barrier.

2.4 FLOORING

- .1 Interior flooring systems must have a General Emissions Evaluation completed; these products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017.

- .2 If flooring systems are made from naturally occurring, inorganic materials (i.e.: granite, untreated and unfinished solid wood, etc.), such products do not need to undergo VOC testing and can be deemed as inherently non-emitting materials.
- .3 Submit supporting documentation required for all applicable flooring systems used in the building.

2.5 COMPOSITE WOOD

- .1 Composite wood must be documented to have low formaldehyde emissions that meet the California Air Resources Board (CARB) 93120 Airborne Toxic Control Measure (ATCM). The requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde resins apply.
- .2 Submit supporting documentation as required for all composite wood used in the building.

2.6 CEILINGS, WALLS, THERMAL, AND ACOUSTIC INSULATION

- .1 Ceilings, walls, thermal and acoustic insulation products must have a general emissions evaluation completed; these products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017.
- .2 Submit supporting documentation as required for all ceilings, walls, thermal and acoustic insulation products used in the building.

2.7 FILTRATION MEDIA REQUIREMENTS

- .1 Air filter minimum efficiency reporting value (MERV) ratings shall be determined by ASHRAE 52.2-2007.
- .2 Air handling equipment not used during construction:
 - .1 Install filters as per mechanical specifications
- .3 Air handling equipment used during construction:
 - .1 Install filters as per mechanical specifications
 - .2 Install new filters with a minimum MERV 8 rating at all return and exhaust grills and inlets before any HVAC system is operated
 - .3 Replace all air handling filtration media prior to building occupancy
 - .4 Submit supporting documentation as required for all filtration media used during construction.

PART 3 EXECUTION

3.1 POLLUTANT SOURCE IDENTIFICATION

- .1 Identify potential sources of indoor air pollutants on construction site.

- .2 Any construction activity or material producing odour and/or dust is considered a source of air pollutant. Pollutant sources include but are not limited to:
 - .1 Materials producing detectable odour such as paints, stains, grouts, cleaning products, fuels, caulking, and sealants.
 - .2 Materials creating dust such as concrete products, gypsum board, wood products, tile, and acoustic ceiling panels.
 - .3 Equipment emitting products of combustion or creating odour and/or dust such as generators, compressors, soldering guns, portable heaters, vehicles, and welding equipment.
 - .4 Construction activities disrupting pollutants such as demolition, repairs, and renovations.

3.2 MINIMIZE POLLUTANTS

- .1 Minimize pollutants generated inside building from sources identified under "Pollutant Source Identification" using following measures:
 - .1 Prohibiting smoking inside building at all times during construction.
 - .2 Fuelling up equipment outside building.
 - .3 Storing gasoline or solvents outside building.
 - .4 Restricting outdoor vehicular/equipment traffic and operation where emissions can enter building.
 - .5 Reducing on-site emissions by using equipment that burns propane/natural gas or is powered by electricity.
 - .6 Exhausting pollutant sources directly outside using temporary or permanent ventilation equipment. Where exhaust is not feasible, locally re-circulate air through a portable air cleaner.
 - .7 Collecting and bagging sawdust from woodworking tools.
 - .8 Covering and/or sealing indoor sources of odour and dust.
 - .9 Using painting techniques minimizing odour (e.g. roller instead of spraying).
 - .10 Using cleaning practices minimizing dust (e.g. vacuum instead of sweeping).
 - .11 Using cleaning Products minimizing pollution, fumes, VOC's, etc.
 - .12 Prohibiting burning of garbage

3.3 POLLUTANT CONTAINMENT MEASURES

- .1 Prevent movement of pollutants from sources identified under "Pollutant Source Identification" to other areas in building using following measures:
- .2 When possible, perform pollutant generating activities outside building. :
- .3 Move equipment, work and other pollutant sources to locations where they will have minimum impact on indoor air quality.

- .4 Setup small, contained, designated work areas to contain pollutants.
- .5 Avoid open areas and areas with high drafts.
- .6 Erect dust curtains and barriers.
- .7 Depressurize areas using temporary or permanent ventilation equipment
- .8 Use portable fans to exhaust pollutants (e.g. gas engine exhaust) to exterior through windows, doors, etc. Ensure adjacent windows, doors, etc. will not allow pollutants to re-enter building.
- .9 Close windows and doors adjacent to pollutant sources (e.g. dust, vehicle emissions, etc.) outside of building. If windows and doors have not been installed, temporarily seal exterior openings with plastic, wood, etc.
- .10 Pressurize occupied or completed areas of building using temporary or permanent ventilation equipment.

3.4 HOUSEKEEPING MEASURES

- .1 Prevent accumulation of moisture, dust and dirt in building from sources identified under "Pollutant Source Identification" using following measures:
 - .1 Frequently cleaning interior surfaces to minimize dust and dirt accumulation by:
 - .1 Dusting with damp rags.
 - .2 Wet mopping.
 - .3 Sweeping using wetting agents and sweeping compounds
 - .4 Vacuuming with equipment containing HEPA filtration and/or a wet scrubber.
 - .5 Localized cleaning should occur immediately after a construction activity is completed and/or at end of each Day. Perform a full building clean-up at least once a week
 - .2 Close exterior windows and doors or create temporary enclosures using plastic or wood to prevent moisture accumulation indoors.
 - .3 Immediately remove any water accumulated indoors to protect interior surfaces and materials.
 - .4 Cover, seal and protect materials stored and installed on-site from moisture, dust and dirt accumulation.
 - .5 Elevate materials stored on-site off ground to protect from moisture and dirt accumulation.
 - .6 Do not install materials with evidence of moisture damage or excessive moisture accumulation.
 - .7 Use ventilation/dehumidification to control humidity levels within the building, if necessary
 - .8 Promptly clean spills (fuels, lubricants, paints, adhesives, etc.).
 - .9 Clean or remove excess application of solvent-containing Products

3.5 HVAC PROTECTION MEASURES

- .1 During/Before Installation
 - .1 Cover (with plastic) and elevate (off ground) ductwork, fittings, insulation, acoustic lining and equipment stored on site during construction.
 - .2 Seal supply, return and exhaust openings as well as temporary ductwork openings not under immediate work (e.g. open ends in ductwork runs) with plastic. Seal openings immediately after installation in areas that will no longer be under work.
 - .3 Close/cover hatches and access doors in HVAC equipment that will not be under work.
 - .4 Seal HVAC equipment openings (e.g. inlets/outlets of air handlers, fans, VAV boxes, etc.) with plastic until ductwork is connected.
 - .5 Do not use mechanical rooms to store or collect construction waste materials.
 - .6 Install ceiling tiles and seal openings into plenum with plastic prior to final cleaning.
- .2 After Installation (select Option 1 or Option 2 for each HVAC system):
 - .1 Option 1: HVAC Equipment Not Used During Construction (Recommended):
 - .1 Do not operate any permanent HVAC equipment or systems during construction.
 - .2 Seal openings in HVAC systems, ductwork and plenums.
 - .3 If HVAC system protection measures are not implemented, or if system is operated during construction, Contractor must provide duct cleaning services, plus necessary access doors, at no extra cost to Contract.
 - .4 After construction and final cleaning work is complete Contractor shall:
 - .1 Remove HVAC protection measures.
 - .2 Install new filters in air handling equipment.
 - .3 Start-up systems.
 - .4 Prepare systems for Testing, Adjusting and Balancing Contractor and Commissioning Agent.
 - .2 Option 2: HVAC Equipment Used During Construction:
 - .1 Install new filters in air handling equipment before any HVAC system is operated. Provide a duct-mounted filter (external to equipment) if necessary.
 - .2 Install new filters with a minimum MERV 8 rating at return and exhaust grilles and inlets before any HVAC system is operated.
 - .3 Temporarily shut down return/exhaust side of HVAC systems during heavy construction/demolition.
 - .4 Permanently close off return/exhaust side of HVAC systems in areas with high dust levels. Cover duct openings with plastic in these areas.

- .5 If HVAC system is operated without above protection measures in place, Contractor must provide duct cleaning services, plus necessary access doors, at no extra cost to Contract.
- .6 After construction and final cleaning work is complete Contractor shall:
 - .1 Remove temporary filters installed on return grilles.
 - .2 Install new filters in air handling equipment.
 - .3 Prepare systems for Testing, Adjusting and Balancing Contractor and Commissioning Agent.

3.6 SCHEDULING

- .1 Schedule construction activities to minimize amount of VOC's, odours and fumes absorbed by porous materials (e g ceiling tiles, carpet, etc.).
- .2 Complete applications of wet and odorous materials such as paints, sealants and coatings before installing absorbent "sink" materials such as ceiling tiles, carpets and fabric-covered furnishings.
- .3 Allow for Testing, Adjusting and Balancing to be carried out following construction and before occupancy (refer to HVAC Protection Measures).
- .4 Allow for corrective work related to general deficiencies, Testing, Adjusting and Balancing, and is Commissioning to be carried out following construction and before occupancy.

3.7 INSPECTIONS AND MAINTENANCE

- .1 Inspect indoor air quality management measures and remedy any deficiencies on a weekly basis.
- .2 Record inspections using the IAQ Management Inspection Form and denote measures implemented at time of inspection, any deficiencies as well as corrective actions taken.
- .3 Provide photos using the Photo Documentation Checklist at various occasions during construction to demonstrate continuous compliance.
- .4 Pollutant containment, housekeeping and HVAC protection measures will be reviewed by the Consultant during each site visit.
- .5 Deficiencies identified by the Consultant must be remedied and documented in the IAQ Management Inspection Form within 48 hours of notification.
- .6 Clean or replace any equipment or materials incorrectly stored or improperly protected at no extra cost to the Contract.

3.8 REMOVAL OF PROTECTION MEASURES

- .1 Remove products/materials installed as a part of indoor air quality management measures prior to the building turnover. Any remedial work required as a result of removing measures is responsibility of Contractor.

3.9 PRE-OCCUPANCY IAQ TESTING

- .1 Post construction/pre-occupancy IAQ testing is to be conducted by a separate testing agent. The testing agent is to be retained and coordinated by the Contractor.
- .2 It is the Contractor's responsibility to allow for the scheduling of the required IAQ testing following construction and prior to occupancy in the areas identified by the testing agent.
- .3 Testing shall include the minimum number of sampling locations as provided by the LEED Consultant including all occupied spaces and no less than one sampling location per floor. Sample locations should be evenly distributed throughout the building to obtain representation for all areas.
- .4 Indoor sampling shall be completed between 900 mm and 1800 mm from the floor.
- .5 Results indicating that air quality testing has been completed and maximum chemical contaminant concentration requirements are required for each area tested.
 - .1 Testing must demonstrate chemical contaminants do not exceed the following concentrations:

Contaminant	Maximum Concentration
Particulate Matter	(PM10): 50 ug/m ³ (PM2.5): 15 ug/m ³
Formaldehyde	27 parts per billion
Total Volatile Organic Compounds	500 ug/m ³
Carbon Monoxide	9 PPM and no more than 2 PPM above outdoors

- .2 Testing must also demonstrate target chemicals do not exceed the following concentrations as listed in CDPH Standard Method v1.2, Table 4-1 (except formaldehyde):

Contaminant	Maximum Concentration (ug/m ³)
Acetaldehyde	70
Benzene	1.5
Carbon disulfide	400
Carbon tetrachloride	20
Chlorobenzene	500
Chloroform	150
Dichlorobenzene (1,4-)	400
Dichloroethylene (1,1)	35
Dimethylformamide (N,N-)	40
Dioxane (1,4-)	1500

Epichlorohydrin	1.5
Ethylbenzene	1000
Ethylene glycol	200
Ethylene glycol monoethyl ether	35
Ethylene glycol monoethyl ether acetate	150
Ethylene glycol monomethyl ether	30
Ethylene glycol monomethyl ether acetate	45
Hexane (n-)	3500
Isophorone	1000
Isopropanol	3500
Methyl chloroform	500
Methylene chloride	200
Methyl <i>t</i> -butyl ether	4000
Naphthalene	4.5
Phenol	100
Propylene glycol monomethyl ether	3500
Styrene	450
Tetrachloroethylene	17.5
Toluene	150
Trichloroethylene	300
Vinyl acetate	100
Xylenes, technical mixture (m-, o-, p-xylene combined)	350

- .3 In the event that passing results cannot be obtained for each of the IAQ tests it is the responsibility of the contractor to flush the failing area with temporary or permanent fans and arrange for re-testing prior to occupancy.
- .6 Copies of all testing results and reports must be submitted to the LEED Consultant upon testing completion but before occupancy.

END OF SECTION

IAQ 1 – LOW-EMITTING MATERIALS IDENTIFICATION
(Submit to the Consultant 14 days prior to ordering product/material)

Project Name:		Completed By:	
Project Location:		Company:	

Complete the following table for all applicable materials as per Section 01 81 19. This includes the following:

- Composite Wood on site and within the weather barrier including particle board, medium density fiberboard (both medium density & thin), hardwood plywood with veneer, composite or combination core, and wood structural panels or structural wood products, exclude products covered in flooring, ceiling, wall panels or furniture material category
- Carpet, carpet cushion, and all flooring materials

For the purposes of LEED® documentation, I certify the following information:

Product & Manufacturer	Cost	Surface Area	FloorScore Certified? (hard surface flooring)	Green Label Product? (carpet materials)	Certified CARB ultra-low-emitting formaldehyde (ULEF) or no added formaldehyde (NAF)? (composite wood)	Attached Supporting Documentation
						<input type="checkbox"/> MSDS <input type="checkbox"/> Product Data Sheet <input type="checkbox"/> Product Literature <input type="checkbox"/> Manufacturer Letter
						<input type="checkbox"/> MSDS <input type="checkbox"/> Product Data Sheet <input type="checkbox"/> Product Literature <input type="checkbox"/> Manufacturer Letter
						<input type="checkbox"/> MSDS <input type="checkbox"/> Product Data Sheet <input type="checkbox"/> Product Literature <input type="checkbox"/> Manufacturer Letter
						<input type="checkbox"/> MSDS <input type="checkbox"/> Product Data Sheet <input type="checkbox"/> Product Literature <input type="checkbox"/> Manufacturer Letter
						<input type="checkbox"/> MSDS <input type="checkbox"/> Product Data Sheet <input type="checkbox"/> Product Literature <input type="checkbox"/> Manufacturer Letter

I hereby certify that the information provided above is complete and correct:

_____	_____	_____
Signature of Authorized Official	Position	Date

Volatile Organic Compound (VOC): Organic chemicals that produce vapors at room temperature and atmospheric pressure (e.g. gasoline, solvents, etc). VOCs react with sunlight and nitrogen to form ground-level ozone, a chemical that has detrimental effects on human health and the environment.

Carpet and Rug Institute (CRI) Green Label: A program established by the national trade association representing the carpet and rug industry to identify carpet products that have been tested by an independent laboratory and have met the criteria for low VOC emissions. (www.carpet-rug.org)

Urea Formaldehyde: A combination of urea and formaldehyde that is used in some glues which readily decomposes at room temperature. Urea Formaldehyde is carcinogenic and an irritant to most people when present in high concentrations.

FloorScore Program: FloorScore program tests and certifies flooring products for compliance with indoor air quality emission requirements. Flooring products include vinyl, linoleum, laminate flooring, wood flooring, ceramic flooring, rubber flooring, wall base, and associated sundries.

IAQ 2: IAQ MANAGEMENT INSPECTION FORM

(Complete Weekly. Submit most recent copy to the Consultant on a monthly basis)

Project Name:		Completed By:	
Project Location:		Company:	

Date		IAQ Management Measures			Initials
		Currently Implemented	Deficiencies	Corrective Action Taken	
EX.	Sept 17/09	Dust curtain and HVAC pressurization protecting finished offices on 2 nd floor	Standing water present adjacent to sprinkler room in basement	Water removed. Adjacent materials were not damaged	G.L.

I hereby certify that the information provided above is complete and correct:

_____	_____	_____
Signature of Authorized Official	Position	Date

IAQ 3: PHOTO DOCUMENTATION CHECKLIST

(Submit with photos to Consultant after construction and prior to demobilization)

Project Name:		Completed By:	
Project Location:		Company:	

Indoor Air Quality Management Measure	Date:	
	Observed	N/A
Tobacco smoke prohibited inside the building (signage)	<input type="checkbox"/>	<input type="checkbox"/>
Gasoline and solvents stored outside the building	<input type="checkbox"/>	<input type="checkbox"/>
Outdoor equipment restricted around building	<input type="checkbox"/>	<input type="checkbox"/>
Electric, propane or natural gas powered equipment	<input type="checkbox"/>	<input type="checkbox"/>
Pollutant sources exhausted to outside	<input type="checkbox"/>	<input type="checkbox"/>
Portable air cleaner used to filter air in work areas	<input type="checkbox"/>	<input type="checkbox"/>
Sawdust from wood working tools collected and bagged	<input type="checkbox"/>	<input type="checkbox"/>
Indoor sources of odour and dust covered/sealed	<input type="checkbox"/>	<input type="checkbox"/>
Painting techniques used to minimize odour	<input type="checkbox"/>	<input type="checkbox"/>
Temporary dust curtains and barriers	<input type="checkbox"/>	<input type="checkbox"/>
Designated cutting and work areas	<input type="checkbox"/>	<input type="checkbox"/>
Materials covered, sealed and protected	<input type="checkbox"/>	<input type="checkbox"/>
Materials stored elevated off the ground	<input type="checkbox"/>	<input type="checkbox"/>
Building sealed from the exterior environment	<input type="checkbox"/>	<input type="checkbox"/>
Wetting agents, sweeping compounds, wet rags/mops	<input type="checkbox"/>	<input type="checkbox"/>
Vacuuming with HEPA filtration and/or wet scrubber	<input type="checkbox"/>	<input type="checkbox"/>
Ventilation/dehumidification to remove moisture	<input type="checkbox"/>	<input type="checkbox"/>
Protecting stored ductwork, lining, insulation & fittings	<input type="checkbox"/>	<input type="checkbox"/>
Scheduled construction activities	<input type="checkbox"/>	<input type="checkbox"/>
Openings in ducts sealed w/ plastic	<input type="checkbox"/>	<input type="checkbox"/>
Openings & hatches in HVAC equip. sealed w/ plastic	<input type="checkbox"/>	<input type="checkbox"/>
Supply, return and exhaust openings sealed w/ plastic	<input type="checkbox"/>	<input type="checkbox"/>
Ceiling plenum openings sealed w/plastic	<input type="checkbox"/>	<input type="checkbox"/>
Ceiling tiles installed prior to final cleaning	<input type="checkbox"/>	<input type="checkbox"/>

I hereby certify that the information provided above is complete and correct:

<hr/> Signature of Authorized Official	<hr/> Position	<hr/> Date
<hr/>		

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to Division 01 requirements and documents referred to therein.

1.2 SUMMARY

- .1 Section Includes:
 - .1 General requirements relating to commissioning of Project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.

1.3 REFERENCES

- .1 Acronyms:
 - .1 AFD - Alternate Forms of Delivery, service provider.
 - .2 BMM - Building Management Manual.
 - .3 Cx - Commissioning.
 - .4 EMCS - Energy Monitoring and Control Systems.
 - .5 IST – Integrated Systems Testing.
 - .6 O&M - Operation and Maintenance.
 - .7 PI - Product Information.
 - .8 PV - Performance Verification.
 - .9 TAB - Testing, Adjusting and Balancing.

1.4 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.
- .2 Objectives:
 - .1 Verify installed equipment, systems and integrated systems operate in accordance with Contract Documents and design criteria and intent.
 - .2 Ensure appropriate documentation is compiled into the BMM.
 - .3 Effectively train O&M staff.
- .3 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.

- .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .4 Design Criteria: as per client's requirements or determined by design consultant. To meet Project functional and operational requirements.

1.5 COMMISSIONING OVERVIEW

- .1 Section 01 91 13.13 - Commissioning (CX) Plan.
- .2 For Cx responsibilities refer to Section 01 91 13.13 - Commissioning (CX) Plan.
- .3 Cx to be a line item of Contractor's cost breakdown.
- .4 Cx activities supplement field quality and testing procedures described in relevant technical Sections.
- .5 Cx is conducted in concert with activities performed during stage of Project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .6 Consultant will issue Interim Acceptance Certificate when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Commissioning Authority.
 - .2 Equipment, components, systems, and integrated systems have been fully commissioned and function as per design intent to meet Project functional, operational requirements, and construction documents.
 - .3 Completion of O&M training session to operational and maintenance staff.
 - .4 Final O&M and Training Manual received, reviewed and approved by Commissioning Authority for suitability.
 - .5 Successful completion of integrated system tests, life safety support systems tests and after meeting all requirements of the authority having jurisdiction.

1.6 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Commissioning Authority, to ensure effective performance.
- .2 Costs for corrective Work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or holdback assessments.

1.7 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review Contract documents, confirm by writing to Commissioning Authority.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.
 - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
 - .3 Fully understand Cx requirements and procedures.
 - .4 Have Cx documentation shelf-ready.
 - .5 Understand completely design criteria and intent and special features.
 - .6 Submit complete start-up documentation to Commissioning Authority.
 - .7 Have Cx schedules up-to-date.
 - .8 Ensure systems have been cleaned thoroughly.
 - .9 Complete TAB procedures on systems, submit TAB reports to Commissioning Authority for review and approval.
 - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Commissioning Authority in writing of discrepancies and deficiencies on finished Works.

1.8 CONFLICTS

- .1 Report conflicts between requirements of this Section and other Sections to Commissioning Authority before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.9 INFORMATION SUBMITTALS / ACTION SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit no later than 4 weeks after award of Contract:
 - .1 Draft Cx documentation.
 - .2 Preliminary Cx schedule.
 - .2 Request in writing to Commissioning Authority for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to Commissioning Authority where not specified and obtain written approval at least 8 weeks prior to start of Cx.

- .4 Provide additional documentation relating to Cx process required by Commissioning Authority.

1.10 COMMISSIONING DOCUMENTATION

- .1 Commissioning Authority to review and approve Cx documentation.
- .2 Provide completed and approved Cx documentation to Commissioning Authority.

1.11 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Construction Schedule.
- .2 Provide adequate time for Cx activities prescribed in technical Sections and commissioning Sections including:
 - .1 Approval of Cx reports.
 - .2 Verification of reported results.
 - .3 Repairs, retesting, re-commissioning, re-verification.
 - .4 Training.

1.12 COMMISSIONING MEETINGS

- .1 Convene Cx meetings following Project meetings and as specified herein.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage. Commissioning Authority to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and Subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until Project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by Contractor, who will record and distribute minutes.
- .7 Ensure Subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.13 STARTING AND TESTING

- .1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

1.14 WITNESSING OF STARTING AND TESTING

- .1 Provide 14 days notice to the Commissioning Authority and Owner prior to commencement of start-up and testing work.
- .2 Commissioning Authority and Owner's representative to witness of start-up and testing.
- .3 Commissioning Authority to be present at tests performed and documented by sub-trades, Suppliers and equipment manufacturers.

1.15 MANUFACTURER'S INVOLVEMENT

- .1 Factory testing: manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Provide testing documentation for approval by Commissioning Authority.
 - .3 Arrange for Commissioning Authority to witness tests.
 - .4 Obtain written approval of test results and documentation from Commissioning Authority before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Commissioning Authority.
 - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
 - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's personnel:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 To report results in clear, concise, logical manner.

1.16 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.

- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to Specification, approved Shop Drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Commissioning Authority after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Commissioning Authority. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
 - .1 Minor equipment/systems: implement corrective measures approved by Commissioning Authority.
 - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Commissioning Authority.
 - .3 If evaluation report concludes that major damage has occurred, Commissioning Authority shall reject equipment.
 - .1 Rejected equipment to be remove from site and replace with new.
 - .2 Subject new equipment/systems to specified start-up procedures.

1.17 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to Commissioning Authority for approval before commencement of commissioning.
- .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up check lists.
 - .4 Start-up reports,
 - .5 Step-by-step description of complete start-up procedures, to permit Commissioning Authority to repeat start-up at any time.

1.18 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

- .2 With assistance of manufacturer develop written maintenance program and submit to Commissioning Authority for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.
- .5 The Contractor shall prepare and submit a comprehensive O&M Manual that integrates the Environmental Compliance Approval (ECA) requirements with Stormwater Management Pond operations, in consultation with the Consultant.

1.19 TEST RESULTS

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

1.20 START OF COMMISSIONING

- .1 Notify Commissioning Authority at least 21 Days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.21 INSTRUMENTS / EQUIPMENT

- .1 Submit to Commissioning Authority for review and approval:
 - .1 Complete list of instruments proposed to be used.
 - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
 - .1 2-way radios.
 - .2 Ladders.
 - .3 Equipment as required to complete Work.

1.22 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
 - .1 Under actual operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.

- .4 EMCS trending to be available as supporting documentation for performance verification.

1.23 WITNESSING COMMISSIONING

- .1 Commissioning Authority and Owner's Representative to witness activities and verify results.

1.24 AUTHORITIES HAVING JURISDICTION

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to Commissioning Authority within 5 days of test and with Cx report.

1.25 COMMISSIONING CONSTRAINTS

- .1 Since access into secure or sensitive areas will be very difficult after occupancy it is necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems in these areas before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

1.26 EXTRAPOLATION OF RESULTS

- .1 Weather or seasonally sensitive commissioning shall occur during the appropriate season, even if after substantial completion. Where commissioning cannot be conducted under near-rated or near-design conditions, extrapolation of part-load results to design conditions may be permitted when approved by the Commissioning Authority, using manufacturer's data and methods.

1.27 EXTENT OF VERIFICATION

- .1 Laboratory areas:
 - .1 Provide manpower and instrumentation to verify up to 100% of reported results.
- .2 Elsewhere:
 - .1 Provide manpower and instrumentation to verify up to 30% of reported results, unless specified otherwise in other Sections.
- .3 Number and location to be at discretion of Commissioning Authority.
- .4 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.

- .5 Review and repeat commissioning of systems if inconsistencies found in more than 20% of reported results.
- .6 Perform additional commissioning until results are acceptable to Commissioning Authority.

1.28 REPEAT VERIFICATIONS

- .1 Assume costs incurred by Commissioning Authority for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Commissioning Authority approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Commissioning Authority deems Contractor's request for second verification was premature.

1.29 SUNDRY CHECKS AND ADJUSTMENTS

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

1.30 DEFICIENCIES, FAULTS, DEFECTS

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Commissioning Authority.
- .2 Report problems, faults or defects affecting Cx to Commissioning Authority in writing. Stop Cx until problems are rectified. Proceed with written approval from Commissioning Authority.

1.31 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx Specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when Contract Cx deliverables have been submitted and accepted by Commissioning Authority.

1.32 ACTIVITIES UPON COMPLETION OF COMMISSIONING

- .1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

1.33 TRAINING

- .1 In accordance with Section 01 79 00 – Demonstration and Training.

1.34 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

- .1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in Contract.

1.35 OCCUPANCY

- .1 Cooperate fully with Commissioning Authority during stages of acceptance and occupancy of facility.

1.36 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these Specifications.
 - .2 Calibration certificates have been deposited with Commissioning Authority.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.37 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.
- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
 - .1 Unless otherwise specified actual values to be within +/- 2% of recorded values.

1.38 OWNER'S PERFORMANCE TESTING

- .1 Performance testing of equipment or system by Commissioning Authority will not relieve Contractor from compliance with specified start-up and testing procedures.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

1.2 REFERENCES

.1 Acronyms:

- .1 Cx - Commissioning.
- .2 BMM - Building Management Manual.
- .3 EMCS - Energy Monitoring and Control Systems.
- .4 MSDS - Material Safety Data Sheets.
- .5 PI - Product Information.
- .6 PV - Performance Verification.
- .7 TAB - Testing, Adjusting and Balancing.
- .8 WHMIS - Workplace Hazardous Materials Information System.

.2 Definitions:

- .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
- .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.
- .3 Term "Cx" in this section means "Commissioning".

.3 Reference Standards:

- .1 American Water Works Association (AWWA).
- .2 The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE 202-2018, Standard 202 -2018 -- Commissioning Process for Buildings and Systems (ANSI Approved; IES Co-sponsored).
- .3 Canadian Standards Association (CSA Group):
 - .1 CSA Z320-11 (R2021), Building Commissioning, Includes Update No. 1(2011).
- .4 National Fire Protection Association (NFPA):
 - .1 NFPA (Fire) 13, Standard for the Installation of Sprinkler Systems, 2022 Edition.
 - .2 NFPA (Fire) 14, Standard for the installation of Standpipe and hose Systems, 2019 Edition
 - .3 NFPA (Fire) 20, Installation of Stationary Pumps for Fire Protection, 2022 Edition.
- .5 Underwriters' Laboratories of Canada (ULC):

- .1 ULC 1001-11, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems (CAN/ULC S1001-11).

1.3 GENERAL

- .1 Provide a fully functional facility.
 - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
 - .2 Facility user and O&M personnel have been fully trained in aspects of installed systems.
 - .3 Optimized life cycle costs.
 - .4 Complete documentation relating to installed equipment and systems.
- .2 Use this Cx Plan as master planning document for Cx:
 - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
 - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
 - .3 Sets out deliverables relating to O&M, process and administration of Cx.
 - .4 Describes process of verification of how built Works meet Owner/Investor's requirements.
 - .5 Produces a complete functional system prior to issuance of Certificate of Occupancy.
 - .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 - .1 Overview of Cx.
 - .2 General description of elements that make up Cx Plan.
 - .3 Process and methodology for successful Cx.

1.4 DEVELOPMENT OF 100% CX PLAN

- .1 Cx Plan to be 100% completed within 8 weeks of award of Contract to take into account:
 - .1 Approved Shop Drawings and product data.
 - .2 Approved changes to Contract.
 - .3 Contractor's Project schedule.
 - .4 Cx schedule.
 - .5 Contractor's, Sub-Contractor's, Suppliers' requirements.
 - .6 Project construction team's and Cx team's requirements.
- .2 Submit completed Cx Plan to Owner and Consultant and obtain written approval.

1.5 REFINEMENT OF CX PLAN

- .1 During construction phase, revise, refine and update Cx Plan to include:
 - .1 Changes resulting from Client program modifications.
 - .2 Approved design and construction changes.

- .2 Revise, refine and update every 6 months during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Owner and Consultant for review and obtain written approval.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

- .1 Cx Team consists of following members:
 - .1 Owner's Commissioning Authority is responsible for:
 - .1 Ensuring Cx activities are carried out to ensure delivery of a fully operational Project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O&M personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
 - .6 Organizing Cx.
 - .7 Monitoring operations Cx activities.
 - .8 Witnessing, certifying accuracy of reported results.
 - .9 Witnessing and certifying TAB and other tests.
 - .10 Developing BMM.
 - .11 Ensuring implementation of final Cx Plan.
 - .12 Performing verification of performance of installed systems and equipment.
 - .13 Implementation of Training Plan.
 - .2 Implementing specified Cx activities in coordination with the Contractor including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
 - .2 Consultant is responsible for:
 - .1 Reviewing the Cx plan and demonstration scripts are in accordance with design expectations.
 - .2 Conducting periodic site reviews to observe general progress during construction.

- .3 Construction Team: Contractor, Sub-Contractors, Suppliers and support disciplines, is responsible for construction/installation in accordance with Contract Documents, including:
 - .1 Assigning one person as point of contact with Owner, Consultant and Cx Manager for administrative and coordination purposes.
- .4 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

- .1 Employ the following Cx participants to verify performance of equipment and systems:
 - .1 Installation Contractor/Subcontractor:
 - .1 Equipment and systems except as noted.
 - .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include performance verification.
 - .3 Specialist Subcontractor: equipment and systems supplied and installed by specialist Subcontractor.
 - .4 Specialist Cx agency:
 - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this Project.
 - .5 Client: responsible for intrusion and access security systems.
 - .6 Ensure that Cx participant:
 - .1 Could complete Work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O&M personnel, including:
 - .1 Modify ventilation rates to meet changes in off-gassing.
 - .2 Changes to heating or cooling loads beyond scope of EMCS.
 - .3 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
 - .4 Redistribution of electrical services.
 - .5 Modifications of fire alarm systems.
 - .6 Modifications to voice communications systems.
 - .7 Provide names of participants to Commissioning Authority and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

1.8 EXTENT OF CX

- .1 Cx Structural and Architectural Systems:
 - .1 Architectural and structural:
 - .1 Beam and slab deflection:
 - .1 Refer to Section G – Structural Movements/S005 & Table 1/S005 of Entuitive's structural drawings.
 - .2 Exterior systems:
 - .1 Refer to Section G – Structural Movements/S005 & Table 1/S005 of Entuitive's structural drawings.
 - .3 Doors, windows, related hardware:
 - .1 Door and window hardware.
 - .2 Commission mechanical systems and associated equipment:
 - .1 Plumbing systems:
 - .1 Domestic CWS and HWS.
 - .2 Regular sanitary waste systems.
 - .3 Sewage pumps.
 - .4 Storm water systems.
 - .5 Sump pumps.
 - .2 HVAC and exhaust systems:
 - .1 HVAC systems.
 - .2 General exhaust systems.
 - .3 Exhaust systems and related systems
 - .4 Heat recovery systems
 - .3 Fire and life safety systems:
 - .1 Fire extinguishers.
 - .2 Integrated Systems Testing (IST) of fire protection and life safety systems.
 - .4 Noise and vibration control systems for mechanical systems.
 - .5 Seismic restraint and control measures.
 - .1 Refer to Section B – Lateral Load Restraining System/S005 of Entuitive's structural drawings.
 - .6 IAQ environmental control systems:
 - .1 Indoor conditions
 - .2 Indoor air quality (IAQ)
 - .3 Environmental control systems
 - .7 EMCS:
 - .1 Energy metering systems.
 - .3 Commission electrical systems and equipment:
 - .1 High voltage:
 - .1 High voltage switch gear and transformation equipment.
 - .2 High voltage distribution systems.

- .2 Low voltage below 750 V:
 - .1 Low voltage equipment.
 - .2 Low voltage distribution systems.
 - .3 Voice communications systems.
 - .4 Audio/visual systems.
 - .5 Electronic data and communications information systems.
- .3 Emergency power generation systems:
 - .1 Generators.
 - .2 Fuel systems.
 - .3 Transfer switchgear and controllers.
- .4 Lighting systems:
 - .1 Lighting equipment.
 - .2 Distribution systems.
 - .3 Emergency lighting systems, including battery packs.
 - .4 Fire exit emergency signage.
- .5 Other systems and equipment:
 - .1 Intrusion and access security and safety systems.

1.9 DELIVERABLES RELATING TO O&M PERSPECTIVES

- .1 General requirements:
 - .1 Compile English and French documentation.
 - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
 - .1 Warranties.
 - .2 Project record documentation.
 - .3 Inventory of spare parts, special tools and maintenance materials.
 - .4 Maintenance Management System (MMS) identification system used.
 - .5 WHMIS information.
 - .6 MSDS data sheets.
 - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.10 DELIVERABLES RELATING TO THE CX PROCESS

- .1 General:
 - .1 Start-up, testing and Cx requirements, conditions for acceptance and Specifications form part of relevant technical sections of these Specifications.
- .2 Definitions:
 - .1 Cx as used in this Section includes:
 - .1 Cx of components, equipment, systems, subsystems, and integrated systems.

- .2 Factory inspections and performance verification tests.
- .3 Deliverables: Commissioning Authority provides:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed performance verification (PV) report forms.
 - .6 Results of Performance Verification Tests and Inspections.
 - .7 Description of Cx activities and documentation.
 - .8 Description of Cx of integrated systems and documentation.
 - .9 Training Plans.
 - .10 Cx Reports.
 - .11 Prescribed activities during warranty period.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
 - .1 Pre-Start-Up inspections: by Commissioning Authority prior to permission to start up and rectification of deficiencies to Consultant's satisfaction.
 - .2 Contractor to use approved check lists.
 - .3 Commissioning Authority will monitor some of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Commissioning Authority and does not form part of Cx Specifications.
 - .6 Consultant may monitor some of these inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - ARCHITECTURAL AND STRUCTURAL:
 - .1 Slab and beam deflection test: test after removal of temporary supports and concrete has cured to ensure adequacy for raised floors.
 - .2 Exterior walls: conduct thermographic surveys to ensure appropriate level of tightness after exterior envelope has been completed. Permanent HVAC systems are able to provide appropriate negative or positive pressure, a temperature of at 20 degrees C can be maintained between inside and outside and wind speed is less than 10 kph.
 - .3 Doors, windows, related hardware:
 - .1 Overhead doors
 - .2 Door and window hardware
- .3 Pre-Cx activities - MECHANICAL:
 - .1 Plumbing systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.

- .2 Complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
- .2 HVAC equipment and systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be approved by Commissioning Authority and Consultant.
- .3 EMCS:
 - .1 EMCS trending to be available as supporting documentation for performance verification.
 - .2 Perform point-by-point testing in parallel with start-up.
 - .3 Carry out point-by-point verification.
 - .4 Demonstrate performance of systems, to be witnessed by Commissioning Authority prior to start of 30 day Final Acceptance Test period.
 - .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
 - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
- .4 Pre-Cx activities - LIFE SAFETY SYSTEMS
 - .1 Include equipment and systems identified above.
 - .2 Reports of test results to be witnessed and certified by Commissioning Authority before submission to Consultant; retest in presence of Consultant when requested.
- .5 Pre-Cx activities - ELECTRICAL:
 - .1 High voltage distribution systems over 750 V:
 - .2 Low voltage distribution systems under 750 V:
 - .1 Requires independent testing agency to perform pre- energization and post-energization tests.
 - .3 Emergency power generation systems
 - .1 Transfer switches: test by simulating loss of power. Verify availability of power at equipment requiring same.
 - .4 Lighting systems:
 - .1 Emergency lighting systems:
 - .1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.
 - .5 Low voltage systems: these include:
 - .1 Communications, low voltage lighting control systems and data communications systems.

- .6 Security, surveillance and intrusion alarm systems

1.12 START-UP

- .1 Start up components, equipment and systems.
- .2 Equipment manufacturer, Supplier, installing specialist Sub-Contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
- .3 Commissioning Authority to monitor some of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Commissioning Authority.
- .4 Performance Verification (PV):
 - .1 Contractor to perform.
 - .1 Repeat when necessary until results are acceptable to Consultant Commissioning Authority.
 - .2 Use procedures modified generic procedures to suit Project requirements.
 - .3 Commissioning Authority to witness and certify reported results using approved PI and PV forms.
 - .4 Commissioning Authority to approve completed PV reports and provide to Owner.
 - .5 Consultant reserves right to verify up to 30% of reported results at random.
 - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Perform Cx by specified Commissioning Authority using procedures developed by Commissioning Authority and approved by Owner.
- .2 Commissioning Authority to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.
- .4 Commissioning Authority to witness, certify reported results of, Cx activities and forward to Owner.
- .5 Consultant reserves right to verify a percentage of reported results at no cost to Contract.

1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

- .1 Cx of integrated systems shall be implemented to bring systems from a state of individual substantial completion to full dynamic operation. During the testing process, unexpected, conflicting and incorrect system operations shall be identified, recorded and corrected. The completion of testing shall result in expected and reliable functioning of all complementary systems, in all modes and demand loading.

- .2 Cx to be performed by specified Commissioning Authority using procedures developed by Commissioning Authority and approved by Owner.
- .3 Tests to be witnessed by Commissioning Authority and documented on approved report forms.
- .4 Upon satisfactory completion Contractor to prepare Cx Report, to be certified by Commissioning Authority and submitted to Owner for review.
- .5 Owner reserves right to verify percentage of reported results.
- .6 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance Commissioning Authority, Contractor, and Project Manager to co-operate to complete inventory data sheets and provide assistance to Owner in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.15 INSTALLATION CHECK LISTS (ICL)

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.16 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.17 PERFORMANCE VERIFICATION (PV) REPORT

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.18 DELIVERABLES RELATING TO ADMINISTRATION OF CX

- .1 General:
 - .1 Because of risk assessment, Commissioning Authority shall complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

1.19 CX SCHEDULES

- .1 Commissioning Authority shall prepare detailed critical path Cx Schedule and submit to Owner for review and approval same time as Project Construction Schedule. Include:
 - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
 - .1 Design criteria, design intents.
 - .2 Pre-TAB review: 28 days after Contract award, and before construction starts.

- .3 Commissioning Authority's credentials: 60 days before start of Cx.
- .4 Cx procedures: 3 months after award of Contract.
- .5 Cx Report format: 3 months after Contract award.
- .6 Discussion of heating/cooling loads for Cx: 3 months before start-up.
- .7 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.
- .8 Notification of intention to start TAB: 21 days before start of TAB.
- .9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
- .10 Notification of intention to start Cx: 14 days before start of Cx.
- .11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.
- .12 Identification of deferred Cx.
- .13 Implementation of training plans.
- .14 Cx of smoke management/control systems: after Cx of related systems is completed and 7 days before proposed date of Cx these systems.
- .15 Cx reports: immediately upon successful completion of Cx.
- .16 Emergency evacuation exercises: after 80% occupancy.
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of Project and hand-over to Property Manager.
- .3 6 months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Contractor, Commissioning Authority, and Owner will monitor progress of Cx against this schedule.

1.20 CX REPORTS

- .1 Commissioning Authority shall submit reports of tests, witnessed and certified by Commissioning Authority.
- .2 Include completed and certified PV reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results may be subject to verification by Consultant.

1.21 ACTIVITIES DURING WARRANTY PERIOD

- .1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:
 - .1 Fine tuning of HVAC systems.

- .2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.
- .3 Full-scale emergency evacuation exercises.

1.22 TESTS TO BE PERFORMED BY OWNER/USER

- .1 None is anticipated on this Project.

1.23 TRAINING PLANS

- .1 Refer to Section 01 79 00 – Demonstration and Training.

1.24 FINAL SETTINGS

- .1 Upon completion of Cx to satisfaction of Owner lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 RESOLUTION LOG

- .1 Provide resolution log in accordance with CSA Z320.

END OF SECTION

Commissioning Plan

YORK REGION NORTH ROADS OPERATIONS CENTRE



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Overview

Purpose of this Commissioning Plan

This Commissioning Plan is meant to be additional instructions to the Commissioning Plan included in as part of the contract documents/specifications. Any conflicting instructions between the documents, the original contract documents/specifications shall preside. This Commissioning Plan is to be used as a Commissioning planning, management and communications tool. It sets out scope, standards, roles and responsibilities, expectations, and deliverables. It provides an overview of commissioning, and sets out the process and the methodology for successful commissioning of the project. The Commissioning Plan provides direction for the commissioning process during construction, particularly providing resolution for issues and providing details that cannot be, or were not, fully developed during design, such as scheduling, participation of various parties of this particular project, actual lines of reporting and approvals, coordination, etc.

This plan does not provide a detailed explanation of required testing procedures. The detailed testing requirements and procedures are found in the Specifications and any applicable Codes or Standards. Additional details regarding functional and Pre-Functional testing will be developed during construction when start-up sequencing is better understood.

Commissioning Scope

GCMYs scope according to the Owner's contract commences during the construction phase of this project will involve the completion of a number of activities, mainly by the equipment suppliers and installing contractors and coordinated by the Commissioning Authority.

According to the Contract Documents:

- Preparation and submission of a commissioning plan, including, pre-functional check sheets and functional check sheets for each system to be commissioned
- During construction, inspect the site and be familiar with project particulars
- Coordinate and participate in the execution of pre-functional and functional checks and tests.
- Witness and ensure Owner's staff have been trained to use and troubleshoot each system included in the project.
- Verify completeness of the O&M manuals.
- Inspect site to assess the operation of the system approximately 8 to 10 months after substantial completion

- Compile final commissioning report to indicate whether systems, subsystems, and equipment have been properly installed according to the contract documents.

Abbreviations and Definitions

The following are common abbreviations used in this document.

A/E	Architect and Design Engineers
CA	Commissioning Authority
CC	Controls Contractor
FM	Facility Manager/Service Provider
FT	Functional Performance Test
GC	General Contractor
MC	Mechanical Contractor
PC	Pre-functional Test sheet
PM	Project Manager
SUBS	Subcontractors to General
TAB	Test and Balance Contractor
CX	Commissioning
CX PLAN	Commissioning Plan document
EC	Electrical Contractor

Systems to be Commissioned

The following marked systems will be commissioned in this project.

HVAC Systems

X	Energy Recovery Ventilators
X	Heat Exchangers
X	In-Slab Radiant Heating (Floor and Snow Melt)
X	VAVs
X	FCUs/CUs/SB (Branch Selector)
X	VRF Heat Pumps
X	Unheated Air Curtains
X	Ceiling Fans (Big Ass Fans)
X	Unit Heaters
X	Entrance Heaters
X	DHWH
X	Pumps
X	Humidifier
X	Piping, cleaning and flushing
X	Duct pressure testing

X	Testing, Adjusting and Balancing work
X	Temperature, Humidity and CO2 sensors
X	HVAC Controls
X	Air Flushing

Electrical Systems

X	Lighting controls
X	Dimming controls
X	Emergency Lighting
X	Exit Signs
X	Main Switchgear
X	Electrical Panels
X	Meters
X	150kW Outdoor Generator
X	ATS's
X	Roll-up Doors

Plumbing

X	Faucets, water closets, urinals, shower fixtures
X	Floor Drains
X	Domestic Water Pump Operation
X	Domestic Hot Water Heater
X	Domestic Hot Water Tanks
X	Sump Pumps and Control

Building Envelope

X	Wall Assembly
X	Air/Vapour Barrier
X	Roofing
X	Thermal Scans (Positive & Negative Pressure)
X	Passive House Pressure Tests (Positive and Negative)

General Building Information

Project	York Region North Roads Operations Centre
Owner	The Regional Municipality of York
Building Name	YRNROC
Address	3252 Baseline Road, Sutton West, ON
Building Type	Office and Garage Expansion
Approximate ft²	Office – 697 m ² Garage – 1,081 m ²
Construction Period	Spring 2025 – Early 2027

Commissioning Team Members

Owner	Name & Title	Fang Li, Sr. Project Manager, Property Services Branch	Cell #	905-215-2629
	E-Mail:	fang.li@york.ca	Office #:	
	Company:	York Region	Ext.	
	Address:	17250 Yonge Street Newmarket, ON L3Y 6Z1	Fax #:	
Project Manager	Name & Title		Cell #	
	E-Mail:		Office #:	
	Company:		Ext.	
	Address:		Fax #:	
General Contractor	Name & Title		Cell #	
	E-Mail:		Office #:	
	Company:		Ext.	
	Address:		Fax #:	
Commissioning Authority	Name & Title	Gavin Yeung, Director	Cell #	
	E-Mail:	gavin.yeung@gcmy.ca	Office #:	416-859-4994
	Company:	GCMY Inc.	Ext.	
	Address:	20 Bay St., Suite 1100 Toronto, ON M5J 2N8	Fax #:	
Architect	Name & Title	Angela Ng, Intern Architect	Cell #	647-749-3388 x 305
	E-Mail:	Angela.ng@gecarchitecture.com	Office #:	
	Company:	GEC Architecture	Ext.	
	Address:	#403, 179 John St., Toronto, M5T 1X4, Canada	Fax #:	
Mechanical Engineer	Name & Title	Nathan Lao, Associate	Cell #	416-598-2920 Ex 360
	E-Mail:	nlao@mcw.com	Office #:	
	Company:	MCW	Ext.	
	Address:	Queen's Quay Terminal	Fax #:	

		207 Queen's Quay West, Suite 615, Toronto, ON, M5J 1A7, Canada		
Electrical Engineer	Name & Title	Shiv Bhojak, Principal	Cell #	
	E-Mail:	sbhojak@mcw.com	Office #:	416-598-2920 x 345
	Company:	MCW	Ext.	
	Address:	Queen's Quay Terminal 207 Queen's Quay West, Suite 615, Toronto, ON, M5J 1A7, Canada	Fax #:	
Passive House Consultant	Name & Title	Dave Fraser, CPHC	Cell #	519-400-2354
	E-Mail:	dave@peelpassivehouse.ca	Office #:	
	Company:	Peel Passive House	Ext.	
	Address:	118 Craigleith Rd., Blue Mountain, ON, Canada, L9Y 0S3	Fax #:	
Mechanical Contractor	Name & Title		Cell #	
	E-Mail:		Ext #:	
	Company:		Office #:	
	Address:		Fax #:	
Electrical Contractor	Name & Title		Cell #	
	E-Mail:		Ext #:	
	Company:		Office #:	
	Address:		Fax #:	
TAB Contractor	Name & Title		Cell #	
	E-Mail:		Office #:	
	Company:		Ext.	
	Address:		Fax #:	
Controls Contractor	Name & Title		Cell #	
	E-Mail:		Ext #:	
	Company:		Office #:	
	Address:		Fax #:	

Roles and Responsibilities

Location of Role Descriptions

Descriptions and explanations of the roles and responsibilities of those in the commissioning process are found in the following places in the Contract Documents.

LIST OF TEAM MEMBERS	Cx Plan
MANAGEMENT PLAN OUTLINE	Cx Plan
GENERAL ROLES	Cx Plan

SPECIFIC RESPONSIBILITIES

Information For All Parties	Cx Plan, Construction Specifications
General Contractors/Project Manager	Cx Plan, Construction Specifications
Mechanical Contractor, Controls Contractor, Subs-Trades And Manufacturers, Testing And Balancing	Cx Plan, Construction Specifications
Electrical Contractor, Subs-Trades And Manufacturers	Cx Plan, Construction Specifications
Commissioning Authority	Cx Plan, Commissioning Specifications
Architect/Design Engineers	Cx Plan

Team Members

The members of the commissioning team consist of the CA, PM, assigned members of the GC, A/E (particularly the mechanical engineer), the mechanical contractor, electrical contractor, TAB representative, controls contractor, any other installing subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/ engineer is also a member of the commissioning team.

General Management Plan

The CA was hired by the Owner. In general, the CA coordinates the commissioning activities and reports to the Owner. The commissioning responsibilities of all contractors' are detailed in the specifications. The specifications will take contractual precedence over this Cx Plan. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. Refer to the management protocols section below.

General Description of Roles

General descriptions of the commissioning roles are as follows:

CA	Coordinates the Cx process, writes tests, oversees and documents performance tests
GC	Facilitates the Cx process, ensures that Subs perform their responsibilities and integrates Cx into the construction process and schedule
Subs	Demonstrate proper system performance
A/E	Perform construction observation, approve O&M manuals and assist in resolving problems
PM	Facilitates and supports the Cx process and gives final approval of the Cx work
Mfr	The equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform contracted startup

Commissioning Process

This section sequentially details the commissioning process by commissioning task or activity.

Commissioning Plan

The CA finalizes the draft Cx Plan using the information gathered from the scoping meeting, construction meetings, and/or from discussions with the PM. The commissioning schedule is below in Appendix A. The schedule is fine-tuned as construction progresses. The commissioning plan is approved by the PM.

Site Observation

The CA, and PM if applicable, makes periodic visits to the site, as necessary, to witness equipment and system installations.

Miscellaneous Meetings

The CA attends selected planning and job-site meetings in order to remain informed on construction progress and to update parties involved in commissioning. The PM and GC provide the CA with information regarding substitutions, change orders and any Architect's Supplemental Instructions (ASI) that may affect commissioning equipment, systems or the commissioning schedule. The CA may review construction meeting minutes, change orders or ASIs for the same purpose.

Later during construction, necessary meetings between various commissioning team parties will be scheduled by the CA, through the PM, as required.

Miscellaneous Management Protocols

The following protocols will be used on this project.

Issue	Protocol
For requests for information (RFI) or formal documentation requests:	The CA goes first through the PM.
For minor or verbal information and clarifications:	The CA goes direct to the informed party.
For notifying contractors of deficiencies:	The CA documents deficiencies through the PM, but may discuss deficiency issues with contractors prior to notifying the PM.

For scheduling functional tests or training:	The CA may provide input for and do some coordination of training and testing, but scheduling shall be coordinated through the PM.
For scheduling commissioning meetings:	The CA selects the date and schedules through the PM.
For making a request for significant changes:	The CA has no authority to issue change orders.
For making small changes in specified sequences of operations:	The CA may <u>not</u> make changes to specified sequences without approval from the A/E.
Subcontractors disagreeing with requests or interpretations by the CA shall:	Try and resolve with the CA first. Then work through GC who will work with CA directly or through the PM to resolve the situation.

Site Inspections

Prior to the start of construction, the CA and/or the PM will inspect the site, become familiar with the project particularities, “as-is” condition of the site, and other factors affecting the work. During construction, the CA will inspect the project approximately once per month or as necessary. Each site inspection will be followed up with a site inspection report. Site inspection reports will be provided to the PM and GC for review and resolution of deficiencies.

Initial Submittals and Documentation

Standard Submittals

The PM will provide CA with drawings, approved shop drawings, change notices, etc., as required. The GC Coordinator will provide the CA with equipment commissioning requirements that typically includes pre-functional readiness forms, installation and start-up procedures, O&M data, performance data and control drawings. The CA reviews and approves submissions relative to commissioning issues expressed in the contract documents, not for general contract compliance (which is the A/E’s responsibility).

Special Submittals, Notifications and Clarifications

The Subs, GC or A/E notify the CA of any new design intent or operating parameter changes, added control strategies and sequences of operation, or other change orders that may affect commissioned systems. The controls contractor shall provide the CA a full points list with details requested by the CA. Thirty (30) days prior to performing Functional Testing, the Subs provide the CA full details of the procedures. As the phases of the TAB are completed, the draft TAB report is provided to the CA with full explanations of results, data table legends, etc. The final TAB report shall be provided to the CA upon completion.

The submittals to the CA do not constitute compliance for submittals for the O&M manuals. Documentation requirements for the O&M manuals are the A/E's responsibility.

The CA may request additional design narrative from the A/E and from the controls contractor depending on how complete the documentation is that was submitted with the approved shop drawings. The CA may submit written RFIs to contractors through the PM, or address them directly for clarifications, as needed.

Prefunctional Checklists, Tests and Startup

Prefunctional checklists (PC) are important to ensure that the equipment and systems are hooked up and operational and that functional performance testing may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout by the Contractor. No sampling strategies are used. In general, the prefunctional testing for a given system, must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., oil levels OK, fan belt tension, labels affixed, gages in place, sensor calibration, etc.). However, some prefunctional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). The word prefunctional refers to before functional testing. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist.

Contractors typically already perform some, if not many, of the prefunctional checklist items the commissioning authority will recommend. However, few contractors document in writing the execution of these checklist items. This project requires that the procedures be documented in writing by the installing technician. The CA does not witness much of the prefunctional checklisting, except for testing of larger or more critical pieces of equipment and some spot-checking.

Execution of Checklists and Startup

Four (4) weeks prior to startup, the Subs and vendors schedule startup and initial checkout with the PM, GC and CA. The startup and initial checkout are directed and executed by the Sub or vendor. The CA, and PM if necessary, observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, when a sampling strategy is used. For components of equipment, (e.g., VAV boxes), the CA observes a sampling of the prefunctional and start-up procedures.

Commissioning Process

To document the process of startup and checkout, the site technician performing the line item task initials and dates each paragraph of procedures in the “Startup Plan” and checks off items on the prefunctional and manufacturer field checkout sheets, as they are completed. Only individuals having direct knowledge of a line item being completed shall check or initial the forms.

The Subs and vendors execute the checklists and tests and submit a signed copy of the completed start-up and prefunctional tests and checklists to the CA, using Form C-3a or b. The CA may review prefunctional checklists in progress, as necessary. On smaller equipment or projects, the checklists (which all contain more than one trade’s responsibility), may be passed around to the Subs to fill out. For larger projects, each trade may need a full form and the CA will consolidate them later.

Sampling Strategy for CA Observation of Prefunctional Checkout and Startup

The following table provides a tentative list of the equipment and how much of the startup work will be witnessed by the commissioning authority. Observation of prefunctional checklist execution will be at the discretion of the CA.

Equipment or System	Fraction To Be Tested/Observed by CA
Equipment Start-ups	Witness and confirm and review start-up reports to confirm equipment operation under peak demand/load and confirm failure conditions
Electrical and Lighting Systems	25%
ERVs	100%
AC Units	100%
Exhaust Fans	100%
VRF Heat Pumps	100%
Destratification Fans	100%
Pumps	100%
Humidifier	100%
Unit Heaters	100%
DHWH	100%
Pipe Cleaning and Flushing	Witness and verify
Pipe Pressure Testing	Witness and verify
Passive House Pressure Tests	Witness and verify
Wall Assembly	Cx will review wall assembly mock-up prior to installation. Cx will review and visually inspect exterior wall assembly installation prior to closing up – contractors to notify when complete.

Air/Vapour Barrier	Cx will review wall assembly mock-up prior to installation. Cx will review and visually inspect exterior wall assembly installation prior to closing up – contractors to notify when complete
Roofing	Cx will review wall assembly mock-up prior to installation. Cx will review and visually inspect exterior wall assembly installation prior to closing up – contractors to notify when complete
Thermal Scan	Cx will witness thermal scan completed during positive and negative pressure. Cx will review thermal scan report after completion
HVAC Controls	Test and Confirm Control Points and Complete Integrated Systems Testing (testing each input sequence and confirming the appropriate output)
TAB work	Review TAB Report, Witness and confirm air flow and volumes
Other misc. equipment	As necessary

Deficiencies and Non-Conformance

The Subs clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully at the bottom of the procedures form or on an attached sheet. The procedures form and deficiencies are provided to the CA within two days of test completion. The Subs and vendors are required to correct and retest deficiencies or uncompleted items, involving the PM and others as necessary and provided corrections to prefunctional checklists and start-up reports to the CA. The installing Subs or vendors correct all areas that are deficient or incomplete according to the checklists and tests.

TAB

Where TAB is required, the TAB contractor submits the outline of the TAB plan and approach to the CA and the controls contractor eight (8) weeks prior to starting the TAB. Included in the approach, is an explanation of the intended use of the building control system. The CA reviews the plan and approach for understanding and coordination issues and may comment, but does not “approve.” The controls contractor reviews the feasibility of using the building control system for assistance in the TAB work. The TAB submits weekly written reports of discrepancies, contract interpretation requests and lists of completed tests to the CA and PM. This facilitates quicker resolution of problems and will result in a more complete TAB before functional testing begins.

TAB work will not begin until the control system has been prefunctionally tested and selective functional tests have been performed and approved by the CA.

Controls Checkout Plan

The controls contractor develops and submits a written step-by-step plan to the CA which describes the process they intend to follow in checking out the control system and the forms on which they will document the process. The controls contractor will also meet with the TAB contractor prior to the start of TAB and review the TAB plan to determine the capabilities of the control system for use in TAB. The controls contractor will provide the TAB with any necessary unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.). The controls contractor shall also provide a technician qualified to operate the controls to assist the TAB contractor in performing TAB.

The controls contractor shall execute the tests and trend logs assigned to them in prefunctional checklists, calibrations, start-up and selected functional tests and remain on site for assistance for mechanical system functional tests as required.

Development of Functional Test and Verification Procedures

Overview

Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all of the control system's sequences of operation and components are verified to be responding as the sequences state. The CA develops the functional test procedures in a written form, which is performed by the installing contractor or vendor.

Development Process

Before test procedures are written, the PM and A/E will provide the CA with all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, control sequences and setpoints. The CA develops specific test procedures to verify proper operation of each piece of equipment and system. When necessary, the A/E and Contractors will provide the CA with clarification regarding sequences and operation to develop these tests. Prior to execution, the CA provides a copy of the primary equipment tests to the installing Sub (via the GC) who reviews the tests for feasibility, safety, warranty and equipment protection.

Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the

results using the control system's trend log capabilities or by stand-alone dataloggers. The CA follows the Specifications when provided and uses judgment where needed to determine which method is most appropriate. According to the Specifications, not all pieces of identical equipment receive in-depth testing. The CA reviews owner-contracted, factory or required owner acceptance tests and determines what further testing may be required to comply with the Specifications. Redundancy is minimized.

Execution of Functional Testing Procedures

Overview and Process

The CA schedules functional tests through the PM, GC and affected Subs. For any given system, prior to performing functional testing, the CA waits until the prefunctional checklist has been submitted with the necessary signatures, confirming that the system is ready for functional testing. The CA oversees, witnesses and documents the functional testing of all equipment and systems according to the Specifications and the Cx Plan. The Subs execute the tests. The control system is tested before it is used to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems and finally to interlocks and connections between systems.

Deficiencies and Retesting

The CA documents the results of the test. Corrections of minor deficiencies identified are made during the tests at the discretion of the CA. The CA records the results of the test. Deficiencies or non-conformance issues are noted and reported to the PM. GCs are responsible to manage Subs to correct deficiencies, and notify the CA of corrections. The CA may choose to retesting through the PM if deemed necessary. Decisions regarding deficiencies and corrections are made between CA or PM and the GC/Sub. For areas in dispute, final authority, resides with the PM (Owner).

Facility Staff Preparation

The Owner's facilities operating staff are encouraged to attend and participate in the testing process. The CA will notify the PM, who will then notify the facility staff when the commissioning events will occur.

Sampling

Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy to be determined at the discretion of the CA.

O&M Manuals and Warranties

Standard O&M Manuals

The CA verifies the completeness of the O&M manuals to ensure that all required material is included (names and addresses of contractors and sub-trades, warranties and certificates, reviewed shop drawings, diagrams, etc).

Commissioning Report

At the conclusion of the commissioning work, a final commissioning report shall be compiled and submitted to the Board. The format of the commissioning report is as follows:

TAB 1	All records, minutes and documentation related to site inspections performed by the CA during the construction process.
TAB 2	Records of all other meetings, discussions and other coordination activities between the CA and the PM, GC, A/E, and/or Subs.
TAB 3	Copies of all equipment start-ups and balancing reports received from the Contractor.
TAB 4	All signed pre-functional tests confirming acceptance by the CA. Initially rejected pre-functional sheets shall be included, indicating deficiencies found. Repeated test check sheets shall be included, together with a description of the corrective actions taken by the contractor.
TAB 5	All signed functional tests confirming acceptance by the commissioning agent. Initially rejected functional sheets shall be included, indicating deficiencies found. Repeated test check sheets shall be included, together with a description of the corrective actions taken by the contractor.
TAB 6	Contractor training materials, training sign-in sheets, and any other training materials provided.
TAB 7 + Electronic Format	Confirmation by the CA that the O&M manuals have been reviewed, found complete, in accordance with the design specifications and were transferred to the Owner's Representative in both hard copy and electronic format.
Electronic Format	Final as-build documentation in electronic format.

Training of Owner Personnel

The CA shall witness the training process and certify that the Owner's facility staff has been trained to use and troubleshoot each system included in the project. The training shall be conducted by the Contractor, using own forces or retaining manufacturer's representatives, as

Commissioning Process

necessary. CA will confirm that training shall include the following the topics in the tables below.

Basis of System Design, Operational Requirements, and Criteria

	System, subsystem, and equipment descriptions.
	Performance and design criteria if Contractor is delegated design responsibility
	Operating standards
	Regulatory requirements
	Equipment function
	Operating characteristics
	Limiting conditions
	Performance curves

Emergencies

	Instructions on meaning of warnings, trouble indications, and error messages
	Instructions on stopping
	Shutdown instructions for each type of emergency
	Operating instructions for conditions outside of normal operating limits
	Sequences for electric or electronic systems
	Special operating instructions and procedures

Operations

	Startup procedures
	Equipment or system break-in procedures
	Routine and normal operating instructions
	Regulation and control procedures
	Control sequences
	Safety procedures
	Instructions on stopping
	Normal shutdown instructions
	Operating procedures for emergencies
	Operating procedures for system, subsystem, or equipment failure
	Seasonal and weekend operating instructions
	Required sequences for electric or electronic systems
	Special operating instructions and procedures

Adjustments

	Alignments
	Checking adjustments
	Noise and vibration adjustments
	Economy and efficiency adjustments

Troubleshooting

	Diagnostic instructions
	Test and inspection procedures

Maintenance

	Inspection procedures
	Types of cleaning agents to be used and methods of cleaning
	List of cleaning agents and methods of cleaning detrimental to product
	Procedures for routine cleaning
	Procedures for preventive maintenance
	Procedures for routine maintenance
	Instruction on use of special tools

Repairs

Commissioning Process

	Diagnosis instructions
	Repair instructions
	Disassembly; component removal, repair, and replacement; and reassembly instructions
	Instructions for identifying parts and components
	Review of spare parts needed for operation and maintenance

Appendix A: Commissioning Schedule

Scheduling Priorities

The following sequential priorities are followed:

- 1) Equipment is not “temporarily” started (for heating or cooling), until pre-start checklist items and all manufacturer’s pre-start procedures are completed and moisture, dust and other environmental and building integrity issues have been addressed.
- 2) Functional testing is not begun until prefunctional and start-up and TAB is completed, for a given system (this does not preclude a phased approach).
- 3) The controls system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional testing completed.
- 4) TAB is not performed until the controls system has been sufficiently functionally tested and approved by the CA for TAB work, except for
- 5) TAB is not performed until the envelope is completely enclosed and ceiling complete, unless the return are is ducted.

Project Schedule

The commissioning schedule is summarized in the table below. The commissioning schedule may change as construction progresses.

Task/Activity	Date
Construction Commissioning Plan Issued	TBD
Prefunctional forms developed and distributed	TBD
Building Envelope Mock-Up Inspections	TBD
M&E Rough-In Inspections and Pressure Testing	TBD
Pipe Cleaning and Flushing	TBD
Hydronic System Pressure Tests	TBD
Startup and initial checkout executed	TBD
TAB	TBD
Passive House Pressure Tests	TBD
Thermal Scans	TBD
Functional performance tests	TBD
IAQ Testing or Air Flushing (LEED Requirement)	TBD
O&M documentation verification	TBD
Training and training verification	TBD
Seasonal testing	TBD

Contact Information

Contact Information

GCMY Inc.
20 Bay St., Suite 1100
Toronto, ON M5J 2N8
(416) 859-4994



Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.

1.2 INSTALLATION/START-UP CHECK LISTS

- .1 Include the following data:
 - .1 Product manufacturer's installation instructions and recommended checks.
 - .2 Special procedures as specified in relevant technical Sections.
 - .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Commissioning Agent supplemental additional data lists will be required for specific Project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Commissioning Agent. Check lists will be required during Commissioning and will be included in Building Maintenance Manual (BMM) at completion of Project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the BMM at completion of Work.
- .2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Commissioning Agent's approval.

1.4 PERFORMANCE VERIFICATION (PV) FORMS

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with Project requirements.

- .2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.
- .3 Prior to PV of integrated system, complete PV forms of related systems and obtain Commissioning Agent's approval.

1.5 SAMPLES OF COMMISSIONING FORMS

- .1 Commissioning Agent will develop and provide to Contractor required Project-specific Commissioning forms in electronic format complete with Specification data.
 - .1 Integrated Systems Testing of Fire Protection and Life Safety Systems.
- .2 Revise items on Commissioning forms to suit Project requirements.
- .3 Samples of Commissioning forms and a complete index of produced to date will be attached to this Section.

1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, but are not available from Commissioning Agent develop appropriate verification forms and submit to Commissioning Agent for approval prior to use.
 - .1 Additional commissioning forms to be in same format as provided by Commissioning Agent.

1.7 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Commissioning Agent provides Contractor Project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required Shop Drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record analytical and substantiating data.
 - .7 Verify reported results.
 - .8 Form to bear signatures of recording technician and reviewed and signed off by Commissioning Agent.
 - .9 Submit immediately after tests are performed.
 - .10 Reported results in true measured SI unit values.
 - .11 Provide Commissioning Agent with originals of completed forms.

- .12 Maintain copy on site during start-up, testing and commissioning period.
- .13 Forms to be both hard copy and electronic format with typed written results in Building Management Manual.

1.8 LANGUAGE

- .1 To suit the language profile of the awarded Contract.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

(APPENDIX A) - Example

COMMISSIONING

Integrated Systems Testing of Fire Protection and Life Safety Systems

_____ on behalf of
Name of Company or Person Performing Integrated Systems Testing
(INTEGRATED TESTING COORDINATOR)

_____ has developed
Name of Building Owner or Designer/Design Engineer
and implemented the integrated testing plan at:

Address of Installation (Municipality)

This test was carried out as required by the Ontario Building Code, and in accordance with the appropriate standard noted below.

_____ hereby confirms
that

Name of Company or Person Performing Integrated Systems Testing

on _____, the integrated testing was performed in accordance with integrated
Month/Day/Year

testing plan to ensure proper operation & inter-relationship between the systems per original design prepared by _

Name of Designer

And subsequently updated to "As-Built" status by: _

Name of Contractor

The integrated testing was performed on _____ and proper operation and
Month/Day/Year

inter-relationship between the systems found to be fully operational in accordance with:

1. The Ontario Building Code, and
2. CAN/ULC 1001-11 Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems.

Note: Interconnection between the following integrated systems was subject to the test:

<input type="checkbox"/> fire alarm systems,	<input type="checkbox"/> elevator recalls,
<input type="checkbox"/> sprinkler & standpipes systems,	<input type="checkbox"/> emergency power,
<input type="checkbox"/> fire pumps	<input type="checkbox"/> emergency lighting,
<input type="checkbox"/> electromagnetic locks,	<input type="checkbox"/> smoke and fire shutters and dampers,
<input type="checkbox"/> door hold-open devices,	<input type="checkbox"/> smoke control, ventilation, pressurization,
<input type="checkbox"/> kitchen fire suppression	<input type="checkbox"/> other

Name of Company or Person Performing Integrated Systems Testing Signature or Person Responsible for Test

Note: Modifications to the integrated system after _____ will invalidate this Certificate.

Month/Day/Year

Signature of Person Assuming Responsibility for Test

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Removal of existing construction necessary to permit installation or performance of other Work and fitting and repairing work required to restore surfaces to original conditions after installation of other Work.
- .2 Related Requirements:
 - .1 Section 03 35 00 – Concrete Finishing
 - .2 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

- .1 Definitions:
 - .1 Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
 - .2 Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.
- .2 Reference Standards:
 - .1 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
 - .1 Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
 - .2 Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
 - .3 Products: List products to be used and firms or entities that will perform the Work.
 - .4 Dates: Indicate when cutting and patching will be performed.
 - .5 Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
 - .6 Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure to the Consultant prior to making cuts or modifications.
 - .7 Consultant's Acceptance: Obtain acceptance of cutting and patching proposal before cutting and patching. Review and acceptance of cutting and patching proposal does not waive right to later require removal and replacement of unsatisfactory work.

- .2 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00 - LEED Product Requirements.

1.4 QUALITY ASSURANCE

- .1 Structural Elements: Do not cut and patch structural elements in a manner that could change their load carrying capacity or load deflection ratio.
- .2 Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety, including but not limited to the following:
 - .1 Primary operational systems and equipment.
 - .2 Air or smoke barriers.
 - .3 Fire protection systems.
 - .4 Control systems.
 - .5 Communication systems.
 - .6 Electrical wiring systems.
- .3 Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety, including but not limited to the following:
 - .1 Water, moisture, or vapour barriers.
 - .2 Membranes and flashings.
 - .3 Exterior curtain wall construction.
 - .4 Equipment supports.
 - .5 Piping, ductwork, vessels, and equipment.
 - .6 Noise and vibration control elements and systems.
- .4 Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Consultant's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner. If possible, retain original Installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage original Installer or fabricator, engage another recognized, experienced, and specialized firm, including but not limited to the following:
 - .1 Processed concrete finishes.
 - .2 Masonry.
 - .3 Ornamental metal.
 - .4 Firestopping and smoke seals.
 - .5 Finished flooring.
 - .6 Finished coatings.
 - .7 Wall covering.

- .8 HVAC enclosures, cabinets, or covers.
- .5 Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.
- .6 Should material resembling spray or trowel-applied asbestos or other designated substance listed as hazardous as defined in the Hazardous Product Act be encountered, stop work, take preventative measures, and notify Consultant and Owner immediately.

1.5 WARRANTY

- .1 Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

Part 2 Products

2.1 MATERIALS

- .1 General: Comply with requirements specified in other Sections of these Specifications.
- .2 Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible:
 - .1 If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed and in accordance with Delegated Design Requirements:
 - .1 Provide X-ray or other approved methods to determine locations of existing services and reinforcing in existing concrete slabs and block walls before cutting and renovations. Advise Consultant of findings before proceeding with the Work and revise penetration locations as required and directed by Consultant. Existing concrete slab thickness is to be confirmed by Contractor.
 - .2 Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - .3 Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- .1 Temporary Support: Provide temporary support of Work to be cut.
- .2 Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- .3 Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- .4 Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to minimize interruption of services to occupied areas.

3.3 PERFORMANCE

- .1 General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay:
 - .1 Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- .2 Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations:
 - .1 In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - .2 Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - .3 Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond core drill.
 - .4 Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - .5 Proceed with patching after construction operations requiring cutting are complete.
- .3 Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications:
 - .1 Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 - .2 Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

- .3 Floors and Walls: Where walls or partitions that are removed extend from one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, colour, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform colour and appearance.
- .4 Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
- .5 Ceilings: Patch, repair, or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance.
- .6 Maintain existing fire ratings as required.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 The following Definitions shall apply in this Specification:
- .2 Contract Documents
 - .1 The Contract Documents consist of the Drawings, Specifications and Reports which form part of the agreed Contract.
- .3 Consultant
 - .1 The Consultant is the Architect, SEOR, persons or entities engaged by the Owner. The term Consultant means the Consultant or the Consultant's authorized representative.
- .4 Contractor
 - .1 The term Contractor is defined to include any of the following: Construction Manager, General Contractor, Structural Steel Erector, Structural Steel Fabricator, Subcontractor or Supplier.
- .5 Owner
 - .1 The Owner is the person or entity identified as such in the Contract. The term Owner means the Owner or the Owner's authorized agent or representative but does not include the Consultant.
- .6 SEOR
 - .1 The SEOR is defined as the Structural Engineer of Record for the Contract.

1.2 WORK INCLUDED

- .1 Comply with Division 1, General Requirements and all documents referred to therein.
- .2 Provide all labour, materials, plant and equipment necessary to perform structural alterations indicated or noted on the drawings and as specified herein.
 - .1 Verification of field conditions and dimensions.
 - .2 Design of shoring, needling, and associated bracing along with the necessary foundations thereto as required to safely install new structural members.
 - .3 Temporary shoring, needling, and associated bracing and where necessary jacking of existing work and removal thereof as required to safely install new structural members.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Demolition of Structure, Section 02 41 19.
- .2 Concrete Forming, Section 03 10 00.

- .3 Concrete Reinforcement, Section 03 20 00.
- .4 Cast-in-Place Concrete, Section 03 30 00.
- .5 Structural Steel, Section 05 12 00.

1.4 REFERENCE STANDARDS, CODE AND ACTS

- .1 Conform to Ontario Regulation 332/12 (The Building Code) as amended by all subsequent Ontario Regulations issued to the date of this specification and applicable acts of authorities having jurisdiction.
 - .1 CSA A23.1-09 - Concrete Materials and Methods of Concrete Construction.
 - .2 CSA A23.2-09 - Test Methods and Standard Practices for Concrete.
 - .3 CSA S16-09 - Design of Steel Structures.
 - .4 CSA S269.1-1975 (R2003) - Falsework for Construction Purpose
- .2 Where there are differences between the specifications and drawings and the codes, standards and acts, the most stringent shall govern.

1.5 GENERAL

- .1 The drawings governing alterations to existing structural work were prepared using the following assumptions:
 - .1 The existing building is built in accordance with the original contract documents, significant details of which have been reproduced on the drawings.
 - .2 The workmanship and materials employed on the existing buildings were of good quality and the building has not deteriorated significantly.
 - .3 Bearing walls, structural steel, and structural concrete framing is reasonably true and plumb.
 - .4 Existing building documents used in preparing the documents for this contract include the following:
 - .1 Building Permit and Tender by URS Architects & Engineers Canada Inc. dated June 9, 2005.
 - .2 Issued for Construction by Engineering Link dated April 9, 2018

1.6 EXAMINATION

- .1 Examine the site and buildings on it. Establish conditions under which the work is to be done, and accept the premises as found upon taking possession of the property. The Owner will make no allowance for conditions that were apparent at the time of submission of tender. Direct all inquiries to the Consultant.
- .2 Before proceeding with alterations to structural members, verify that the existing building information shown on the drawings and the assumptions described above are correct. Should the drawing or the assumptions described above not

be correct, notify the Consultant immediately. The Consultant will determine revisions necessary to the work as shown. The Contractor shall provide the necessary assistance to enable the Consultant to determine the extent of the revisions necessary.

- .3 Investigate the existing building to determine actual field conditions, take field dimensions, ascertain loads and forces to be supported or resisted, probe structural bearing members to determine soundness, and perform other inspection as deemed necessary to carry out design of shoring, needling, bracing, and the like, to schedule the sequence of operations, and prepare shop drawings and details.

1.7 DESIGN

- .1 Design shoring, bracing, needling, scaffolding, and the like, along with the necessary foundations so that loads applied to them will be safely carried. Superimposed live loads, construction loads, and wind loads shall be taken into account and the lateral stability of the elements supported and the shoring and needling shall be insured.
- .2 The members requiring shoring or needling, the elements to be altered, the general sequence of operations and in some circumstances the type of needling and shoring are shown. These general requirements shall govern the design.
- .3 The design of shoring, needling and foundations thereto and the sequence of their installation and sequence of the work shall be prepared by a Professional Engineer licensed in the Province of Ontario.
- .4 Prepare design of shoring, and the like, in co-operation with other trades so that new work may be installed as required.

1.8 RESPONSIBILITY

- .1 The Contractor shall be responsible for all damage arising out of the work of the Contract and for all damage to adjacent private or public property. The Contractor shall make good damages caused in the performance of this contract to the satisfaction of the Consultant.
- .2 Review of shoring and needling design drawings by the Consultant shall in no way relieve the Contractor of its responsibility for carrying out the work in a manner which ensures the complete safety of the existing work, persons, and adjacent property and also ensures that no damage occurs thereto, during any period of the alterations.

1.9 SUBMITTALS

- .1 Prepare and submit to the Consultant drawings fully describing the shoring, needling, bracing and scaffolding work, the sequence of their installation and removal and the sequence of alterations.
- .2 Each drawing submitted shall bear the signature and stamp of a qualified Professional Engineer licensed in the Province of [Ontario]

- .3 Submit calculations to the Consultant if requested.
- .4 The Professional Engineer employed to design the shoring, bracing, needling and the like shall also be employed to fully supervise their installation and removal and shall submit weekly reports to the Consultant regarding these phases of the work.

Part 2 Products

2.1 Materials

- .1 Concrete, grouting, formwork and reinforcing steel shall conform to the requirements of CSA A23.1.
- .2 Structural Steel shall conform to the requirements of CSA S16.

Part 3 Execution

- 3.1 Carry out shoring and needling by means of jacking, wedging, or by other suitable means so that load is transferred to the shoring and needling without damaging the work supported. Ensure that over wedging does not damage the work.

3.2 Cutting and coring of Existing Structures

- .1 All dimensions provided by the Consultants are to be confirmed with the appropriate Contractor prior to cutting/coring.
- .2 Any revisions to the dimensions provided by the Consultants must be reviewed by the Consultants prior to cutting/coring.
- .3 Unless noted otherwise, no reinforcement is permitted to be cut when new openings are cut through the existing structure.
- .4 Do not cut or damage any existing post-tensioned tendons.
- .5 Prior to cutting the existing structure, all reinforcement (including any post-tensioned tendons) in the affected areas is to be located by a positive means, (i.e. x-raying, local chipping of slab, or use of cover meter) unless otherwise permitted by the Consultant and as shown on the drawings.
- .6 After reinforcement has been located in these areas, notify Consultant who will review the prior to cutting/coring. Make any necessary adjustments to the holes locations as required by the Consultant.
- .7 For any openings which are to be sawcut into the existing structure, pre-drill the corners using a 100 mm (4") diameter core drill. Do not overcut corners of opening.
- .8 For any areas where reinforcement is cut, the Contractor is to indicate the direction and layer of reinforcement on the as built drawings.
- .9 Where the drawings call for existing reinforcement to be exposed without cutting, take measures to ensure the existing reinforcement is exposed without being damaged.

3.3 QUALITY CONTROL

- .1 Spec. Note: Review sub-sections Quality Control, Notification, Inspection and Testing and Defective Materials and Work with Architect/Client. These sections all, or in part, may better be placed in General Conditions. If so, do not include here, but satisfy yourself that these sections are adequately covered in the General Conditions. If they are not, provide the Architect with suggested revisions. Our specification sections must not conflict with those found in the General Conditions.
- .2 Implement a system of quality control to ensure that the minimum standards specified herein are attained.
- .3 Bring to the attention of the Consultant any defects in the work or departures from the Contract Documents which may occur during Construction. The Consultant will decide upon corrective action and give his recommendations in writing.
- .4 The Consultant's general review during construction and inspection and testing by independent inspection and testing agencies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

3.4 NOTIFICATION

- .1 Prior to commencing significant segments of the work, give the Consultant and independent inspection and testing agencies appropriate notification so as to afford them reasonable opportunity to review the work. Failure to meet this requirement may be cause for the Consultant to classify the work as defective.

3.5 Inspection and Testing

- .1 Independent inspection and testing agencies shall be engaged by the Construction Manager for the purpose of inspecting and/or testing portions of the Work. Independent inspection/testing agencies engaged by the Construction Manager shall be acceptable to and approved by the Consultant.

3.6 DEFECTIVE MATERIALS AND WORK

- .1 Where evidence exists that defective work has occurred or that work has been carried out incorporating defective materials, the Consultant may have tests, concrete coring, inspections or surveys performed, analytical calculations of structural strength made and the like in order to help determine whether the work must be repaired or replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor's expense, regardless of their results, which may be such that, in the Consultant's opinion, the work may be acceptable.
- .2 All testing shall be conducted in accordance with the requirements of the Ontario Building Code, except where this would in the Consultant's opinion cause undue delay or give results not representative of the rejected material in place. In this

case, the tests shall be conducted in accordance with the standards given by the Consultant.

- .3 Materials or work which fail to meet specified requirements may be rejected by the Consultant whenever found at any time prior to final acceptance of the work regardless of previous inspection. If rejected, defective materials or work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the Owner.

END OF SECTION 02 20 10

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 This Section requires the selective removal and subsequent offsite disposal of site items as indicated on Drawings. Do not disturb items identified to remain in place.

1.2 REFERENCES

.1 Definitions:

- .1 Demolish: Detach items from existing construction and legally dispose of them off site, unless indicated to be removed and salvaged or removed and reinstalled.
- .2 Remove and Salvage: Detach items from existing construction and deliver them to Owner.
- .3 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- .4 Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

.2 Reference Standards:

- .1 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .2 Canadian Standards Association (CSA Group):
 - .1 CSA S350-M1980 (R2003), Code of Practice for Safety in Demolition of Structures.
- .3 Department of Justice Canada (Jus):
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.
- .4 Provincial Legislation:
 - .1 Legislation specific to Authority Having Jurisdiction for work governed by this Section.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Pre-Construction Meeting: Arrange a pre-construction meeting attended by Contractor's key personnel, Subcontractors representatives, and Consultant to discuss the following:

- .1 Verify project requirements.
- .2 Review demolition conditions.
- .3 Coordination with other Subcontractors affected by work of this Section.
- .4 Examine existing site conditions adjacent to demolition work, prior to start of Work.
- .5 Waste reporting requirements.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets. WHMIS SDS acceptable to Labour Canada and Health and Welfare Canada.
- .2 Certificates: Submit copies of certified weigh bills, bills of lading or receipts from authorized disposal sites and re-use and recycling facilities for material removed from site on weekly basis.
- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00 - LEED Product Requirements

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: Perform work as follows; use most restrictive requirements where differences occur between the municipal, provincial and federal jurisdictions:
 - .1 Provincial and Federal Requirements: Perform work in accordance with governing environmental notification requirements and regulations of the Authority Having Jurisdiction.
 - .2 Municipal Requirements: Perform hauling and disposal operations in accordance with regulations of Authority Having Jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Except where otherwise specified, all materials indicated or specified to be permanently removed from the Place of the Work shall become Contractor's property. Maximize to the fullest extent possible, salvage, and recycling of such materials, consistent with proper economy and expeditious performance of the Work.
- .2 To reduce the quantity of material otherwise destined for disposal at a landfill, the Contractor is encouraged to consider utilizing the services of businesses and non-profit organizations that specialize in salvage and recycling of used building materials, but does so at his own option and risk.
- .3 A current listing of recyclers specializing in specific categories of materials may be obtained during normal office hours from:

Ministry of Environment
Public Information Centre
Phone: (416) 325-4000 or 1-800-565-4923
or by viewing
Ontario Environment Business Directory (OEBD)
Website: www.ontario.ca/page/ontario-environment-business-directory
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Protect open excavations in accordance with requirements of the Authorities Having Jurisdiction.
- .2 Protect existing site features to remain or identified for salvage or re-use; make repairs and restore to a similar condition to existing where damage to these items occurs as directed by the Consultant and at no cost to Owner:
 - .1 Remove and store salvaged materials to prevent damage.
 - .2 Store and protect salvaged materials as required for maximum preservation of material.
 - .3 Handle salvaged materials the same as new materials.
- .3 Perform selective site demolition work to prevent adverse affects to adjacent watercourses, groundwater and wildlife, and to prevent excess air and noise pollution:
 - .1 Do not dispose of volatile waste materials including but not limited to, mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers; follow proper disposal procedures throughout the project.
 - .2 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers or onto adjacent properties.
 - .3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with Authorities Having Jurisdiction.
- .4 Protect existing site features and structures, trees, plants and foliage on site and adjacent properties.
- .5 Notify Consultant before disrupting building access or services.
- .6 Should material resembling designated substance listed as hazardous as defined in the Hazardous Product Act be encountered, stop work, take preventative measures, and notify Consultant and Owner immediately.

Part 2 Products

2.1 EQUIPMENT

- .1 Use equipment suitable for work identified.
- .2 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

Part 3 Execution

3.1 PREPARATION

- .1 Inspect with Consultant and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.

- .2 Locate and protect utilities. Preserve active utilities traversing site in operating condition.
- .3 Notify and obtain approval of utility companies before starting demolition.
- .4 Disconnect and Cap Identified Mechanical Services:
 - .1 Natural Gas Supply Lines: Remove in accordance with gas company requirements.
 - .2 Sewer and Water Lines: in accordance with Authorities Having Jurisdiction requirements, and securely plug to form watertight seal.
 - .3 Other Underground Services: Remove and dispose of as indicated on Drawings.
- .5 Immediately notify Consultant and utility company concerned in case of damage to any utility or service, designated to remain in place.
- .6 Immediately notify the Consultant should uncharted utility or service be encountered, and await instruction in writing regarding remedial action.
- .7 Protection of In-Place Conditions
 - .1 Prevent movement, settlement, or damage to adjacent structures, utilities, and landscaping features and parts of building to remain in place. Provide bracing and shoring required.
 - .2 Keep noise, dust, and inconvenience to occupants to minimum.
 - .3 Protect building systems, services and equipment.
 - .4 Provide temporary dust screens, covers, railings, supports and other protection as required.
 - .5 Do Work in accordance with Ontario Occupational Health and Safety Act.

3.2 REMOVAL AND DEMOLITION OPERATIONS

- .1 Remove items indicated on Drawings; do not disturb items identified to remain in place.
- .2 Removal of Pavements, Curbs and Gutters:
 - .1 Square up adjacent surfaces to remain in place by saw cutting or other method approved by Consultant.
 - .2 Protect adjacent joints and load transfer devices.
 - .3 Protect underlying and adjacent granular materials where they are exposed and identified to remain.
 - .4 Prevent contamination with base course aggregates, when removing asphalt pavement for subsequent incorporation into hot mix asphalt concrete paving.
- .3 Excavate a minimum of 300 mm below pipe inverts, when removing pipes under existing or future pavement area.

- .4 Remove as many trees as required to complete demolition operations; prevent damage to trees identified to remain; obtain written permission from Consultant prior to removal of trees not identified on Drawings:
 - .1 Sell or donate trees identified for removal and that are healthy and marketable; remove trees that are not healthy or marketable using alternate disposal methods.
 - .2 Grind, chip, or shred other vegetation for mulching and composting.
- .5 Stockpile topsoil for final grading and landscaping; provide erosion control and seeding if not immediately used.
- .6 Dispose of materials not identified for salvage or re-use on site at certified landfill site or recycling facility as indicated in Section 01 74 19 – Construction Waste Management.

3.3 RESTORATION

- .1 Restore areas and existing works outside areas of demolition to conditions that existed prior to beginning of Work.
- .2 Use soil treatments and procedures that are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent watercourses or ground water.

3.4 CLEANING

- .1 Remove debris, trim surfaces and leave work site clean, upon completion of Work.
- .2 Use cleaning solutions and procedures that are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent watercourses or ground water.

END OF SECTION

Part 1 General

1.1 PRICE AND PAYMENT

- .1 Removal of existing asphalt pavement will be measured in square metres of surface actually removed regardless of depth removed.
- .2 Payment under this item will include operations involved in removing, hauling and stockpiling designated pavement and cleaning of remaining pavement surface.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Divert excess materials from landfill
 - .2 Separate materials identified for recycling place in identified areas in accordance with Waste Management Plan
 - .3 Label location of salvaged material's storage areas and provide barriers and security devices
 - .4 Remove materials that cannot be salvaged for re use or recycling and dispose of in accordance with applicable codes at licensed facilities
- .2 Pre Construction Meeting: Arrange a pre construction meeting attended by Contractor's key personnel and Consultant to discuss the following:
 - .1 Verify project requirements.
 - .2 Review site conditions.
 - .3 Coordination with other Subcontractor's affected by work of this Section.
 - .4 Examine existing site conditions adjacent to demolition work, prior to start of Work.
 - .5 Waste reporting requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Action Submittals: Provide following submittals before starting work of this Section:
 - .1 Shop Drawings: Submit shop drawings indicating diagrams or details showing sequence of demolition work.
- .2 Informational Submittals: Provide following submittals during course of work:
 - .1 Certificates: Submit copies of certified weigh bills, bills of lading or receipts from authorized disposal sites and re use and recycling facilities for material removed from site on weekly basis.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: ensure Work is performed in compliance with applicable Provincial regulations.
- .2 Comply with hauling and disposal regulations of Authority Having Jurisdiction.

1.5 SITE CONDITIONS

- .1 Protect existing site features to remain or identified for salvage or re use; make repairs and restore to a similar condition to existing where damage to these items occurs as directed by Consultant and at no cost to Owner:
 - .1 Remove and store salvaged materials to prevent contamination.
 - .2 Store and protect salvaged materials as required for maximum preservation of material.
 - .3 Handle salvaged materials same as new materials.
- .2 Perform pavement removal work to prevent adverse effects to adjacent watercourses, groundwater and wildlife, and to prevent excess air and noise pollution:
 - .1 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers or onto adjacent properties.
 - .2 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with Authorities Having Jurisdiction.
- .3 Protect existing site features and structures, trees, plants and foliage on site and adjacent properties.

Part 2 Products

2.1 EQUIPMENT

- .1 Use cold milling, planning or grinding equipment with automatic grade controls capable of operating from stringline, and capable of removing part of pavement surface to depths or grades indicated.

Part 3 Execution

3.1 PREPARATION

- .1 Verify extent and location of asphalt identified for removal, disposal, alternative disposal, recycling, salvage and items to remain.
- .2 Locate and protect utilities, preserve active utilities traversing site in operating condition.
- .3 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to TRCA requirements and sediment and erosion control drawings, compliance to EPA 832/R-92-005, whichever is more stringent.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

- .4 Prior to beginning removal operation, inspect and verify with Consultant areas, depths and lines of asphalt pavement to be removed.
- .5 Protection: protect existing pavement not designated for removal, light units and structures from damage. In event of damage, immediately replace or make repairs to approval of Consultant at no additional cost.

3.2 REMOVAL

- .1 Remove existing asphalt pavement to lines and grades as indicated and established by Consultant on site.
- .2 Demolition of pavements, curbs and gutters:
 - .1 Square up adjacent surfaces to remain in place by saw cutting or other method acceptable to Consultant on site.
 - .2 Protect adjacent joints and load transfer devices.
 - .3 Protect underlying and adjacent granular materials where they are exposed and identified to remain.
 - .4 Prevent contamination with base course aggregates, when removing asphalt pavement for subsequent incorporation into hot mix asphalt concrete paving.
- .3 Use equipment and methods of removal and hauling which do not damage or disturb underlying pavement.
- .4 Prevent contamination of removed asphalt pavement by topsoil, underlying gravel or other materials.
- .5 Suppress dust generated by removal process.

3.3 FINISH TOLERANCES

- .1 Finished surfaces in areas where asphalt pavement has been removed within +/- 5 mm of grade specified but not uniformly high or low.

3.4 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Sweep remaining asphalt pavement surfaces clean of debris resulting from removal operations using rotary power brooms and hand brooming as required.

END OF SECTION

PART 1 General

1.1 DEFINITIONS

- .1 The following Definitions shall apply in this Specification:
- .2 Contract Documents
 - .1 The Contract Documents consist of the Drawings, Specifications and Reports which form part of the agreed Contract.
- .3 Consultant
 - .1 The Consultant is the Architect, SEOR, persons or entities engaged by the Owner. The term Consultant means the Consultant or the Consultant's authorized representative.
- .4 Contractor
 - .1 The term Contractor is defined to include any of the following: Construction Manager, General Contractor, Structural Steel Erector, Structural Steel Fabricator, Subcontractor or Supplier.
- .5 Owner
 - .1 The Owner is the person or entity identified as such in the Contract. The term Owner means the Owner or the Owner's authorized agent or representative but does not include the Consultant.
- .6 SEOR
 - .1 The SEOR is defined as the Structural Engineer of Record for the Contract.

1.2 WORK INCLUDED

- .1 Comply with Division 1, General Requirements and documents referred to therein.
- .2 Spec. Note: Ensure that under "GENERAL REQUIREMENTS" (Division 1) or "SUBMITTALS" (Section 01300) the Architect has included a clause indicating that the Contractor is solely responsible for the preparation of Shop Drawings and that the Consultant reviews them only for "General Conformance" to the Contract Document.
- .3 Provide labour, materials, products, equipment and services required to complete the demolition work.
- .4 Schedule of Structure to Be Demolished
- .5 Also, refer to drawings for location of building and extent of demolition work.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Structural Alterations: Section 02 20 10

1.4 REFERENCE STANDARDS, CODES AND ACTS

- .1 Conform to Ontario Regulation 332/12 The Building Code as amended by all subsequent Ontario Regulations issued to the date of these terms of reference and applicable acts of authorities having jurisdiction.

1.5 PERMITS AND REGULATIONS

- .1 Arrange and pay for all permits, notices, and inspections necessary for the proper execution and completion of the demolition work, except for the demolition permit which shall be obtained and paid for by the Owner or by his authorized representative.
- .2 Engage the services of a Professional Engineer licensed in [the Province of Ontario] to provide supervision during demolition and to prepare and submit the required documents to the municipal authorities at completion of Work. Submit a copy of the documents to the Owner and the Architect.

Part 2 Products

2.1 SALVAGE AND DISPOSAL OF MATERIALS

- .1 All materials from the demolition, except as specified below or otherwise directed, shall become the property of the Contractor. Remove all material and debris from the site as quickly as possible and dispose of legally. Burning of debris or selling of materials on the site will not be permitted.
- .2 Salvage materials and/or equipment to be turned over to the Owner as directed by the Consultant. Remove carefully the following items to be salvaged, protect during demolition, and place in locations designated:

Part 3 Execution

3.1 PROTECTION

- .1 Supply, install, and maintain temporary hoardings and sidewalk covers, including lighting if required, in compliance with requirements of authorities having jurisdiction, and to the approval of the Owner, to provide a smooth, continuous exterior surface in one plane, unbroken by supports, perforations or other structural members. Remove hoardings at completion of work of this Section as and when directed by the Owner.
- .2 Provide barricades and guard rails as required to give full protection to the general public, to workmen employed on the demolition and to adjoining properties.
- .3 Protect adjacent properties against damages which might occur from falling debris or other causes; do not interfere with use or occupancy of adjacent buildings; maintain free, safe passage to and from same.
- .4 Take precautions to guard against movement or settlement of existing structures to remain, adjacent land, buildings, and paving. If at any time the safety of such land, buildings, or pavements appears to be in danger, suspend operations and notify the Consultant promptly. Take measures to support such land, buildings, and pavements. Do not resume demolition until the Consultant permits.

- .5 Do not place nor store material in streets, lanes, or passageways, except as permitted by authorities having jurisdiction.
- .6 Do not restrict traffic on public streets, lanes, and sidewalks except as permitted by authorities having jurisdiction.
- .7 Do not commence demolition of buildings until all personnel and Owner's equipment are removed from the buildings except such equipment listed below to be removed by the Contractor and turned over to the Owner.
- .8 Drain fuel tanks and remove the fuel from the site in an acceptable manner prior to start of demolition work.

3.2 EXISTING SERVICES

- .1 Arrange and pay for the disconnection, capping, and plugging of gas, water, sewer, electric, telephone, and other services to the structures to be demolished. In advance, notify each utility company involved and obtain approval before commencing that portion of the work. Disconnect and cap services at the property line.
- .2 Make good to the requirements of the local authorities public roads, walkways and curbs soiled or damaged due to work of this Section.

3.3 DEMOLITION

- .1 Refer to the Schedule specified herein and to the drawings for extent of demolition work.
- .2 Carry out demolition in strict accordance with requirements of authorities having jurisdiction.
- .3 At end of each workshift leave work in a safe condition so that no part of the remaining structure is in danger of toppling, collapsing, or falling.
- .4 During demolition operations, keep work wetted down thoroughly to prevent dust and dirt from rising. Provide waterline for this purpose. Furnish connections that may be required and pay for cost of water used. Upon completion, remove installed temporary waterline.
- .5 Demolish the portion of building noted including removal of roofs, walls, floors, paving, foundation walls, drains and other piping.
- .6 Collapse enclosed spaces existing below grade, if any.
- .7 Remove combustible materials, plastics, metal, glass, wood, and other organic material from site.
- .8 Break up and remove existing slabs on grade.
- .9 Remove from the site all pieces of concrete weighing more than 900 kg (2000 lbs) or larger than 0.5 m³ (½ yd³) whichever is the more restrictive, or break into small pieces.
- .10 Remove fuel tanks from the site.

- .11 Fill excavated areas, voids, and depressions below grade at areas of demolished structure (outside new basement walls) with clean rubble containing only whole or broken masonry units, mortar, stone, small pieces of concrete, gravel, sand, or crushed stone. Remove all combustible materials, metal, glass, and wood or other organic material from backfill material.
- .12 On completion, grade and level the finished site around remaining structure, sloped to drain away from remaining structure and in manner to prevent puddles, flush with adjacent grades, adding clean granular fill as required.

3.4 NOTIFICATION

- .1 Prior to commencing significant segments of the work, give the Consultant and Independent Inspection and Testing Companies appropriate notification so as to afford them reasonable opportunity to review the work. Failure to meet this requirement may be cause for the Consultant to classify the work as defective.

END OF SECTION 02 41 19

Part 1 General

1.1 SECTION INCLUDES

- .1 Removal and disposal of impacted soil present in the vicinity of the existing inground bus lift hoists.

1.2 RELATED REQUIREMENTS

- .1 Section 31 23 33 – Excavation, Trenching, and Backfilling

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Comply with all applicable legislation and by-laws, including, but not limited to:
 - .1 Treatment and Disposal of Petroleum Contaminated Soil, June 2016
 - .2 Contaminated Sites Remediation Act (CSRA), April 2014.
- .2 Coordination
 - .1 The Contractor shall coordinate with all regulatory agencies having authority and scheduling for delivery of materials to the Provincial approved treatment/disposal facility.
 - .2 The Contractor shall notify the Contract Administrator within two (2) hours upon discovery of any petroleum contaminated materials.
 - .3 The Contractor shall provide at least two (2) working days' notice to the Project Administrator prior to the removal of any contaminated soil.

1.4 GENERAL

- .1 Excavation, transportation, and disposal, at a Ontario Sustainable Development approved facility, of contaminated soil, debris, concrete, and stone, containing gasoline, fuel oil, and lube oil range hydrocarbons as confirmed by on-site inspection and testing.
- .2 Segregation and stockpiling of clean overburden material, if present, for potential re-use as backfill.
- .3 Containment, transportation, and disposal, by a licensed disposal contractor, of any free phase petroleum product, as directed by the Contract Administrator.
- .4 Containment, treatment, and disposal of all groundwater in excavations, all run-off entering the excavations and wash water generated during the excavation of soils as agreed to by the Contract Administrator and regulatory authorities.
- .5 Coordination with all regulatory agencies having authority and scheduling for delivery of materials to the Provincial approved treatment/disposal facility.

1.5 REMOVAL

- .1 The Contract Administrator or his representative will oversee contaminated material removal activities and will make decisions as to the extent of contaminated material removed.

The Contract Administrator will provide instructions as to the method and type of record keeping required for documenting quantities of contaminated soil to be transported off- site for disposal.

- .1 Make submittals of documents in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Locate and protect adjacent structures and foundations, trees, lawns, fencing, service poles, wires, utilities, paving, survey benchmarks, monitoring wells, and monuments not intended for removal which may be affected by the Work.
- .3 Notify all regulatory agencies having authority, as required.
- .4 All excavations are to remain within the established site property boundaries.
- .5 The vertical and lateral limits of the excavations will be based on area required for the completion of work.

1.6 CONTAINMENT OF MATERIAL ON SITE

- .1 All groundwater in excavations, all run-off entering the excavations of impacted soil and wash water generated during the excavation of impacted soils, will be temporarily stored on-site in spill-proof and leak-proof containers, as approved by the Contract Administrator, prior to their disposal. All waters will be disposed based upon the Contractor's method, as approved by the Contract Administrator, following receipt of analytical results. The Contractor shall be prepared to demonstrate that the treatment method is the most cost efficient. In addition, the Contract Administrator shall demonstrate that the methodology chosen has minimized the amount of impacted materials on the site.
- .2 Contractor shall cover contaminated soil stockpiles temporarily staged on the site at all times with PVC plastic or equivalent to prevent loss or erosion.
- .3 All free phase petroleum products will be contained in spill and leak proof containers, as approved by the Contract Administrator, prior to removal off-site for disposal.
- .4 All storage vessels for soils, product or groundwater must be readily accessible for sampling by the Contract Administrator. These vessels must have a means of securing access to prevent unauthorized and/or accidental entry into the vessels by trespassers.
- .5 All storage vessels for soils, product and groundwater must be readily accessible for clean-out prior to their removal from the site.

1.7 TESTING

- .1 All contaminant sampling and testing of soils and water will be carried out by the Contract Administrator. All other sampling and testing will be conducted by the Contractor at their expense.
- .2 Following completion of final soil testing, documentation shall be prepared by the Contract Administrator. Samples may require up to five (5) working days to receive analytical results; Contractor to schedule work to conform to this timing.
- .3 The Contract Administrator shall contact Regulatory Agency for agreement that contamination has been cleaned up.

1.8 PROTECTION

- .1 Prevent debris from blocking roads, ditches, and drains.
- .2 Ensure safe passage of persons around the excavation area.
- .3 Suppress dust and odours during excavation activities.

END OF SECTION

Part 1 General

1.1 UNIT PRICES

- .1 Provide unit price for excavation, remediation and disposal of contaminated soils in the event that they are encountered during removal of underground fire tank soil testing.
- .2 Unit prices will apply where more than 75 m³ of soil is required to be removed from boundary area around the fire tank; base contract shall account for this initial removal amount.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide required information in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit a written report describing in detail procedures used to remove liquid from underground storage tank, cleaning and removing of underground storage tank, and disposal of liquid residues; provide verification that materials were disposed of in an environmentally responsible waste disposal facility; provide photographic documentation of work, including lab and field results, and receipts from disposal sites for tank and liquid residue.
- .3 Submit a written contingency plan for actions to be taken in the event of a release or emergency including:
 - .1 Emergency contact numbers;
 - .2 Classification of land use;
 - .3 Plans for covering/containing contaminated soil;
 - .4 Plans for site assessment/remediation work; and,
 - .5 Reducing risk to human health.

1.3 QUALITY ASSURANCE

- .1 Refer to laws, by laws, ordinances, rules, regulations and orders of authority having jurisdictions, and other legally enforceable requirements applicable to Work at that area; or become in force during Work performance.
- .2 Underground fire tank removal and disposal shall comply with requirements of authorities having jurisdiction.

1.4 PROJECT SITE CONDITIONS

- .1 Obtain necessary permissions and permits from Municipal Authorities where closure or obstruction of streets, sidewalks or driveways is required by work of this Section.

Part 2 Products

2.1 MATERIALS

- .1 Provide necessary materials, equipment and tarps to prevent further contamination of site, and for safe handling and containment of fuel, fuel storage and removed contaminated soils.

Part 3 Execution

3.1 PREPARATION

- .1 Provide all necessary personal protective equipment, purging and inert gases, and electrical protection equipment, and verify that equipment is working properly before starting work of this Section.

3.2 UNDERGROUND STORAGE TANK REMOVAL

- .1 Liquid Removal:
 - .1 Provide samples of liquids from underground fire storage tank to a certified hazardous waste testing facility for laboratory analysis and approval for liquid disposal and disposal location.
 - .2 Remove liquid from tank for disposal prior to removing tank from ground.
 - .3 Obtain disposal facility receipts noting proper liquid disposal.
- .2 Storage Tank Cleaning:
 - .1 Remove tank from ground, place it on ground adjacent to removal location, and secure it prior to cleaning.
 - .2 Measure levels of combustible vapours and oxygen, and ventilate tank if required to bring vapour or oxygen levels to safe limits:
 - .1 Ventilate tank using a small gas exhauster until vapour concentration is reduced to 10% or less of lower explosive limit.
 - .2 Oxygen content shall range from 19.5% to 23.5%.
 - .3 Cut access ports for cleaning into tank after vapour and oxygen concentrations are at a safe level.
 - .3 Clean tank by mopping, scraping, sweeping or steam cleaning interior of tank.
 - .4 Collect, contain and place residuals removed from tank in a 200 litre capacity drum for transporting and disposal acceptable to authorities having jurisdiction.
 - .5 Obtain disposal facility receipts noting proper effluent disposal.
- .3 Storage Tank Disposal:
 - .1 Verify that final vapour and oxygen concentrations are within requirements noted above before proceeding to cut and dismantle tank for its disposal.
 - .2 Remove dismantled tank to a disposal facility acceptable to authorities having jurisdiction.
 - .3 Obtain disposal facility receipts noting proper tank disposal.

3.3 REMOVED TANK AREA ASSESSMENT

- .1 Collect five soil samples from removed underground storage tank area as follows:
 - .1 One sample from each of sidewalls.
 - .2 One sample from base.
- .2 Place samples in glass sample jars and seal with Teflon coated lids, and place jar on ice.
- .3 Deliver samples with completed chain of custody documentation to laboratory.
- .4 Laboratory shall analyze each sample for Total Petroleum Hydrocarbon (TPH) concentrations.
- .5 Site Restoration: Refer to Section 31 23 33.01 - Excavating, Trenching and Backfilling for excavation, backfilling and compaction requirements for non contaminated remediation work.

3.4 CONTAMINATED SOIL REMEDIATION

- .1 Perform remediation work in accordance with Section 02 50 00 - Site Remediation
- .2 Collect additional soil samples beyond boundaries of original fire tank location. When soil assessments reveal evidence of leakage or spillage of hydrocarbons at levels above those established by authorities having jurisdiction relating to environmental management for underground storage tank closures.
- .3 Boundary of tank shall not to exceed 75 m³ of soil removed; work beyond this boundary will be considered as an extra to Contract and shall be based on unit pricing.
- .4 Continue soil removal and soil contamination assessment testing around tank until contamination levels are within acceptable levels.
- .5 Remove contaminated soil from site and haul it to an approved sanitary landfill for proper disposal.

END OF SECTION

Part 1 General

1.1 Definitions

- .1 The following Definitions shall apply in this Specification:
- .2 Contract Documents
 - .1 The Contract Documents consist of the Drawings, Specifications and Reports which form part of the agreed Contract.
- .3 Consultant
 - .1 The Consultant is the Architect, SEOR, persons or entities engaged by the Owner. The term Consultant means the Consultant or the Consultant's authorized representative.
- .4 Contractor
 - .1 The term Contractor is defined to include any of the following: Construction Manager, General Contractor, Structural Steel Erector, Structural Steel Fabricator, Subcontractor or Supplier.
- .5 Owner
 - .1 The Owner is the person or entity identified as such in the Contract. The term Owner means the Owner or the Owner's authorized agent or representative but does not include the Consultant.
- .6 SEOR
 - .1 The SEOR is defined as the Structural Engineer of Record for the Contract.

1.2 WORK INCLUDED

- .1 Comply with Division 1 - General Requirements and all documents referred to therein.
- .2 Provide all labour, materials, plant and equipment to complete the concrete formwork indicated in the Contract Documents, including the installation of cast in inserts and assemblies as therein.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Concrete Reinforcement, Section 03 20 00
- .2 Cast-in-Place Concrete, Section 03 30 00
- .3 Structural Steel, Section 05 12 00, For anchor assemblies, bolts and the like to be cast into concrete.

1.4 REFERENCE STANDARDS, CODES AND ACTS

- .1 Conform to the requirements of the local building code identified on the Structural General Notes as amended by all subsequent Regulations issued to the date of this specification and applicable acts of authorities having jurisdiction.

- .2 All references to the Standards and publications noted below shall be to the edition referenced in the local building code identified on the Structural General Notes, or to the edition referenced in the latest published editions or revisions of all Standards published by the Canadian Standards Association issued to the date of this Specification, whichever is the later edition or revision.
- .3 All references noted below, which are not referenced by the local building code or the Standards published by the Canadian Standards Association, shall be to the latest edition and revision published to the date of this Specification.
- .4 Standards and publications referenced by the Standards noted below shall apply even if they are not included in the list. Where such reference is made, it shall be to that latest edition and revision published to the date of this Specification.
 - .1 CSA A23.1/ CSA A23.2 - Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
 - .2 CSA S413 - Parking Structures
 - .3 CSA O86 - Engineering Design in Wood
 - .4 CSA O121 - Douglas Fir Plywood
 - .5 CSA O151 - Canadian Softwood Plywood
 - .6 CSA O153 - Poplar Plywood
 - .7 CSA O437 Series - OSB and Waferboard
 - .8 CSA O325.0 - Construction Sheathing
 - .9 CSA S269.1 - Falsework and formwork
 - .10 CAN/CSA-S269.3 - Concrete Formwork
- .5 Where there are differences between the Contract Documents and the codes, standards or acts, the most stringent shall govern.

1.5 TOLERANCES

- .1 Perform forming operations and place hardware so that finished concrete will be within the tolerances set out in CSA A23.1.
 - .1 Variations in building lines which result in extension of the building over lot lines or restriction lines will not be permitted.
- .2 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

1.6 Qualifications

- .1 The formwork and reshoring shall be designed by a qualified professional engineer licensed by the authority having jurisdiction with a minimum of 5 years Canadian experience in the design of such temporary construction Work.

1.7 DESIGN

- .1 Formwork and Reshoring.
 - .1 The Contractor shall design formwork and reshoring to safely support vertical and lateral loads until they can be supported by the structure.
 - .2 Design formwork to the requirements of CAN/CSA S269.3.

1.8 SUBMITTALS

- .1 Shop Drawings for Formwork and Reshoring
 - .1 The structural Drawings shall not be reproduced, in whole or in part, for use as shop drawings.
 - .2 Provide adequate space on all shop drawings immediately above the drawing title block for the Consultant's Shop Drawing review stamp. Where requested by the Consultant, the stamp is to be inserted by this section directly into the shop drawing prior to submission. The stamp shall be positioned in the same location on each shop drawing, and in no case shall the allocated space be less than 63mm x 75mm. Request the details of these requirements from the Consultant no less than 2 weeks before the commencement of shop drawings.
 - .3 Well in advance of construction, submit to the Consultant shop drawings showing the complete design and detailing of the slab formwork and reshoring systems stamped by a qualified professional engineer licensed by the authority having jurisdiction.
 - .4 As a minimum, the shop drawings shall show the following:
 - .1 All design assumptions including references to the relevant codes, standards and sets, design loads, assumed concrete placing rate and the like.
 - .2 Layout of formwork panels and shores;
 - .3 Formwork details related to stripping and reshoring;
 - .4 Camber;
 - .5 Sequence for installing reshores;
 - .6 Stripping schedule;
 - .7 Number of slabs reshored at any given time;
 - .8 Method, sequence, and schedule of construction, materials, arrangement of joints, form ties, shores, liners and locations of temporary embedded parts in architectural form concrete elements; and
 - .9 Complete details associated with forming sloped slabs together with placing and compaction procedures for sloping slabs, including details of construction and placing of top forms.

- .5 Include in the shop drawing submission a method statement as to how the cambers specified in the Contract Documents will be achieved in the field.
- .2 Construction Joints
 - .1 Well in advance of construction, submit to the Consultant shop drawings showing the location of all horizontal and vertical construction joints in the structure. Drawings shall include plans, wall elevations and additional sections and details (as necessary) which clearly indicate the proposed location of the joints. Drawings shall include dimensions for all construction joints to reference grid lines and elevations.
 - .2 Drawings shall include any specific provisions or requirements where the elements are noted to be poured monolithically on the Contract Documents.
- .3 Surveys
 - .1 Submit surveys showing position of formwork, cast-in-place inserts and structural elements as noted below.
 - .2 As a minimum include the following:
 - .1 Elevation and location of centreline with respect to grids of all footings, caissons, piles;
 - .2 Location of centreline of all columns with respect to grids at each floor level;
 - .1 Before concrete placement.
 - .2 After concrete placement, prior to removal of any formwork and reshores from below.
 - .3 Location and alignment of edge of slabs with respect to grids at all floor levels;
 - .4 Location and elevation of cast-in-place hardware at all levels; and
 - .3 All surveys submitted must clearly indicate the date when the survey was carried out.
- .4 As-Built Drawings
 - .1 Mark on a complete set of final drawings any changes, additions or deletions that occur during construction as a result of the Contractor's Work, change orders, or for any other reason.
 - .2 For all shop drawings marked "Reviewed as Noted" or "Revise and Resubmit", update and submit a record set of these drawings at the completion of the structural Work. Ensure that these drawings reflect the changes and are coordinated with the final drawings noted above.

Part 2 Products

2.1 MATERIALS

- .1 Formwork
 - .1 Formwork lumber: Conform to O86.1 and CSA - O325.0.
 - .2 Sheathings for exposed surfaces: New, Douglas Fir plywood not less than 19 mm thick, concrete form grade, sanded one side, conforming to CSA-O325.0.
 - .3 Preformed Steel Forms: Minimum 1.6 mm or 16 gauge matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
 - .4 Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of the wet concrete mix until initial set.
 - .5 Corners: Chamfered as required architecturally, in maximum lengths possible.
- .2 Waterstops
 - .1 Construction and Control Joints: Provide polyvinyl Chloride (PVC) waterstop Type 7 (internal type) or Base Seal Type 61 (external type) as manufactured by CPD Construction Products or an equivalent approved by the Consultant.
 - .3 Dovetail anchor slots: Minimum 0.8 mm thick (22 gauge) galvanized steel with insulation filled slots.
 - .4 Flashing Reglets: Minimum 0.8mm (22 gauge) thick galvanized steel with alignment splines for joints.
 - .5 Form Spacers: (Stay-in-place form spacers exposed to weather, earth, or moisture shall not be made of wood, and shall be corrosion and decay resistant.)

Part 3 Execution

3.1 CONCRETE WORK AT EXISTING STRUCTURE

- .1 Prior to undertaking any Work in or adjacent to the existing structure, verify that conditions are as indicated on the Contract Documents. If they are not, do not proceed until the Consultant has given instructions.
- .2 Protect and support existing services that may interfere with Work in the existing structure.

3.2 FORMWORK

- .1 General

- .1 Erect, support, brace, and maintain formwork to safely support vertical and lateral loads until they can be supported by the structure.
- .2 All formwork shall be inspected by the Contractor and the professional engineer responsible for its design, prior to the concrete pour to ensure that they have been erected in conformance with the formwork shop drawings.
- .3 Align joints in formwork and make water-tight. Keep form joints to a minimum.
- .4 Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing prior to concreting.
- .2 Construction
 - .1 Form footing sides unless footings are shown to be placed against undisturbed soil.
 - .2 Mark building, grid or other lines on forms to permit the accurate positioning of dowels into concrete elements above and all other reinforcing steel.
 - .3 Construct templates and supports to rigidly fix reinforcing dowels in the forms prior to concreting.
 - .4 Set anchor rods, templates, steel connection units, hardware, and/or other inserts into the forms and secure them rigidly so that they do not become displaced during concreting.
 - .5 In the case of sloping slabs, employ suitable forming procedures compatible with the concrete placing and compaction techniques to ensure that completed concrete has the design characteristics specified in the Contract Documents, and in particular, to prevent movement of plastic concrete resulting in cracking, loss of bond, etc., and to achieve a surface equivalent to a fine wood float finish suitable to receive the roofing membrane.
 - .6 Application of Form Release Agent
 - .1 Apply form release agent in accordance with the manufacturer's recommendations.
 - .2 Apply prior to placement of reinforcement, anchoring devices, and embedded items.
 - .3 Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings, which are affected by the agent. Soak inside surface of untreated forms with clean water and keep surfaces covered prior to placement of concrete
- .3 Sleeves, Recesses and Formed Openings

- .1 Form sleeves, recesses and openings in accordance with reviewed sleeving drawings, except where such items are specified to be formed or sleeved by the appropriate Section in the Contract Documents.
- .2 No sleeves, recesses, or openings through structural members shall be formed without the Consultant's approval.
- .3 During cold weather, protect members from damage due to water freezing in confined areas, recesses, sleeves or formed 'openings'.

3.3 STRIPPING OF FORMS AND RESHORING

- .1 Where forms are stripped from horizontal or sloping members before concrete has reached its specified strength, reshore the members so that they can safely support their own load plus construction loads. In addition, ensure that the stripped member is of sufficient strength to safely carry its own weight over the area stripped out at any instant, together with any superimposed construction loads.
 - .1 Install reshores so that they are supported on members which can safely support the reshore load.
 - .2 As a guide, under the curing conditions specified in the Contract Documents, 70% of the 28 day strength should be attained 7 days after concreting in normal weather and 14 days after concreting in "Cold Weather".
 - .3 Base decision to strip forms upon satisfactory results of 7 day concrete cylinder tests and on Site curing conditions or on in situ tests.
 - .4 Stripping and reshoring shall proceed simultaneously so as not to leave an area greater than 80 sq. m. unsupported by either formwork or reshoring at any instant. Install reshores tight to construction above and below so that they will not significantly shorten under load, but take care not to preload the construction below or raise the construction above by over-tightening.
 - .5 Maintain reshoring or formwork in place for a minimum of 28 days or for such longer time as may be required to ensure that the concrete has reached its specified 28 day strength.
 - .6 Do not strip within one and a half bays of a construction joint until new concrete beyond the construction joint has reached 70% of its specified 28 day strength.
 - .7 Side forms for vertical members may be stripped as soon as the concrete is sufficiently strong to stand unsupported and safely resist imposed loads.
 - .8 Prior to pouring the concrete elements directly supported above, remove sonotube forms to such an extent to allow the Consultant to review the quality of any exposed column surface. Provide necessary protection to the exposed surfaces upon completion of review.

3.4 CONSTRUCTION JOINTS

- .1 Obtain approval from the Consultant for location and details of construction joints not shown on the Contract Documents.

3.5 WATERSTOPS

- .1 Install waterstops in accordance with the manufacturer's requirements, to provide continuous water seal. Do not distort or pierce waterstop. Do not displace reinforcement when installing waterstops. Tie waterstops rigidly in place.
- .2 Splice waterstops in accordance with the manufacturer's requirements.
- .3 Where waterstops are noted to be installed adjacent to existing Work, prepare existing surfaces to receive waterstop in accordance with manufacturer's recommendations.

3.6 QUALITY CONTROL

- .1 Implement a system of quality control to ensure that the minimum standards specified in the Contract Documents are attained.
- .2 Bring to the attention of the Consultant any defects in the Work or departures from the Contract Documents which may occur during construction. The Consultant will decide upon corrective action and give recommendations in writing.
- .3 The Consultant's general review during construction and inspection and testing by independent inspection and testing companies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of its contractual responsibility.

3.7 NOTIFICATION

- .1 Prior to commencing significant segments of the Work, give the Consultant and independent inspection and testing companies appropriate notification so as to afford them reasonable opportunity to review the Work. Failure to meet this requirement may be cause for the Consultant to classify the Work as defective.

3.8 INSPECTION AND TESTING

- .1 The Owner or Consultant will appoint an independent inspection and testing companies to make inspections or perform tests as the Consultant directs. The independent inspection and testing companies shall be responsible only to the Consultant, and shall make only such inspections or tests as the Consultant may direct.

3.9 DEFECTIVE MATERIALS AND WORK

- .1 Where evidence exists that defective Work has occurred or that Work has been carried out incorporating defective materials, the Consultant may have tests, inspections or surveys performed, analytical calculations of structural strength,

made and the like, in order to help determine whether the Work must be corrected or replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor's expense, regardless of their results, which may be such that, in the Consultant's opinion, the Work may be acceptable.

- .2 All testing shall be conducted in accordance with the requirements of the Building Code, except where this would, in the Consultant's opinion, cause undue delay or give results not representative of the rejected material in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.
- .3 Materials or Work which fail to meet the requirements Specified in the Contract Documents may be rejected by the Consultant whenever found at any time prior to the Total Performance of the Work regardless of previous inspection. If rejected, defective materials or Work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the Owner.

END OF SECTION 03 10 00

Part 1 General

1.1 DEFINITIONS

- .1 The following Definitions shall apply in this Specification
- .2 Contract Documents
 - .1 The Contract Documents consist of the Drawings, Specifications and Reports which form part of the agreed Contract.
- .3 Consultant
 - .1 The Consultant is the Architect, SER, persons or entities engaged by the Owner. The term Consultant means the Consultant or the Consultant's authorized representative.
- .4 Contractor
 - .1 The term Contractor is defined to include any of the following: Construction Manager, General Contractor, Structural Steel Erector, Structural Steel Fabricator, Subcontractor or Supplier.
- .5 Owner
 - .1 The Owner is the person or entity identified as such in the Contract. The term Owner means the Owner or the Owner's authorized agent or representative, but does not include the Consultant.

1.2 WORK INCLUDED

- .1 Comply with Division 1 - General Requirements and all documents referred to therein.
- .2 Provide all labour, materials, plant and equipment to complete the steel reinforcement Work indicated in the Contract Documents and specified in this Section.

1.3 RELATED SECTIONS

- .1 Concrete Formwork, Section 03 10 00
- .2 Cast-in-Place Concrete, Section 03 30 00

1.4 REFERENCE STANDARDS, CODES AND ACTS

- .1 Conform to the requirements of the local building code identified on the Structural General Notes as amended by all subsequent Regulations issued to the date of this Specification and applicable acts of authorities having jurisdiction.
- .2 All references to the Standards and publications noted below shall be to the edition referenced in the local building code identified on the Structural General Notes, or to the edition referenced in the latest published editions or revisions of all Standards published by the Canadian Standards Association issued to the date of this Specification, whichever is the later edition or revision.

- .3 All references noted below, which are not referenced by the local building code or the Standards published by the Canadian Standards Association, shall be to the latest edition and revision published to the date of this Specification.
- .4 Standards and publications referenced by the Standards noted below are to apply even if they are not included in the list. Where such reference is made, it shall be to that latest edition and revision published to the date of this Specification.
 - .1 ASTM A82/A82M - Steel Wire, Plain, for Concrete Reinforcement.
 - .2 ASTM A123/A123M - Zinc (Hot-Dip Galvanized) Coatings on Steel Products.
 - .3 ASTM A184/A184M - Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
 - .4 ASTM A185/A185M - Steel Welded Wire Reinforcement, Plain, for Concrete.
 - .5 ASTM A416/A416M - Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - .6 ASTM A496/A496M - Steel Wire, Deformed, for Concrete Reinforcement.
 - .7 ASTM A497/A497M - Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - .8 ASTM A704/A704M - Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
 - .9 ASTM A775/A775M - Epoxy-Coated Reinforcing Steel Bars.
 - .10 ASTM A884/A884M - Standard Specification for Epoxy – Coated Steel Wire and Welded Wire Fabric for Reinforcement.
 - .11 ASTM D3963/D3963M - Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars.
 - .12 CSA A23.1/ CSA A23.2 - Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
 - .13 CSA A23.3 - Design of Concrete Structures.
 - .14 CSA S304.1 - Design of Masonry Structures
 - .15 CSA A371 - Masonry Construction for Buildings
 - .16 CAN/CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.
 - .17 CAN/CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .18 CSA S413 - Parking Structures
 - .19 CAN/CSA S806 - Design and Construction of Building Components with Fibre-Reinforced Polymers.

- .20 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .21 RSIC (Reinforcing Steel Institute of Canada) – Manual of Standard Practice.
- .1 Where there are differences between the Contract Documents and the codes, standards, or acts, the most stringent shall govern.

1.5 QUALIFICATIONS

- .1 The Contractor shall ensure that those responsible for welding reinforcement shall be certified by the Canadian Welding Bureau under the requirements of W186.

1.6 SAMPLES AND ASSISTANCE

- .1 Supply samples of the following materials, the cost of which shall be paid for by the Contractor:
 - .2 Reinforcing steel designated by the Consultant from steel shipped to the site
 - .3 Mechanical splices designated by the Consultant
 - .4 Welded reinforcement splices designated by the Consultant
 - .5 Support accessories (chairs, bolsters, spacers) identified by the Consultant
 - .6 Replace samples removed from the Site as necessary
 - .7 Inform the Consultant when fabrication will be undertaken. Allow Consultant to access the fabricator's plant during fabrication process.

1.7 SUBMITTALS

- .1 Shop Drawings for Reinforcement
 - .1 The structural Drawings shall not be reproduced, in whole or in part, for use as shop drawings.
 - .2 Prepare reinforcement shop drawings and bar lists taking into account all openings and recesses shown on the architectural, structural, mechanical and electrical Drawings, and on the sleeving shop drawings prepared by all other Sections.
 - .3 Prepare shop drawings to a minimum scale of [1:50] or larger as deemed necessary by the Contractor. Shop drawings shall be clear and complete and shall allow placement of reinforcement without reference to the Contract Documents.
 - .4 Provide adequate space on all shop drawings immediately above the drawings title block for the Consultant's shop drawing review stamp. Where requested by the Consultant, the stamp is to be inserted by this section directly into the shop drawing prior to submission. The stamp shall be positioned in the same location on each shop drawing, and in no case shall the allocated space be less than

63 mm x 75 mm. Request the details of these requirements from the Consultant no less than 2 weeks before the commencement of shop drawings.

- .5 Detail reinforcement in accordance with the Contract Documents, CSA A23.1 and detailing standards in RSIC Manual of Standard Practice.
- .6 As a minimum, the shop drawings shall show the following:
 - .1 Bar sizes, spacing, lap lengths, location and quantities of reinforcement and welded wire fabric.
 - .2 Bar spacing requirements and provisions for spacers where required.
 - .3 Locations where reinforcement is considered to be bundled, as defined by CSA A23.1.
 - .4 Identification of each bar with a code mark corresponding to the bar lists.
 - .5 Detail sections to fully illustrate placement of concrete reinforcement at areas such as openings, change of levels, spandrel elements, stairs and wherever else required.
 - .6 Large scale detail concrete sections at areas of steel concentrations such as at intersections of beams and columns, column splices or wherever else required.
 - .7 Placing sequence for areas with multiple layers of reinforcement.
 - .8 Minimum clearances between reinforcement and minimum concrete cover.
 - .9 Location, number and type of support accessories, including support bars suitably sized and spaced to rigidly support the weight of reinforcement and imposed loads during construction. Where 10M top bars and welded wire fabric are shown in the Contract Documents, provide adequate supports to ensure that these bars are not bent or displaced prior to or during the concreting operation.
 - .10 Location and embedment of dowels.
 - .11 Location of joist reinforcement in masonry walls.
 - .12 The size, location, and elevation of mechanical splices, as well as required installation procedures.
 - .13 Large-scale detail masonry sections at areas of steel concentrations such as at intersections of walls, beams, and pilasters, pilaster splices, or wherever else required.

- .14 Detail sections to fully illustrate placement of masonry reinforcement at areas such as openings, masonry beams and lintels, and wherever else required.
- .7 Provide dowels for reinforced masonry walls (load bearing or non load bearing) from slabs and walls. Coordinate location of walls with architectural Drawings.
- .8 Submit code marks or symbols used on reinforcement of each manufacturer so that the Consultant may identify grades and sizes of reinforcement.
- .2 Certificates
 - .1 Reinforcement from Canadian Manufacture: Provide the Consultant with a certified copy of the mill test reports for reinforcing steel showing physical and chemical analysis. For weldable reinforcement, include verification of its weldability. Reports to be submitted a minimum of 4 weeks prior to commencing fabrication.
 - .2 Steel Fibres: Provide certification and test reports for each shipment of fibres. Reports to be submitted a minimum of 4 weeks prior to batching concrete.
- .3 As-Built Drawings
 - .1 Mark on a complete set of final drawings any changes, additions, or deletions that occur during construction as a result of the Contractor's Work, change orders, or for any other reason.
 - .2 For all shop drawings marked "Reviewed as Noted" or "Revise and Resubmit", update and submit a record set of these drawings at the completion of the structural Work. Ensure that these drawings reflect the changes and are coordinated with the final drawings noted above.

1.8 TOLERANCES

- .1 Perform fabrication and setting so that completed Work will be within the tolerances set out in CSA A23.1.
- .2 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

Part 2 Materials

2.1 REINFORCEMENT

- .1 Reinforcing Steel, Deformed: Canadian manufacture to CAN/CSA-G30.18, billet steel, Grade 400R regular bars, unfinished.
- .2 Welded Steel Wire Reinforcement, Plain: ASTM A185/A185M, in flat sheets, galvanized.

- .3 Epoxy Coated Reinforcement: To ASTM A775/A775M and D3963/D3963M.
- .4 High Strength Reinforcement: Williams Grade 150 ksi All-thread-Bar manufactured to ASTM A722/A722M

2.2 MECHANICAL SPLICES

- .1 Mechanical Tension Splices: Type 2 mechanical splices, per CSA A23.3, lenton couplers, complete with bar end protectors and coupler end protectors, as supplied by Erico Canada Inc or an equivalent approved by the Consultant.
- .2 Mechanical Compression Splices: BAR-LOCK mechanical coupler system manufactured by Dayton/Richmond Concrete Accessories, End-Bearing Compression Splice SPEED-SLEEVE as supplied by Erico Canada Inc or an equivalent approved by the Consultant.

2.3 ACCESSORIES

- .1 Minimum gauge as required for support of stability of steel reinforcement during reinforcement placement and concreting operation.
- .2 Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapour barrier puncture.
- .3 Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel type; size, and shape as required.
- .4 Special Bar Supports for Reinforced Soil/Rock: Use precast concrete supports for exposed concrete beams and soffits and concrete cast against soil/rock. Precast concrete supports shall be made of concrete quality, class and strength at least equal to that specified in the Contract Documents for the member in which they are used.

2.4 STEEL FIBRES

- .1 Steel fibres shall meet the requirements of ASTM A820/A820M Type 1, deformed fibres. Minimum ultimate tensile strength shall be 150,000 psi. Minimum aspect ratio shall be 80. Minimum fibre length shall be 2.36 inches. Maximum fibre diameter shall be 0.03 inches. Steel fibres shall be Dramix RC 80/60 BN as manufactured by Bekaert Corporation or an equivalent approved by the Consultant.
- .2 Steel fibre concrete shall be proportioned as required in ASTM C1116/C1116M, alternative 3, in consultation with fibre manufacturer based on the required concrete properties indicated on the Drawings and in the Specifications.

Part 3 Execution

3.1 FABRICATION

- .1 Fabricate reinforcement in accordance with:
 - .1 CSA A23.1.

- .2 RSIC - Reinforcing Steel Manual of Standard Practice.
- .3 CSA-W186 Welded reinforcement.
- .2 Epoxy Coated Reinforcement: Clean surfaces, weld and re-protect welded joint in accordance with CSA-A23.1 and manufacturer's written instructions.
- .3 Locate reinforcement splices not indicated on the Drawings, at point of minimum stress. Review location of splices with the Consultant. Stagger splices to minimize cross sectional area at any one point in beams and walls.
- .4 Unless noted otherwise in the Contract Documents, bend reinforcement once only and at room temperature of 18°C, do not straighten or rebend reinforcement and do not field bend reinforcement. Do not use bars with kinks or bends not shown on the Drawings. Replace bars which develop cracks or splits.
- .5 Fabrication of High Strength Reinforcement
 - .1 Williams All-Thread-Bars shall not be welded or subjected to the heat of a torch or used as an electrical ground. Field cutting shall be done with an abrasive wheel or band saw only.

3.2 PLACEMENT

- .1 Prior to placing concrete, place support and secure reinforcement against displacement to CSA 23.1 and as indicated on reviewed placing drawings.
- .2 Do not displace or damage vapour barrier during reinforcement placement.
- .3 Accommodate placement of formed openings.
- .4 Maintain concrete cover as noted on the Contract Documents.
- .5 Where continuous drop panels or slabs thickenings are noted on the Drawings, place bottom slab reinforcement in the bottom of the continuous drop panel or slab thickening, unless noted otherwise on the Drawings.
- .6 Provide splices only where shown on the Contract Documents or reviewed shop drawings. No other splices will be permitted without approval of the Consultant.
- .7 Securely tie every other cross over (intersection) of reinforcement in top and bottom layers.
- .8 Where slab reinforcement intersects column, beam, or wall reinforcement, securely tie slab reinforcement to the vertical reinforcement in the other elements.
- .9 Securely tie all reinforcing steel mats to adjacent top or bottom mats or mats at the same level. Provide "continuity bars" connecting top layers of reinforcing with bottom layers as per typical details.
- .10 Ensure all dowels and embedded members are securely tied to slab reinforcement.
- .11 Where concrete toppings and curbs are placed directly over bare concrete slab surfaces, provide continuity bars connecting topping or curb reinforcement to the

structural slab reinforcement. Install continuity bars at 2 metre centres minimum around the perimeter of toppings and at 2 metre centres along the length of curbs.

.12 Additional Requirements for Epoxy Coated Reinforcement

- .1 All systems for handling, transporting, and storing coated bars shall be such that the epoxy coating shall not be damaged. Do not drop or drag bars. Store on suitable non-metallic supports.
- .2 During and after the placement of coated bars, repair all damaged portions of the coating. Any damaged accessories shall also be repaired. The Consultant may require that damaged bars be replaced instead of repaired.
- .3 The cutting of coated bars by burning shall not be permitted.
- .4 Do not weld coated bars.
- .5 Lap ends and sides of welded wire fabric as noted on the Drawings, but in no case less than 300 mm.
- .6 Additional Requirements for Mechanical Splicing of Reinforcement
- .7 Tension Splices
- .8 Unless noted otherwise in the Contract Documents, mechanical tension splices shall develop 120% of the specified yield strength, but not less than 110% of the actual yield strength, of the reinforcement being spliced or of the smaller bar if the bars spliced are of different sizes.
- .9 In each concrete member, unless otherwise indicated in the Contract Documents, mechanical tension splices in adjacent bars shall be staggered by at least 750 mm.
- .10 Compression Splices
- .11 Non End-Bearing Mechanical Splices
- .12 Unless noted otherwise in the Contract Documents, mechanical compression splices shall develop 120% of the specified tensile yield strength, but not less than 110% of the actual tensile yield strength of the reinforcement being spliced or of the smaller bar, if the bars spliced are of different sizes.
- .13 In each concrete member, stagger splices of adjacent bars by at least 750 mm.
- .14 End-Bearing Splices
- .15 End bearing splices shall develop the ultimate compressive strength of the reinforcing bars spliced.
- .16 Accurately saw cut the end bearing surfaces of all bars to be spliced 90 degrees to the axis of the bar with a tolerance of 1.5 degrees.

- .17 In setting the bars, rotate until the angle between bearing surfaces is at a minimum, but not more than 3 degrees of full bearing.
- .18 In each concrete member, stagger splices in adjacent bars by 750 mm but not less than 20 bar diameters.
- .13 Take particular care not to damage form sheathing surfaces during installation of reinforcement.

3.3 QUALITY CONTROL

- .1 Provide a system of quality control to ensure that the minimum standards specified in the Contract Documents are attained.
- .2 Bring to the attention of the Consultant any defects in the Work or departures from the Contract Documents which may occur during Construction. The Consultant will decide upon corrective action and give recommendations in writing.
- .3 The Consultant's general review during construction and inspection and testing by the independent inspection and testing companies are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of its contractual responsibilities with respect to quality control
- .4 Prior to commencing significant segments of the Work, give the Consultant and independent inspection and testing companies appropriate notification so as to afford them reasonable opportunity to review the Work. Failure to meet this requirement may be cause for the Consultant to classify the Work as defective.

3.4 INSPECTION AND TESTING

- .1 The Owner or Consultant will appoint the independent inspection and testing companies to make inspections or perform tests as the Consultant directs. The independent inspection and testing companies shall be responsible only to the Consultant, and shall make only such inspections or tests as the Consultant may direct.
- .2 When defects are revealed, the Consultant may request, at the Contractor's expense, additional inspection or testing to ascertain the full extent of the defect.
- .3 Tests of reinforcing steel by independent inspection and testing companies.
 - .1 A series of specimens for each grade and size of reinforcing steel contained in any 100 tonnes and 10 tonnes for concrete reinforcement and masonry reinforcement respectively may be tested. A series of tests will include two bars for each test required of each size and grade of steel used. Reinforcing steel tests will be made in accordance with CSA Standards G30 Series.
 - .2 Nondestructive tests may be made on welded reinforcement.
 - .3 Tension tests to destruction may be performed on approximately 5% of mechanical splices.

3.5 DEFECTIVE MATERIALS AND WORK

- .1 Where evidence exists that defective Work exists or that Work has been carried out incorporating defective materials, the Consultant may have tests, inspections or surveys performed, analytical calculations of structural strength made, and the like, in order to help determine whether the Work must be replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor's expense, regardless of their results, which may be such that, in the Consultant's opinion, the Work may be acceptable.
- .2 All testing shall be conducted in accordance with the requirements of the Building Code, except where this would, in the Consultant's opinion, cause undue delay or give results not representative of the rejected material in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.
- .3 Materials or Work which fails to meet the requirements specified in the Contract Documents may be rejected by the Consultant whenever found at any time prior to the Total Performance of the Work regardless of previous inspection. If rejected, defective materials or Work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the Owner.

END OF SECTION 03 20 00

Part 1 General

1.1 DEFINITIONS

- .1 The following Definitions shall apply in this Specification:
- .2 Contract Documents
 - .1 The Contract Documents consist of the Drawings, Specifications and Reports which form part of the agreed Contract.
- .3 Consultant
 - .1 The Consultant is the Architect, SER, persons or entities engaged by the Owner. The term Consultant means the Consultant or the Consultant's authorized representative.
- .4 Contractor
 - .1 The term Contractor is defined to include any of the following: Construction Manager, General Contractor, Structural Steel Erector, Structural Steel Fabricator, Subcontractor or Supplier.
- .5 Owner
 - .1 The Owner is the person or entity identified as such in the Contract. The term Owner means the Owner or the Owner's authorized agent or representative but does not include the Consultant.

1.2 WORK INCLUDED

- .1 Comply with Division 1 - General Requirements and all documents referred to therein.
- .2 Provide all labour, materials, plant and equipment to complete the cast-in-place concrete Work indicated on the Drawings and specified in this Section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Concrete Forming, Section 03 10 00
- .2 Concrete Reinforcement, Section 03 20 00
- .3 Structural Steel, Section 05 12 00
- .4 Spec. Note: Section 31 23 00 – Excavation and Fill is usually by other, verify with architect.
- .5 Excavation and Fill, Section 31 23 00, For fill under slab-on-grade including moisture barrier

1.4 REFERENCE STANDARDS, CODES AND ACTS

- .1 Conform to the requirements of the local building code identified on the Structural General Notes as amended by all subsequent Regulations issued to the date of this Specification and applicable acts of authorities having jurisdiction.

- .2 All references to the Standards and publications noted below shall be to the edition referenced in the local building code identified on the Structural General Notes, or to the edition referenced in the latest published editions or revisions of all Standards published by the Canadian Standards Association issued to the date of this Specification, whichever is the later edition or revision.
- .3 All references noted below, which are not referenced by the local building code or the Standards published by the Canadian Standards Association, shall be to the latest edition and revision published to the date of this Specification.
- .4 Standards and publications referenced by the Standards noted below are to apply even if they are not included in the list. Where such reference is made, it shall be to that latest edition and revision published to the date of this Specification.
 - .1 CSA A23.1/ CSA A23.2 - Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
 - .2 CSA A23.3 - Design of Concrete Structures
 - .3 CSA A3000 - Cementitious Materials Compendium.
- .5 Where there are differences between the Specifications and Drawings and the codes, standards or acts, the most stringent shall govern.

1.5 TOLERANCES

- .1 Perform placing operations so that completed Work will be within the tolerances set out in CSA A23.1.
- .2 Variations in building lines which result in extension of the building over lot lines or restriction lines will not be permitted.
- .3 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

1.6 QUALIFICATIONS

- .1 The 'foreperson' or 'lead hand' supervising the placement, consolidation, finishing and curing of the concrete shall be certified under an industry recognized concrete finishing program, such as the ACI Concrete Flatwork Finisher/Technician Certification Program.
- .2 The concrete supplier shall be certified by the Ready Mixed Concrete Association of Ontario (RMCAO) and shall hold a current "Certificate of Ready Mixed (or Mobile Mix) Concrete Production Facilities" as issued by the RMCAO.
- .3 Where concrete toppings are specified in the Contract Documents, the Contractor shall ensure that the concrete flooring contractor assumes responsibility for all aspects of the topping construction. This will include, but is not limited to the base course or substrate preparation, review of concrete mix design, concrete supply, bonding agents, placing, finishing and curing etc.

1.7 CONCRETE MIX DESIGN

.1 Design of Concrete Mixes

- .1 Concrete mixes are to be designed in accordance with the Performance Alternative outlined in CSA A23.1. The mixes shall be designed such that they will be homogeneous, uniformly workable, readily placeable into corners and angles of forms and around reinforcement by the methods of placing and consolidation employed on the Work, but without permitting materials to segregate or without permitting excessive free water to collect on the surface. The concrete, when hardened, shall have the qualities specified in the Contract Documents and in the concrete mix design.
- .2 When designing the concrete mixes, the Contractor shall ensure that the supplier is cognizant of the curing requirements outlined in the Contract Documents and CSA A23.1. If a particular concrete mix requires curing in addition to that specified, the Contractor shall be responsible for providing this additional curing.
- .3 Specified Strength: As called for on Drawings. Where walls are integral with columns of different specified strengths, cast walls and columns with concrete of the higher specified strength.
- .4 Modulus of Elasticity (E): For each concrete mix design, the Modulus of Elasticity, shall not be less than $(3300\sqrt{f'_c} + 6900)(Y_c/2300)^{1.5}$ MPa.
- .5 Fly Ash: The use of fly ash in concrete that will be exposed to view or in concrete that will be exposed to freeze-thaw cycles or de-icing chemicals is subject to review and acceptance by the Consultant.
- .6 Use of calcium chloride shall not be permitted.
- .7 The Contractor shall coordinate the mix designs for suitability with concrete pumping.
- .8 The Contractor shall design concrete mixes so they maintain their workability based on assumed minimum discharge and placing rates.

1.8 SAMPLES AND ASSISTANCE

.1 Concrete Test Cylinders

- .1 Supply materials for concrete test cylinders, the cost of which shall be paid for by the Contractor.
- .2 Cooperate in the execution of the concrete quality testing program. Furnish concrete required, protect specimens against injury and loss, and assist in the sampling and storage of specimens, as required.
- .3 Sample concrete, cast cylinders and store in accordance with CSA A23.1 where directed by the Consultant.

- .4 For all concrete compressive strength tests, 100mm x 200mm cylinders shall be used.
- .5 In accordance with requirements of CSA A23.1, provide storage facilities with continuous power supply for a Site storage container for test cylinders.
- .6 Provide sufficient field curing storage facilities so that cylinders representing the various areas can be safely stored in locations representing the curing conditions for those areas. Move the field cured cylinder storage facilities from area to area as the Work progresses.
- .2 Pullout Tests
 - .1 If requested by the Consultant, install pullouts to the requirements of the inspection and testing company.
 - .2 Installation of pullouts shall comply with the requirements of ASTM C900 and ACI 228.1.
- .3 Maturity Tests
 - .1 If pull-out tests are required, maturity meters shall be used to determine when pullout tests can be made.
 - .2 Installation, equipment and procedures shall comply with ACI 228R.
- .4 Substrate (Soil/Rock) Inspection
 - .1 Assist the geotechnical Consultant in making their inspections or tests.

1.9 SUBMITTALS

- .1 Surveys
 - .1 Submit surveys in accordance with Section 03 10 00 - Concrete Forming
- .2 Certificates
 - .1 The Contractor shall ensure that the concrete supplier submits a current "Certificate of Ready Mixed (or Mobile Mix) Concrete Production Facilities," as issued by the RMCAO.
 - .2 Prior to beginning Work and when any change in materials or source of supply is proposed, provide the following certificates prepared by an independent inspection company;
 - .1 Certification that all raw materials used in the production of concrete proposed for the Work comply with the requirements of the Specifications and CSA A23.1.
 - .2 Certification that compressive strength, slump, entrained air content, and other specified properties will be met, using the proposed mixes.

- .3 Certification that classes of exposure C-1, A-1 and C-XL will meet the 56-day limits specified in CSA A23.1 for the rapid chloride permeability test, using the proposed mixes.
- .4 Certification that the chloride ion content in the concrete, before exposure, shall not exceed 0.06% by mass of the cementing materials.
- .3 The Contractor shall ensure that the concrete supplier submits representative chloride permeability test data distributed over a period of 56 days for concrete exposure classes C-1, A-1 and C-XL with and without calcium nitrite corrosion inhibitor or any other admixture containing ionic salts.
- .4 The Contractor shall ensure that the concrete supplier submits their most current "Concrete Mix Design Statistical Analysis" records for the proposed concrete plant. These records shall indicate the concrete supplier's average strength, standard deviation, coefficient of variation and target strength, as per the requirements of CSA-A23.1 and the RMCAO.
- .3 Concrete Mix Designs
 - .1 Well in advance of the supply of concrete to the project submit, using the standard RMCAO form for Concrete Mix Design Submissions, all concrete mix designs for review. The mix designs shall include, as a minimum the following information:
 - .1 Concrete strength;
 - .2 Exposure class;
 - .3 Water-cement ratio;
 - .4 Maximum aggregate size;
 - .5 Maximum SCM replacement;
 - .6 Additional durability and architectural requirements;
 - .7 Slump range;
 - .8 Plastic air range;
 - .9 Method of placement;
 - .10 Dosage of corrosion inhibitor;
 - .11 Class of HVSCM (1 or 2);
 - .12 Other specific information regarding the source and type of all materials being proposed;
 - .13 Source of Supplementary Cementing Materials (SCM's).
 - .14 Assumed minimum discharge and placing rates.

- .2 Describe in detail on the mix design summary, the location(s) where each mix is to be placed in the structure.
- .4 Concrete Quality Plan
 - .1 At least four weeks prior to the supply of concrete to the project, submit a complete "Concrete Quality Plan", in the format provided by the Ready Mixed Concrete Association of Ontario.
- .5 Sloped Concrete Slabs
 - .1 Well in advance of construction, submit complete details of placing and compaction procedures for sloping roofs, including details of construction and placing of top forms and top form panel.
- .6 Curing Procedures
 - .1 At least four weeks prior to implementation in the field, submit a detailed description of the procedures which will be employed to cure the structure.
 - .2 As a minimum, the procedures shall indicate:
 - .1 The method for protecting the concrete from evaporation of surface moisture from the fresh concrete;
 - .2 The type of curing method to be used;
 - .3 Details of how various surfaces will be cured (slabs, walls, columns, ramps etc.)
 - .4 How the surface will be kept moist, and the quality control requirements for keeping the surface moist;
 - .5 The time of initiation and duration of curing;
 - .6 Provisions to address potential problems such as high winds and hot and cold weather;
 - .7 The limitations of access, if any, to the surfaces being cured; and
 - .8 A Quality assurance/Quality control program detailing how the curing program will be implemented, monitored and documented.
 - .3 Submit a 300mm x 300mm sample of each type of material (absorptive mat, fabric, plastic film, waterproof paper etc.) which will be used to cure the concrete.

Part 2 Products

2.1 MATERIALS

- .1 Concrete: Normal density concrete with an air-dry density between 2350 and 2450 kg/m³. Conform to CSA A23.1.
- .2 Cement Type: GU General Use Portland Cement.

- .3 Supplementary Cementing Materials: Conform to CSA.A3001.
- .4 Water: Clean, potable and not detrimental to concrete.
- .5 Nominal Size of Coarse Aggregate: 20 mm, except as noted below.
 - .1 Use pea gravel (5 mm to 10 mm) where concentration of reinforcement requires the use of a smaller diameter aggregate.
 - .2 Use 10 mm (maximum) aggregate in toppings that are less than or equal to 75 mm in thickness, and 20 mm aggregate in toppings greater than 75 mm in thickness.
- .6 Admixtures: Conform to CSA A23.1.
 - .1 Corrosion Inhibitor Admixture: Calcium nitrite based corrosion inhibitor, such as "DCI" or "DCI(S)" by W.R. Grace & Co. (or approved equivalent), shall be added at the rate of 10.1 litres per cubic metre of concrete, to all concrete designated Exposure Class 'C-1', unless noted otherwise in the Contract Documents. The corrosion inhibitor shall contain 30 ± 3 percent of calcium nitrite by weight. The selection of "DCI" or "DCI(S)" (or approved equivalent) shall be as directed by the admixture supplier, based on anticipated placing and curing conditions and the specific concrete mix design selected.
- .7 Shrinkage Control Fibres: "Dramix" steel fibres by Bekaert or approved equivalent, 60/1.05.
- .8 Bonding Agent: Use Sika Sikdur 32 epoxy bonding agent for all bonded topping installations.
- .9 Curing Compound: Conform to CSA A23.1.
- .10 Grout Beneath Base Plates: Non-shrink flowable grout in-Pakt by King Construction Products or approved equivalent, having a compressive strength at 28 days of at least 35 MPa. Where grout is exposed to view or weather, use non-ferrous grout.
 - .1 High Strength Concrete
 - .2 Cement Type: General Use Portland Cement (Type GU) or Low Heat of Hydration Portland Cement (Type LH) meeting the requirements of Standard CSA-A3001A.
 - .3 Supplementary Cementing Materials (SCMs)
 - .4 It is anticipated that one or more supplementary cementing materials will have to be used in the concrete to produce a mix with acceptable fresh and hardened concrete properties and acceptable thermal characteristics during hardening. The materials shall be one or more of the following:
 - .5 Granulated blast furnace slag,
 - .6 Fly-ash,
 - .7 Silica fume.

- .8 Supplementary cementing materials fly-ash, granulated blast furnace slag or silica fume, shall comply with the requirements of Standard CSA A3000 Cementitious Materials Compendium.
- .9 The Contractor shall ensure that the supplier submits evidence satisfactory to the Owner to demonstrate that the storage and dispensing facilities for supplementary cementing materials do not have any deleterious effects on the materials themselves. These facilities will not expose these materials to such effects as the agglomeration or balling of particles or any separation or change in effective particle size of solids in slurries or to freezing and thawing or to excessive heat.
- .10 Aggregates
- .11 The concrete supplier shall demonstrate, by appropriate tests that the aggregates chosen have the potential to meet the design strength and Modulus of Elasticity requirements specified in this Section.
- .12 Coarse Aggregate: Crushed rock conforming in all respects to Standard CSA A23.1. The maximum size of the coarse aggregates shall be 20 mm but smaller maximum sizes may be used.
- .13 Fine Aggregate: Natural and conforming to CSA A23.1.
- .14 HVSCM Concrete
- .15 Cement Type: General Use Portland Cement (Type GU).
- .16 Compressive Strength: Achieved at [56] days.
- .17 Supplementary Cementing Materials (SCMs)
- .18 Supplementary cementing materials fly-ash, granulated blast furnace slag or silica fume, shall comply with the requirements of Standard CSA A23.1 and CSA A3001.
- .11 Water Storage Tanks/Water Tight Construction
 - .1 Cement: Type LH low heat of hydration Portland Cement in accordance with CSA A3000. Alternative use of supplementary cementing materials and chemical admixtures is subject to review by the Consultant.
 - .2 Air Entrainment: 6% plus or minus 1%
 - .3 Compressive Strength: 28 MPa (4 ksi) minimum at 28 days.
- .12 Unshrinkable Fill
 - .1 Cement type-General Use GU Portland
 - .2 Minimum 24 hour strength - 0.07 MPa
 - .3 Maximum 28 day strength - 0.4 MPa
 - .4 Class of exposure - Not Applicable
 - .5 Size of coarse aggregate - 20 mm to 40 mm

- .6 Slump at point of discharge - 150 mm to 200 mm
- .7 Calcium chloride or pozzolanic mineral admixtures shall not be used. Air entraining admixtures may be added if desired by the Contractor.
- .13 Sealant for Exposed Separation Strips, Construction Joints, and Temporary Opening Joints: Multi-Component Polyurethane 'Sikaflex 2C-SL' by Sika, or an equivalent approved by the Consultant.

Part 3 Execution

3.1 General

- .1 Ensure minimum concrete discharge and placing rates are maintained to avoid unexpected cold joints from forming in the structure.

3.2 FOOTINGS

- .1 During cold weather conditions, carefully protect footing bases from freezing.
- .2 Found footings on naturally consolidated undisturbed soil capable of safely supporting the allowable bearing capacity shown on the Drawings within acceptable limits of settlement.
- .3 Founding elevations shown in the Contract Documents are based upon the geotechnical investigation.
- .4 Founding elevations and allowable bearing capacities must be verified by the geotechnical Consultant before footing concrete is placed.
- .5 If, upon excavating to the elevations shown in the Contract Documents, the required bearing capacities are not achieved, or if they are achieved at a higher elevation, inform the Consultant who will provide instructions as to how to proceed.
- .6 Record actual footing founding elevations.
- .7 Construct footings in a particular area commencing from the lowest footing elevation and proceeding to the higher elevations.
- .8 Remove water, disturbed soil and foreign matter from footing excavations before placing concrete. Do not permit the soil at founding elevations to soften due to the presence of water in the excavations or construction activity.
- .9 Remove water, loose rock and foreign matter from footing excavations before placing concrete.
- .10 Provide a 75 mm skim slab beneath all footings, where identified in the geotechnical report. Skim slab shall be placed after all loose material, foreign matter and water has been removed from the excavation and after the geotechnical engineer has inspected the soil at the founding elevation.
- .11 During cold weather, prevent soil adjacent to and beneath all footings from freezing. Do not pour footings on frozen soil or soil which has been allowed to freeze. If the soil at founding elevations is frozen or was frozen and thawed,

remove affected material and found footings on unaffected soil with the required characteristics at no extra cost to the Owner.

- .12 During cold weather, prevent rock adjacent to and beneath all footings from freezing.
- .13 Where excavations for mechanical or electrical services, pits, adjacent foundations and the like encroach upon a 7 in 10 slope noted above between corners of footings and bottom corners of excavations, lower footings a suitable amount so as not to exceed the slope noted above at no extra cost to the Owner.

3.3 Foundation mat

- .1 Massive pours may set up temperature rises and gradients that may cause severe cracking and in extreme cases, loss of strength. Plan and carry out concreting operations, protect and cure the concrete so as to prevent these conditions from occurring.
- .2 Design mix and employ construction procedures in accordance with CSA A23.1 such that the maximum temperature in the concrete and the maximum temperature difference from interior of mass to outside face do not exceed those specified in CSA A23.1. Use insulation or other approved techniques to achieve this.
- .3 Determine maximum temperature of the concrete at the time of placing by estimating the temperature rise during concrete batching, placing, hydration and curing.
- .4 Conduct a mat concrete test pour using the proposed mix design. The Owners inspection and testing company will install and monitor thermocouples in both the test pour and the final pour and report the temperature results achieved. If the Owner has not appointed an inspection and testing company, the Contractor shall arrange for an inspection and testing company to complete this Work. The size of the test pour shall be representative of the volume of concrete to be placed, but in no case less than 2.5 m x 2.5 m x depth or thickness noted on the Drawings.
- .5 In addition to the other requirements of this and other related Specification Sections, adhere to the following:
 - .1 Maximum size of aggregate: 40 mm.
 - .2 Temperature of the concrete at the time of placing: between 7°C and 21°C (45°F and 70°F)
- .6 Just prior to placing, bring surfaces, upon or against which concrete will be placed, above the freezing point.
- .7 In the hot weather months, provide cooling to sub base as required to maintain the initial temperature gradients of the concrete per CSA A23.1.
- .8 Provide appropriate insulation and protection to the concrete surfaces for at least 7 consecutive days immediately after concrete placement.

- .9 Do not remove insulation and protection until the temperature between average ambient and 25mm-50mm below the top of concrete is within the ranges specified in CSA A23.1. The Owners inspection and testing company will install and monitor a system of thermocouples placed at or below the surface of the concrete to determine concrete temperature. Protect the thermocouples, wires, data logger and the like to ensure that it is not damaged during construction.
- .10 Employ necessary procedures to keep temperature differential within concrete to 20°C or less.
- .11 Place concrete in maximum 450 mm lifts and thoroughly vibrate each layer and extend vibration into lower layers.
- .12 Advance each layer at least 6 metres before starting next layer.

3.4 CONSTRUCTION JOINTS

- .1 Obtain approval from the Consultant for location and details of construction joints not shown on the structural Drawings.
- .2 Provided proper placing, curing and protection means and methods are employed by the Contractor, the maximum length/height of concrete pours shall be as follows
 - .1 The maximum length of a suspended concrete slab pour shall be 40 m.
 - .2 The maximum length of a concrete slab on steel deck pour shall be 30 m.
 - .3 The maximum length of a slab-on-grade pour shall be 30 m.
 - .4 The maximum length of a concrete foundation wall pour shall be 15 m.
 - .5 The maximum height of a concrete pour shall be 4.5 m.
- .3 If the construction joints (including joints around temporary openings) will be exposed in its permanent condition, such as in a Parking Garage, the joints must be caulked as outlined in this Specification.

3.5 SLABS-ON-GRADE

- .1 General
 - .1 Do not place concrete slab-on-grade until the specified sub-floor material has been placed, inspected and approved.
 - .2 Do not place concrete on a frozen sub-grade, or on one that contains frozen materials.
 - .3 Do not place concrete on a sub-grade that has been frozen and thawed until the sub-grade has been reviewed by the geotechnical Consultant and approved. If, in the geotechnical consultant's opinion, the safe bearing capacity of the sub-grade has been reduced to below 25 kPa, remove the affected materials and replace with compacted granular fill at no additional cost to the Owner.

- .4 Place clear crushed stone over the sub-base, to depths indicated in the Contract Documents. Thoroughly roll and consolidate to the lines and levels required, with a maximum surface variation of +/- 10mm.
- .5 Upon approval of the placement of the sub-floor material and setting of reinforcement, place and consolidate concrete and finish and cure as specified in this Section.
- .6 Place a bond breaker, minimum 1 layer of building paper between edges of slab-on-grade and abutting surfaces. Where slab-on-grade is exposed to de-icing chemicals, provide an approved sealant at the joint between the slab-on-grade and abutting surfaces.
- .7 Saw-cut slabs-on-grade as shown in the Contract Document, or to the Consultant's approval.
- .8 Carry out cutting in accordance with recommendations contained in CSA A23.1.
- .9 Mask edges of saw-cuts as required to prevent concrete floors from becoming stained.
- .10 Construction joints may be provided in slabs-on-grade so that pours on any one day may be kept to reasonable sizes. Locate construction joints to the Consultant's approval.

3.6 UNSHRINKABLE FILL

- .1 Unshrinkable fill is intended for use locally in place of granular backfill below slabs-on-grade or within excavations where compaction of granular material is difficult to achieve. It is not intended for use below footings or around foundation walls, tunnels, laterally loaded caissons, etc., where vertical and/or lateral structural bearing capacities are required. Obtain written approval from the Consultant prior to using unshrinkable fill.
- .2 The unshrinkable fill material shall flow into the excavation so that it fills the entire space. Care shall be taken to ensure that no air is entrapped beneath horizontal projections or in other locations within the excavation.
- .3 Where bracing, shoring and/or sheeting is used to support the sides of the excavation or to prevent movements that could damage other services or adjacent pavements, this support system shall be removed as backfilling proceeds.

3.7 CONCRETE WORK AT EXISTING STRUCTURE

- .1 Before proceeding with any Work in or adjacent to the existing structure, verify that conditions are as indicated on the Drawings. If they are not, advise the Consultant of discrepancies and do not proceed until the Consultant has given instructions.

- .2 Prior to proceeding with the Work, determine the exact founding elevations of existing footings adjacent to the new Work. Report these findings to the Consultant before proceeding further.
- .3 Install footings adjacent to these existing footings in the sequences indicated in the Contract Documents, and against undisturbed soil as shown in the Contract Documents, and so that the stability of the existing footings and existing slabs-on-grade are maintained at all times. Temporarily support existing foundations as required.
- .4 Where openings are shown to be cut into the existing structure in the Contract Documents, drill at corners and saw cut remainder such that saw cuts do not extend into structure to be retained. Overcutting may require major structural strengthening, the cost of which shall be borne by the Contractor.

3.8 SLOPING SLABS

- .1 In the case of sloping slabs, employ suitable concrete placing and compaction procedures to ensure that completed concrete has the specified design characteristics, and in particular, to prevent movement of plastic concrete resulting in cracking, loss of bond, etc. and to achieve a surface equivalent to a fine wood float finish suitable to receive the roofing membrane.

3.9 PLACING CONCRETE

- .1 Place all concrete in accordance with CSA A23.1, the concrete supplier's requirements and as specified in this Section.
- .2 Immediately before placing concrete, clean forms and reinforcement of foreign matter.
- .3 Discharge concrete into forms in accordance with the time frames specified in CSA A23.1.
- .4 Prior to pouring the concrete elements directly supported above, remove sonotube forms to such an extent to allow the Consultant to review the quality of any exposed column surface. Provide necessary protection to the exposed surfaces upon completion of review.
- .5 Place concrete on steel deck floors in a manner that avoids piling up of concrete. Do not drop concrete directly from buckets, but employ suitable means of distribution. Wet down deck during hot weather prior to concreting.
- .6 Remove concrete spilled onto forms around hoisting equipment before depositing concrete in these areas.
- .7 Pumping Concrete
 - .1 Pumping or pneumatic placing of concrete shall only be used if the velocity of discharge is reduced to a point where no separation or scattering of the concrete occurs, and the consistency of the mix has been designed to allow such a system with no adverse effects on the quality of concrete.

- .2 The shotcrete process shall be deemed as being in contravention of the above clause.
- .3 Excess grout or mortar used to lubricate pipelines, or washout water, must not be discharged into the forms.
- .8 Shotcrete
 - .1 The use of shotcrete to construct any part of the Work shall be at the sole discretion of the Consultant.

3.10 CURING CONCRETE

- .1 Cure all concrete in accordance with CSA A23.1, the concrete supplier's requirements and as specified in this Section.
- .2 HVSCM Concrete
- .3 Cure all HVSCM concrete in accordance with the requirements of CSA A23.1. Wet curing shall commence immediately after placement and finishing of concrete.
- .4 C-XL Concrete
 - .1 All C-XL (extended service life concrete) shall be wet cured at a temperature of at least 10°C for a period of seven consecutive days and for a time necessary to attain 70% of the specified compressive strength, whichever is greater. Wet curing shall commence immediately after placement and finishing of concrete.
- .5 Wet Curing
 - .1 Basic Curing Period - the concrete shall be protected from premature drying and extremes of temperatures, and shall be wet cured at a temperature of at least 10°C for a period of three (3) consecutive days. Wet curing shall commence immediately after placement and finishing of the concrete.
 - .2 Additional Curing for Durability - Immediately following the Basic Curing Period, continue to wet cure the concrete (at a minimum temperature of 10°C for an additional four (4) consecutive days or until the concrete reaches 70% of its 28 day compressive strength, whichever is greater.
 - .3 Wet curing is to be achieved using one or more of the techniques outlined in CSA A23.1.
 - .4 If an absorptive mat or fabric material is used, it is imperative that it be kept continuously wet, by means of sprinklers, soaker hoses, a layer of polyethylene sheeting above, or another acceptable means.
 - .5 The use of curing compounds shall not be permitted in these areas.

3.11 PROTECTION

- .1 Protect all concrete in accordance with CSA A23.1, the concrete supplier's requirements and as specified in this Section; to prevent freshly deposited concrete from adverse conditions such as high winds, precipitation, freezing, being exposed to abnormally high temperatures or temperature differentials, premature drying, and moisture loss, for a period of time necessary to develop the specified properties of the concrete.
- .2 Cold Weather Concreting
 - .1 Between the 15th of October of any year and the 15th of April of the following year, or when the temperature is at or below 5°C or anticipated to fall below 5°C within 24 hours of placing concrete, provide on hand and ready for use all equipment necessary for adequate cold weather protection and curing before concrete placement is begun.
 - .1 Contractor is to submit a detailed procedure for review and approval by the consultant team prior to any construction commencing that outlines the means and method for protection of concrete in cold weather conditions. At a minimum, the submittal should include proper material selection and concrete mix design for cold weather applications, subgrade and formwork preparation, temperature control before, during and after placement, curing and protection measures, quality control and testing measures and contingency measures.
 - .2 When fresh concrete is to be cast against existing concrete, prevent the loss of heat by extending the protection for the fresh concrete over the existing concrete.
 - .3 Insulate, or enclose within the protective housing, tie rods, reinforcement or metal which projects from the concrete being protected.
 - .4 Construct enclosures tight and safe for wind and snow loadings.
 - .5 Maintain housing, enclosures and supplementary heat in place for entire period of protection, except that sections may be temporarily removed as required to permit placing additional forms or concrete provided the uncovered concrete is not permitted to freeze. Make up time lost from the required period of protection at the required temperature before protection is discontinued and removed. Protection is not to be completely removed until the concrete has cooled to within the temperature differential limits specified in CSA A23.1.
 - .6 Locate heating units to avoid heating concrete locally or drying it excessively. Avoid high temperature and dry heating within enclosures.
 - .7 Take particular care to maintain edges and corners of concrete at the required temperature owing to their greater vulnerability to freezing.
 - .8 Provide sufficient insulation, and heat as necessary, to prevent freezing of frost susceptible soil which lies against structural elements; in particular

protect soil beneath footings and behind foundation walls until the building is completed.

.3 Hot Weather Concreting

.1 When the rate of moisture evaporation exceeds 0.5kg/m² per hour or when the temperature is greater than or equal to 27°C, employ the following measures in addition to the requirements of CSA A23.1:

- .1 Use ice as mixing water, or an approved equivalent temperature reducing or set retarding admixture to lower the concrete temperature.
- .2 Dispatch ready-mix trucks and organize Work to keep mixing time to a minimum. Minimize exposure of mixing trucks to the hot sun while waiting. Water shall be made available to spray the exterior of the drum while the truck is waiting to discharge its concrete.
- .3 Provide adequate personnel and organize Work to keep placing time to a minimum.
- .4 Place concrete in layers thin enough and areas small enough so that the time interval for placing is reduced and compaction will ensure complete union of adjacent portions.
- .5 With formed concrete, reliance shall not be placed on the forms alone to provide curing. Spray formwork with water to keep it tight and free from cracking.

.4 Protection of Completed Work

- .1 At all times during the Work, protect exposed concrete, exposed masonry and other exposed members from staining or becoming coated with concrete leakage due to continuing concreting operations. Members which become coated may be classed as defective by the Consultant.
- .2 Protect exposed members from staining due to rusting of reinforcement projecting beyond construction joints.
- .3 Take suitable measures to prevent spalling and cracking damage occurring to the structure due to water freezing in expansion joints, small holes, slots, depressions and take suitable measures to prevent damage occurring to foundations and the like due to frost action in the soil or backfill.
- .4 The application of de-icing salts on completed Work is not permitted.

3.12 TOPPINGS

- .1 General
- .2 Conform to CSA A23.1 and the requirements noted below, unless noted otherwise in the Contract Documents.

- .3 Set screeds and bulkheads rigidly and accurately to prevent displacement during concreting.
- .4 Special provisions for bonded and unbonded toppings:
- .5 The maximum pour size for bonded and unbonded toppings is to be limited to 100 m².
- .6 Maintain a one to one length to width aspect ratio for all pours, where extent and geometry of topping permits.
- .7 Toppings are to be poured in a “checker board” pattern to minimize the effects of shrinkage. Adjacent sections of topping shall be poured no sooner than 3 days after the adjoining section was poured.
- .8 Ensure temperature of base course is 10oC minimum prior to pouring toppings.
- .9 Provide hot and cold weather protection for toppings in accordance with CSA A23.1.
- .10 Monolithic Toppings
- .11 Monolithic toppings are constructed by applying a concrete mixture to a “freshly” poured base course that has lost all slump and bleed water, prior to its final set. Alternatively, monolithic toppings can be poured with the main base course to a final thickness equal to the thickness of the base course plus the thickness of the topping.
- .12 Where monolithic toppings are specified in the Contract Documents, place reinforcement and maintain cover requirements based on the thickness of the base slab only. Provide additional layer of reinforcement in monolithic toppings where noted on the Contract Documents.
- .13 Bonded Toppings
- .14 Bonded toppings are constructed by applying the topping mixture over a hardened concrete base to which a bonding agent has been applied. By definition, bonded toppings are designed to bond to the concrete base or an existing concrete surface.
- .15 Bond strength between topping and base course shall not be less than [0.90 MPa], per CSA A23.1.
- .16 Base Course Finishing and Preparation
- .17 Base courses which are to receive bonded toppings are to be finished by one of two of the following methods:
- .18 Rough broom finish (very rough finish – amplitude \pm 5mm).
- .19 Steel trowel finish.
- .20 When a rough broom finish is provided, the slab surface shall be cleaned by high-pressure water blasting to ensure all laitance, dirt, dust, construction debris and the like are removed prior to application of the bonding agent. The bonding

agent shall be applied in strict accordance with manufacturer's recommendations.

- .21 When a steel trowel finish is provided, the slab is to be roughened by means of shot blasting prior to the application of the bonding agent. Ensure all laitance, dirt, dust, construction debris and the like are removed immediately prior to the application of the bonding agent. Employ all necessary means to control dust and debris during shot blasting.
- .22 Placing and Finishing Toppings
- .23 Place and finish the toppings in accordance with CSA A23.1.
- .24 Curing
- .25 Continuously wet cure bonded toppings for a minimum of seven days.
- .26 Jointing
- .27 Bonded toppings do not require special provisions with respect to jointing provided all the provisions noted above are adhered to.
- .28 The location of joints in the topping shall match those in the base course.
- .29 Unbonded (Loose Laid) Toppings
- .30 Unbonded or loose laid toppings are constructed by applying the topping mixture over a bond breaker and hardened concrete base, to which no bonding agent has been applied. By definition, unbonded toppings are specifically designed so as not to bond to the concrete base.
- .31 Base Course Finishing and Preparation
- .32 Base courses which are to receive unbonded or loose laid toppings are to be finished smooth by means of a steel trowel.
- .33 Placing and Finishing Toppings
- .34 Place toppings on bond breaker and finish the toppings in accordance with CSA A23.1.
- .35 Curing
- .36 Continuously wet cure unbonded toppings for a minimum of seven days.
- .37 Jointing
- .38 Unbonded toppings are to be saw cut, as per the typical detail for slabs-on-grade, at a maximum spacing of 3.0 metres in both directions, unless noted otherwise in the Contract Documents. For toppings that are to receive hard architectural floor finishes, the jointing shall be laid out in accordance with the Consultant's requirements and is subject to final approval by the Consultant.
- .39 Cracks in Toppings
- .40 All cracks in concrete toppings shall be repaired by the Contractor. Extent of repair and method of crack repair shall meet the requirements of the flooring installation Contractor and the Owner.

3.13 OPENINGS THROUGH COMPLETED MEMBERS

- .1 Do not cut openings through completed members without the Consultant's approval.
- .2 Where the location of openings is approved, locate the reinforcement by x-ray, scanning, cover meter or other positive means as required by the Consultant and adjust the location of the opening so that no reinforcement is cut unless specifically approved otherwise in writing by the Consultant.
- .3 In the case of precast concrete slabs, holes shall be cut or drilled only by the precast concrete Contractor.

3.14 MAKING GOOD

- .1 Where directed by the Consultant, make good temporary openings left in concrete construction around pipes, ducts and the like using a mortar of the same proportions as the surrounding Work. Reinforce mortar with welded wire fabric where openings exceed 75 mm. Roughen existing surfaces to receive mortar or apply suitable bonding agent such that mortar will be securely bonded to existing concrete.

3.15 GROUTING BENEATH BASE PLATES

- .1 Grout beneath plates bearing on concrete with an approved non-shrink flowable grout. Comply with the manufacturer's directions for mixing and placing grout. Completely fill voids below plates. Fill voids left by shims after shims are removed.
- .2 During cold weather, preheat base plates and footings and maintain temperature at minimum 12°C for 6 days after grouting.
- .3 Refer to Section 05 12 00 – Structural Steel for lifting of base plates to determine adequacy of grouting. If defects are found, more base plates will be raised.

3.16 TREATMENT OF FORMED SURFACES

- .1 Do Work in accordance with CSA A23.1 and as follows:
 - .1 Provide smooth form finish to concrete surfaces exposed to public view and surfaces to receive plaster, damp-proofing, moisture resistant membrane and the like.
 - .2 Remove traces of form lining compound from concrete surfaces which may affect the bonding of following surface application.

3.17 WATER STORAGE TANKS (WATER TIGHT CONSTRUCTION)

- .1 Conform with the requirements of this Section including the following for the construction of the walls and base slabs of the water storage tanks members designated to be watertight.
- .2 Temperature Control
 - .1 Concrete temperature at time of delivery 27°C maximum, 18°C minimum.

- .2 Maximum cooling rate not to exceed 7°C per day.
- .3 In the case of the base slab, employ a temperature monitoring system during each pour to determine the internal concrete temperature at regular intervals. Submit details of the proposed monitoring system to the Consultant for review.
- .3 Joints
 - .1 For each pour, arrange to begin saw-cutting of joints no later than 30 minutes after the maximum temperature in each pour is reached, and to complete the saw-cutting within a maximum of 2 hours.
 - .2 Note that this timing of saw-cutting could occur at any time of the day or night. Plan accordingly.
- .4 Curing
 - .1 Maintain 7 days continuous moist curing after placing concrete. Provide an approved membrane waterproofing immediately thereafter.
- .5 Crack Repair
 - .1 Just prior to the installation of the tank liner and insulation, carefully examine all exposed interior and exterior surfaces and repair any cracks in them.
- .6 Water Test
 - .1 At least 28 days after concreting the last section of each pool or tank, and after the sealing of joints, fill each pool or tank with water and leave standing for 10 days.
 - .2 Fill each pool or tank gradually such that the differential temperature between the water the pool or tank concrete does not exceed 7°C.
 - .3 Locate and repair all areas where leakage occurs and retest until each pool or tank is watertight.

3.18 QUALITY CONTROL

- .1 Implement a system of quality control to ensure that the minimum standards specified in this Section are attained.
- .2 Adhere to the requirements of the project "Concrete Quality Plan" prepared and submitted as required by this Specification.
- .3 Bring to the attention of the Consultant any defects in the Work or departures from the Contract Documents which may occur during Construction. The Consultant will decide upon corrective action and will provide recommendations in writing.
- .4 The Consultant's general review during construction and inspection and testing by independent inspection and testing agencies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in

no way augment the Contractor's quality control or relieve the Contractor of its contractual responsibility.

3.19 NOTIFICATION

- .1 Prior to commencing significant segments of the Work, give the Consultant and independent inspection and testing companies appropriate notification so as to afford them reasonable opportunity to review the Work. Failure to meet this requirement may be cause for the Consultant to classify the Work as defective.

3.20 INSPECTION AND TESTING

- .1 Appointment of Independent Inspection and Testing Companies
 - .1 The Owner or Consultant will appoint the independent inspection and testing companies to make inspections or perform tests as the Consultant directs. The independent inspection and testing companies shall be responsible only to the Consultant, and shall make only such inspections or tests as the Consultant may direct.
 - .2 When defects are revealed, the Owner may request, at the Contractor's expense, additional inspection or testing to ascertain the full extent of the defect.
- .2 Concrete Quality Tests
 - .1 Concrete quality tests shall be carried out in accordance with CSA A23.1 and shall include the following:
 - .1 Slump
 - .2 Air content of fresh concrete
 - .3 Temperature of fresh concrete
 - .4 Compressive strength
 - .5 Density (for low-density and semi-low-density concrete only)
 - .2 Compressive Strength Tests: Compressive cylinder testing will be carried out in accordance with CSA A23.1 and as follows: Three companion laboratory cured concrete standard compression test cylinders; one tested at 7 days and two tested at 28 days, constitute a strength test. During the placing of concrete in cold weather one additional field cured test cylinder will be made and tested at 7 days.
 - .3 High Strength Concrete and HVSCM Concrete: Compressive cylinder testing will be carried out in accordance with CSA A23.1 and as follows: Four companion laboratory cured concrete standard compression test cylinders; one tested at 7 days, one tested at 28 days and two tested at 56 or 91 days, whichever is the specified test age. In addition, two accelerated test cylinders shall be made and tested in accordance with Standard CSA A23.2.
 - .4 Core Samples for Chloride Ion Permeability Test

- .1 C-1, A-1 and C-XL concrete exposure classes: Chloride ion permeability test shall be carried out in accordance to CSA A23.1 and ASTM C1202 and as follows: Each test shall consist of 4 companion in-situ core specimens at locations determined by the Consultant. Test one core specimen at 7 days, one at 28 days and two at 56 days.
- .2 Where cores are taken for chloride ion permeability tests, the core areas are to be filled and reinstated with King Self-Leveling Concrete or suitable equivalent approved by the Consultant. The Independent Testing and Inspection agency will perform four concrete cores for each pour consisting of concrete exposure class C-1, A-1 or C-XL.
- .3 Tensile Bond Tests: Tensile bond tests will be carried out in accordance with CSA A23.1 for all bonded toppings.
- .3 Grout under Baseplates: At least one strength test may be made each day that grout is placed under baseplates.
- .4 Inspection of Substrate
 - .1 Substrate at footing founding elevations will be inspected.

3.21 DEFECTIVE MATERIALS AND WORK

- .1 Where evidence exists that defective Work has occurred or that Work has been carried out incorporating defective materials, the Consultant may have tests, concrete coring, inspections or surveys performed, analytical calculations of structural strength made and the like in order to help determine whether the Work must be repaired or replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor's expense, regardless of their results, which may be such that, in the Consultant's opinion, the Work may be acceptable.
- .2 All testing shall be conducted in accordance with the requirements of the local building code identified on the Structural General Notes, except where this would in the Consultant's opinion cause undue delay or give results not representative of the rejected material in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.
- .3 Materials or Work which fails to meet the requirements specified in the Contract Documents may be rejected by the Consultant whenever found at any time prior to the Total Performance of the Work regardless of previous inspection. If rejected, defective materials or Work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the Owner.

END OF SECTION 03 30 00

1 GENERAL

1.01 RELATED REQUIREMENTS

- .1 Not Used.

1.02 DEFINITIONS

- .1 Environmental Product Declaration (EPD): Third-party verified documentation with the supporting Product Category Rule (PCR) and Life cycle assessment information. Prepared in accordance with ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and having at least a cradle-to-gate scope.
- .1 Industry-wide (generic) EPD with third-party certification (Type III), including external verification in which the manufacturer is explicitly recognized as the participant by the program operator.
- .2 Product-specific Type III EPD - Products with third-party certification (Type III), including external verification in which the manufacturer is explicitly recognized as the participant by the program operator.
- .3 Supplementary Cementitious Materials (SCMs): Materials added to concrete which contribute to the properties of hardened concrete through hydraulic or pozzolanic activity.
- .4 Workability: This term broadly describes the total properties and expectations for concrete delivered to site as follows:
- .5 Individual tested properties of concrete that account for confined or free flow slump, penetration, compaction, or relative plasticity of various concrete mix designs used for the project.
- .6 Overall properties involved with mixing, handling, transportation, and placement using vibratory compaction methods without loss of homogeneity of in-place concrete.

1.03 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
- .2 ASTM D 1751-18, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- .3 CSA Group (CSA):
- .4 CSA A23.1:19 /CSA A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
- .5 CSA A3000-18, Cementitious Materials Compendium

1.04 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Shop Drawings:
 - .1 Submit drawings stamped and signed by a professional engineer registered or licensed in

Province of Ontario, Canada.

- .2 Submit shop drawings prepared in accordance with Contract Drawings to clearly show size, shape, location, and necessary details of reinforcing.
- .3 Submit shop drawings showing formwork and falsework design to CSA A23.1/CSA A23.2.
- .2 Submit placing drawings prepared in accordance with plans to clearly show size, shape, location and necessary details of reinforcing.
- .2 Samples:
 - .1 When requested, submit samples of the following materials for review and acceptance: joint filler.
- .3 Provide testing reports for review by Consultant and do not proceed without written approval when deviations from mix design or parameters are found.

1.05 QUALITY ASSURANCE

- .1 Submit valid and recognized certificate from plant delivering concrete to Consultant a minimum four weeks before starting concrete work.
- .2 Quality Control Plan: Submit written report to Consultant verifying compliance of cast-in-place concrete to performance requirements.
- .3 Mock-Ups: Construct mock-up of all separate concrete finishes on all landscape walls and surfaces.
 - .1 Build mock-up in location where jointly agreed between Contractor and Consultant.
 - .2 Mock-up size: 1.5 m by 1.5 m, illustrating horizontal surfacing.
 - .3 Mock-up may form part of permanent structure when accepted by Consultant.
- .4 Allow 24 hours for inspection of mock-up before proceeding with work.
- .5 When accepted, mock-up will demonstrate minimum standard of quality required for this work.

1.06 DELIVERY, STORAGE, AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Concrete hauling time: Deliver to site of work and discharge within a maximum of 120 minutes after batching.
 - .1 Modifying maximum time limit before receiving written agreement from Consultant and concrete producer as described in **CSA A23.1/CSA A23.2** is prohibited.
 - .2 Submit deviations for review by Consultant.
- .2 Concrete delivery: Ensure continuous concrete delivery from plant meets **CSA A23.1/CSA A23.2**.

1.07 AMBIENT CONDITIONS

- .1 Placing concrete during rain or weather events that could damage concrete is prohibited.
- .2 Protect newly placed concrete from rain or weather events in accordance with **CSA A23.1/CSA**

A23.2.

- .3 Cold weather protection:
 - .1 Maintain protection equipment in readiness on site.
 - .2 Use protection equipment when ambient temperature below is 5°C, or when temperature may fall below 5°C before concrete has cured.
 - .3 Placing concrete upon or against surface at temperature below 5°C is prohibited.
- .4 Hot weather protection:
 - .1 Protect concrete from direct sunlight when ambient temperature is above 27°C.
 - .2 Prevent forms from getting too hot before concrete is placed. Apply accepted methods of cooling that will not negatively affect concrete.
- .5 Protect from drying.

2 PRODUCTS

2.01 DESIGN CRITERIA

- .1 Performance: To **CSA A23.1/CSA A23.2**, and as described in MIXES in PART 2 - PRODUCTS of this Section.

2.02 PERFORMANCE CRITERIA

- .1 Quality Control Plan: Ensure concrete supplier meets performance criteria of concrete as established in Contract Documents. Submit verification of compliance as described in QUALITY ASSURANCE in Part 1 of this Section.

2.03 MATERIALS

- .1 Portland Cement: Grey Portland Cement in accordance with [CSA A3000](#), Type I/II.
- .2 Water: To **CSA A23.1/CSA A23.2**.
- .3 Bituminous impregnated fibreboard: To [ASTM D 1751](#).
- .4 Other concrete materials: To **CSA A23.1/CSA A23.2**.

2.04 MIXES

- .1 Alternative 1 - Performance Method for specifying concrete: To meet Consultant performance criteria to **CSA A23.1/CSA A23.2**.
- .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as described in VERIFICATION in Part 3 of this Section.
- .2 Provide concrete mix to meet the following plastic state requirements:
 - .1 Workability: Free of surface blemishes, loss of mortar, colour variations and segregation.
- .3 Provide concrete mix to meet the following hard state requirements:
 - .1 Durability and class of exposure: C-2
 - .2 Compressive strength at 28 days age: Minimum 32 MPa

- .3 Aggregate size maximum 19 mm
- .4 Concrete mixture for site furnishing footings to follow manufacturer's recommendations.
- .5 Submit concrete supplier's certification.
- .6 Submit quality management plan to ensure verification of concrete quality to specified performance.

2.05 COLOURED CONCRETE

- .1 TORONTO REDIMIX, Canada, Concord, ON
 - .1 Contact:
 - .1 <https://www.torontoredimix.com/>
 - .2 Email: sales@torontoredimix.com
 - .3 Tel.: +1 416 798 7060
 - .2 Colour: Charcoal Gray

3 EXECUTION

3.01 PREPARATION

- .1 Notify Consultant a minimum 24 hours before each concrete pour.
- .2 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of rehandling, and without damage to existing structure or Work.

3.02 INSTALLATION

- .1 Do cast-in-place concrete work in accordance with **CSA A23.1/CSA A23.2**.
- .2 Cast-in sleeves, ties, slots, anchors, reinforcement, frames, conduit, bolts, waterstops, joint fillers and other inserts required to be built-in.
- .1 Sleeves and openings greater than 100 mm x 100 mm that are not indicated in the reviewed shop drawings must be approved by Consultant.

3.03 FINISHES

- .1 Pavements, walkways, curbs, and exposed site concrete:
 - .1 Screed to plane surfaces and use wood floats.
 - .2 Provide round edges and joint spacing using standard tools.
 - .3 Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - .4 Trowel smooth and provide medium-to-fine texture broom finish. Draw a soft bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.04 CONTROL JOINTS

- .1 Form control joints in slabs-on-grade at locations indicated, to **CSA A23.1/CSA A23.2** and install specified joint sealer/filler.
- .2 General: Form construction, isolation and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - .1 When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
 - .2 Set joints as indicated in Contract Documents.
- .3 Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminated at isolation joints.
 - .1 Continue steep reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - .2 Provide tie bars at sides of paving strips where indicated.
 - .3 Butt joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - .4 Dowelled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- .4 Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
 - .1 Locate expansion joints at intervals of 6.0 m (maximum 9.0m) unless otherwise indicated.
 - .2 Extend joint fillers full width and depth of joint.
 - .3 Terminate joint filler not less than 13 mm or more than 25 mm below finished surface if joint sealant is indicated.
 - .4 Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - .5 Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - .6 During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- .5 Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
 - .1 Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 6-mm radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - .2 Tolerance: Ensure that grooved joints are within 75 mm either way from centers of dowels.
- .6 Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 6-mm radius. Repeat tooling of edges after applying surface finishes. Eliminate

edging-tool marks on concrete surfaces.

3.05 EXPANSION AND ISOLATION JOINTS

- .1 Install pre-moulded joint filler in expansion and isolation joints at full depth of slab and flush with finished surface to **CSA A23.1/CSA A23.2**.

3.06 CURING

- .1 Use curing compounds compatible with applied finish on concrete surfaces free of bonding agents and to **CSA A23.1/CSA A23.2**.

3.07 TOLERANCES

- .1 Concrete floor slab finishing tolerance to **CSA A23.1/CSA A23.2** and as follows:
 - .1 Elevation: 19 mm.
 - .2 Thickness: Plus 10 mm, minus 6 mm.
 - .3 Surface: Gap below 3-m-long; unleveled straightedge not to exceed 13 mm.
 - .4 Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 13 mm per 300 mm of tie bar.
 - .5 Lateral Alignment and Spacing of Dowels: 25 mm.
 - .6 Vertical Alignment of Dowels: 6 mm.
 - .7 Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 6 mm per 300 mm of dowel.
 - .8 Joint Spacing: 75 mm.
 - .9 Contraction Joint Depth: Plus 6 mm, no minus.
 - .10 Joint Width: Plus 3 mm, no minus.

3.08 SITE QUALITY CONTROL

- .1 Concrete testing: To **CSA A23.1/CSA A23.2** by testing laboratory. Accelerated test methods apply.
 - .1 Testing laboratory designated by Consultant.
 - .2 Concrete testing will be paid for by Contractor.
- .2 Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 3.4 MPa.
- .3 Test results shall be reported in writing to Consultant, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- .4 Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be

permitted by Prime Consultant but will not be used as sole basis for approval or rejection of concrete.

- .5 Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Prime Consultant.
- .6 Concrete paving will be considered defective if it does not pass tests and inspections.
- .7 Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- .8 Prepare test and inspection reports.

3.09 CLEANING

- .1 Use trigger operated spray nozzles for water hoses.
- .2 Designate cleaning area for tools to limit water use and runoff.
- .3 Provide appropriate area on Project site where concrete trucks can be safely washed out.
- .4 Do not dispose of unused admixtures and additive materials into sewer systems, into lakes, streams or in other location where it will pose health or environmental hazard.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 The Work in this Section is concrete finishing and shall include all labor, materials and equipment to complete the installation.
 - .1 Preparation Work, including sub-grade preparation, compaction, finish grading, construction of formwork, placement of screeds, and installation of reinforcement, when required, shall be done by a qualified Contractor.
 - .2 Provide, place and finish concrete as specified elsewhere.
 - .3 Provide all necessary or required special concrete preparation as specified elsewhere.
 - .4 Provide all necessary repair and patch Work.

.2 Related Requirements:

- .1 Section 03 30 00 – Cast-in-Place Concrete.
- .2 Section 09 30 13 – Tiling.
- .3 Section 09 65 00 – Resilient Flooring.
- .4 Section 32 13 13 – Concrete Paving, Sidewalks, Curbs, and Gutters.

1.2 REFERENCES

.1 Reference Standards:

- .1 American Concrete Institute (ACI):
 - .1 ACI 117-10 (R2015), Specification for Tolerances for Concrete Construction and Materials (ACI 117-10) and Commentary-Reapproved 2015.
 - .2 ACI SPEC 301-20, Specifications for Concrete Construction.
 - .3 ACI 302.1R-15, Guide for Concrete Floor and Slab Construction.
- .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C881/C881M-20a, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - .2 ASTM C979/C979M-16, Standard Specification for Pigments for Integrally Colored Concrete.
 - .3 ASTM D1751-23, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .4 ASTM D1752-18(2023), Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - .5 ASTM D2047-17, Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
 - .6 ASTM D3575-20, Standard Test Methods for Flexible Cellular Materials Made from Olefin Polymers.

- .7 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .8 ASTM E1155-20, Standard Test Method for Determination of FF Floor Flatness and FL Floor Levelness Numbers.
- .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-25.20-95, Surface Sealer for Floors. (Withdrawn)
- .5 Canadian Standards Association (CSA Group):
 - .1 CSA A23.1:19/A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
- .6 International Concrete Repair Institute (ICRI):
 - .1 ICRI 310.2R-2013, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings and Polymer Overlays and Concrete Repair – Guide Only.
- .7 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for each product specified.
 - .2 Submit WHMIS SDS - Safety Data Sheets. WHMIS SDS acceptable to Labour Canada and Health and Welfare Canada for concrete floor treatment materials. Indicate VOC content.
 - .3 Include application instructions for concrete floor treatments.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit closeout data in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Provide manufacturer's printed recommendations for general maintenance, including cleaning instructions and submit a complete list of floor care products that will be required for on-going maintenance.
- .2 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Performance Requirements
 - .1 Product quality and quality of work in accordance with Section 01 61 01 - LEED Product Requirements.
 - .2 Submit written declaration that components used are compatible and will not adversely affect finished flooring products and their installation adhesives.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Temporary lighting:
 - .1 Minimum 1200 W light source, placed 2.5 m above floor surface, for each 40 sq m of floor being treated.
- .2 Electrical power:
 - .1 Provide sufficient electrical power to operate equipment normally used during construction.
- .3 Work area:
 - .1 Make the work area water tight protected against rain and detrimental weather conditions.
- .4 Temperature:
 - .1 Maintain ambient temperature of not less than 10 degree C from seven days before installation to at least 48 hours after completion of work and maintain relative humidity not higher than 40% during same period.
- .5 Moisture:
 - .1 Ensure concrete substrate is within moisture limits prescribed by flooring manufacturer.
- .6 Safety:
 - .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials.
- .7 Ventilation:
 - .1 Arrange for ventilation system to be operated during installation of concrete floor treatment materials by use of approved portable supply and exhaust fans.
 - .2 Ventilate enclosed spaces in accordance with Section 01 51 00 - Temporary Utilities and in accordance with OH & S Regulations.
 - .3 Provide continuous ventilation during and after coating application.

Part 2 Products

2.1 PERFORMANCE/DESIGN CRITERIA

- .1 Refer to Structural Drawings for Slab Cambers as these numbers will rule over the items below.

- .2 Non-Critical Floor Slabs: Floors having a straightedge value of ± 8 mm over 3050 mm; similar to CSA A23.1 Class A Slab Finishing.
- .3 Light Duty Industrial or Commercial Floors: Floors having a straightedge value of ± 6 mm over 3050 mm; similar to CSA A23.1 Class B Slab Finishing.
- .4 Flat Institutional or Commercial Floors: Floors having a straightedge value of ± 5 mm over 3050 mm; similar to CSA A23.1 Class C Slab Finishing.

2.2 LEVELLING MATERIALS

- .1 Underlayment: Cementitious, self levelling, single component, polymer modified underlayment and manufacturer's low VOC recommended primer, for application thicknesses to a minimum feather edge to 13 mm.
 - .1 Acceptable Materials:
 - .1 K 15 Premium Self Levelling Underlayment, Ardex.
 - .2 CustomTech TechLevel 150, Custom Building Products
 - .3 Supercap SC500, Laticrete
 - .4 Novoplan® 2 Plus, MAPEI.
 - .5 Sikafloor Level 125, Sika.
 - .6 Sure-Flo ST, W.R. Meadows.
 - .2 Cementitious, self levelling, single component, polymer modified overlayment, for application thicknesses as recommended by the manufacturer.
 - .1 Acceptable Materials:
 - .1 NXT, Laticrete with NXT Epoxy Primer.
 - .2 Ultraplan 1 Plus, MAPEI Inc.
 - .3 Sikafloor Level 25, Sika Canada Ltd.
 - .3 Patching and Flash Patching Materials: Cementitious based, polymer modified, fine aggregate, single component, rapid curing, early strength floor patching compounds having high adhesion with manufacturer's recommended primer and surface profile; for application in thicknesses to a minimum of 4 mm to 25 mm, and as follows:
 - .1 Acceptable Materials:
 - .1 SD-P, Ardex.
 - .2 CustomTech TechPatchMP, Custom Building Products.
 - .3 Skim Lite, Laticrete.
 - .4 Planiprep SC, MAPEI Inc.
 - .5 SikaQuick 1000, Sika.
 - .6 Sealtight Meadow-Crete H, W.R. Meadows.
 - .4 Fine Finish Flash Patching Materials: Cementitious based, polymer modified, fine aggregate, single component, ultra-fast drying, early strength floor patching compounds having high adhesion with manufacturer's recommended primer and surface profile; for application in thicknesses from 0 mm to 6 mm, and as follows:
 - .1 Acceptable Materials:
 - .1 SD-F Feather Finish®, Ardex.

- .2 CustomTech Silk Patch, Custom Building Products
- .3 Laticrete
- .4 Planipatch®, MAPEI.
- .5 Sika® Level SkimCoat CA, Sika.
- .6 Sealtight Meadow-Patch® T1, W.R. Meadows.

2.3 CRACK REPAIR MATERIALS

- .1 Crack repair and filler: two-component, nonshrink, 100% solids, moisture-insensitive, VOC free, and meeting the requirements of ASTM C881.
 - .1 Basis-of-Design Materials:
 - .1 Mapefloor Patch, MAPEI Canada Inc.

2.4 HARDENERS

- .1 Type: one, Sodium silicate, permanent penetrating sealer and hardener.
 - .1 Liquid applied, water based, chemically reactive.
 - .2 Non-toxic, non-flammable, and anti-dusting have low or no VOC.
 - .3 Colour: colourless.
 - .4 Acceptable Materials:
 - .1 Protech III, Cornerstone Coatings.
 - .2 Ashford Formula, Curecrete.
 - .3 Pentra-Hard, Dayton Superior
 - .4 Euco Diamond Hard, Euclid Chemical Company.
 - .5 L & M Seal Hard, Laticrete International, Inc.
 - .6 Mapecrete Hard SI, Mapei Inc.
 - .7 Sikafloor 3S, Sika Canada.
 - .8 Liqui-Hard, W.R. Meadows Inc.
- .2 Water: potable.

2.5 CURING COMPOUNDS

- .1 Select low VOC, water-based, organic-solvent free curing compounds.
 - .1 Concrete Curing Compounds: maximum VOC limit 100 g/L in accordance with SCAQMD Rule #1113.

2.6 MIXES

- .1 Mixing, ratios and application in accordance with manufacturer's instructions.

2.7 ACCESSORIES

- .1 Joint Filler: flexible, lightweight, non-staining closed cell polyethylene. Chemical resistant Ultraviolet stable and low density compressible foam having the following properties:
 - .1 Density: 32.04 kg/cu.m to ASTM D1751
 - .2 Compression, ASTM D3575

- .1 10% Deflection: 69 KPa maximum
- .2 80% Deflection: 862.49 KPa maximum
- .3 Tensile Strength: 379.5 KPa to ASTM D3575
- .4 Water Absorption: 0.5% volume maximum to ASTM D3575
- .5 Basis-of-Design Materials:
 - .1 Deck-O-Foam, W.R. Meadows
- .2 Edge Joint Filler: ASTM D1751, bituminous impregnated fibreboard, 13 mm thick minimum.
- .3 Control Joint Filler: as indicated in Section 07 92 00 - Sealants.
- .4 Control Joint Filler:
 - .1 Two component, epoxy-urethane, load bearing, self levelling sealant.
 - .1 Basis-of-Design Materials:
 - .1 Loadflex, Sika Canada.
- .5 Waterstop Gasket and Waterstop Sealant: Hydrophilic, bentonite based expanding strip waterstop.
 - .1 Acceptable Materials:
 - .1 RX-101 and compatible Cetseal adhesive, Cetco.
 - .2 Waterstop RX 101, Mapei Inc.
 - .3 Hydrophilic Bentonite Strips, IRA
 - .4 Idrostop B25, MAPEI Inc.
 - .5 Sika SwellStop, Sika.
 - .6 Superstop, Tremco

Part 3 Execution

3.1 EXAMINATION

- .1 Prepare floor surface in accordance with CSA A23.1.
- .2 Verify that slab surfaces are ready to receive work and elevations are as instructed by manufacturer.

3.2 PREPARATION OF EXISTING SLAB

- .1 Rub exposed sharp edges of concrete with carborundum to produce 3 mm radiused edges unless otherwise indicated.
- .2 Saw cut control joints to CSA-A23.1, 24 hours maximum after placing of concrete.
- .3 Bring to an even, level or sloping surface as indicated on the drawings the tops of all floor slabs, including slabs on grade, ready to receive the specified finish.
- .4 Provide minimum floor flatness (F_F) required to CSA-A23.1/A23.2, Table 16, Class A conventional smooth, straight edge tolerance $\pm 8\text{mm}$, overall. $F\text{-number } F_F20$, F_L15 , Waviness Index SWI 5mm.

- .5 Finish interior floors indicated as exposed concrete in accordance with the slab finishing schedule on the structural drawings. For slab areas not noted in the finishing schedule, slabs shall be smooth concrete with steel trowel finish.
- .6 Depress floor slabs where shown and as required for floor finishes.
- .7 Remove any curing agents used during concrete installation a minimum of 28 days prior to installation of flooring materials.
- .8 Use mechanical stripping to remove chlorinated rubber or existing surface coatings.
- .9 Use protective clothing, eye protection, and respiratory equipment during stripping of chlorinated rubber or existing surface coatings.

3.3 FINISHING FORMED SURFACES

- .1 Requirements listed below apply to normal structural concrete; refer to Section 03 30 00 - Cast-in-Place Concrete for additional requirements for formed exposed architectural concrete.
- .2 Unspecified Finish: Provide following finishes as applicable when finish of formed surfaces is not specifically indicated:
 - .1 Unexposed Surfaces:
 - .1 Rough form finish for concrete not exposed to view.
 - .2 Smooth form finish for concrete to receive membrane waterproofing.
 - .2 Exposed Surfaces:
 - .1 Smooth form finish for concrete surfaces exposed to view.
- .3 Rough Form Finish: Leave surfaces with texture imparted by forms; patch tie holes and defects; remove fins longer than 6 mm high.
- .4 Smooth Form Finish: Coordinate as necessary to secure form construction using smooth, hard, uniform surfaces with number of seams kept to a minimum, uniformly spaced in an orderly pattern; patch tie holes and defects; completely remove fins. Grind smooth or repair surface textures that result from forms with raised grain, torn surfaces, worn edges, patches, dents, or other defects.
- .5 Related Unformed Finish: Strike-off concrete smooth and finish with using texture matching adjacent formed surfaces at tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces; continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces.
- .6 Penetrating Sealer Finish: Apply penetrating sealer to vertical and overhead surfaces after any patching, joint sealing or caulking is completed in accordance with manufacturer's written instructions.

3.4 FINISHING FLOORS AND SLABS

- .1 Finish floors and slabs in accordance with CSA A23.1 and ACI 302.1R recommendations for screeding, re-straightening, and finishing operations for concrete surfaces; do not wet concrete surfaces.
- .2 Scratch Finishing:

- .1 Texture concrete surface that have been screeded and bull-floated or darbied while still plastic.
- .2 Use stiff brushes, brooms, or rakes to produce a profile amplitude of 6 mm in one direction.
- .3 Apply scratch finishing to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
- .3 Float (Initial) Finishing:
 - .1 Consolidate surface with power driven floats or by hand floating if area is small or inaccessible to power driven floats.
 - .2 Re-straighten, cut down high spots, and fill low spots.
 - .3 Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.
 - .4 Apply float finishing to surfaces receiving trowel finishing and receiving fluid applied and sheet waterproofing.
- .4 Trowel (Final) Finishing:
 - .1 Commence trowel finishing after all bleed water has disappeared and when the concrete has stiffened sufficiently to prevent the working of excess mortar to the surface.
 - .2 Apply first trowelling and consolidate concrete by power-driven trowel (only use hand trowel where power-driven trowel cannot be used) after applying float finishing; continue trowelling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance; repair or smooth any surface defects that would telegraph through applied coatings or floor covering.
 - .3 Apply a trowel finishing to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 - .4 Finish surfaces to the tolerances indicated above.
- .5 Trowel and Fine Broom Finishing:
 - .1 Apply trowel finishing to surfaces where ceramic or quarry tile is scheduled for installation by either thickset or thin-set method.
 - .2 Slightly scarify surface with a fine broom While concrete is still plastic.
 - .3 Finish surfaces to the tolerances indicated above.
- .6 Broom Finishing:
 - .1 Apply a broom finishing to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - .2 Slightly roughen trafficked surface by brooming with fibre bristle broom perpendicular to main traffic route immediately after float finishing.
 - .3 Coordinate required final finishing if not indicated with Consultant before application.

3.5 APPLICATION: GENERAL

- .1 Seal control joints and joints at junction with vertical surfaces with sealant after floor treatment is dry.

- .2 Apply floor treatment in accordance with Sealer manufacturer's written instructions.
- .3 Clean overspray. Clean sealant from adjacent surfaces.
- .4 Cure concrete in accordance with manufacturers recommended procedures.

3.6 APPLICATION: LIQUID APPLIED FLOOR HARDENER

- .1 Provide hardener on all exposed concrete floors unless noted otherwise.
- .2 Apply liquid floor hardener in accordance with manufacturer's written instructions after initial floating.
- .3 Cure concrete in accordance with manufacturer's recommended instructions.
- .4 Apply hardener to horizontal and vertical exposed concrete to remain unfinished.

3.7 APPLICATION: WATERSTOPS

- .1 Install in accordance with manufacturer's written instructions at exterior construction joints.
- .2 Ensure concrete is free of voids, honeycombing, segregation of the mix, or any conditions which leads to concrete permeability.
- .3 Install in all applicable exterior vertical and horizontal cast-in-place concrete constructions joints, around applicable penetration and structural members. Leaving a minimum of 75mm of concrete cover to the exterior.
- .4 Tightly butt coil ends together to form continuous waterstop.
- .5 Protect installed waterstop from prehydration prior to concrete placement and product encapsulation.

3.8 NON-CONFORMING WORK

- .1 Inspect surfaces for defects immediately after removal of forms. Repair or patch defects within 48 hours of removal of forms with cure repairs same as new concrete.
- .2 Defective Areas: where patches are allowed, repair and patch areas to match surrounding areas in texture and colour.

3.9 PROTECTION

- .1 Protect finished installation in accordance with manufacturer's instructions.

3.10 MAINTENANCE

- .1 Provide training to Owners representative based on written manufacturers instructions as indicated in Section 01 78 00 – Closeout Submittals.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes unit masonry assemblies consisting of the following:
 - .1 Concrete masonry units (CMU).
 - .2 Mortar and grout.
 - .3 Steel reinforcing bars.
 - .4 Masonry joint reinforcement.
 - .5 Ties and anchors.
 - .6 Embedded flashing.
 - .7 Miscellaneous masonry accessories.
- .2 Related Requirements:
 - .1 Section 05 50 00 – Metal Fabrications
 - .2 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
 - .3 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .4 Section 07 84 00 – Firestopping and Smoke seals
 - .5 Section 07 92 00 – Sealants
 - .6 Section 08 11 13 – Steel Doors and Frames
 - .7 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A116-22, Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric.
 - .2 ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A153/A153M-23, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .4 ASTM A240/A240M-23a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .5 ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
 - .6 ASTM A496/A496M-07, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement. (Withdrawn 2013)
 - .7 ASTM A563/A563M-23, Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric).
 - .8 ASTM A641/A641M-19, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .9 ASTM A653/A653M-23 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

- .10 ASTM A1011/A1011M-23, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- .11 ASTM A1064/A1064M-22 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .12 ASTM B633-23, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- .13 ASTM C140/C140M-23a, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
- .14 ASTM C207-18, Standard Specification for Hydrated Lime for Masonry Purposes.
- .15 ASTM E336-23, Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
- .16 ASTM E488/E488M-22, Standard Test Methods for Strength of *Anchors in Concrete Elements.
- .17 ASTM F593-22, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- .18 ASTM F594-22, Standard Specification for Stainless Steel Nuts.
- .19 ASTM F738M-02(2008), Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs. (Withdrawn 2015)
- .20 ASTM F836M-20, Standard Specification for Style 1 Stainless Steel Metric Nuts (Metric) (Withdrawn 2023).
- .21 ASTM F3125/F3125M22-23, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions (830 MPa) and 1040 MPa Minimum Tensile Strength.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 Canadian Standards Association (CSA Group):
 - .1 CSA A23.1:19/A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA A123.3-05 (R2015), Asphalt Saturated Organic Roofing Felt (Reaffirmed 2010).
 - .3 CSA-A165 Series-14 (R2019), CSA Standards on Concrete Masonry Units (Consists of A165.1, A165.2, and A165.3).
 - .4 CAN/CSA A179-14 (R2019), Mortar and Grout for Unit Masonry.
 - .5 CSA A370-14 (R2018), Connectors for Masonry.
 - .6 CAN/CSA A371-14 (R2019), Masonry Construction for Buildings.
 - .7 CSA-A3000:23, Cementitious Materials Compendium.
 - .8 CSA G30.18:21, Carbon Steel Bars for Concrete Reinforcement.
 - .9 CSA S304-14 (R2019), Design of Masonry Structures, include Update No. 1 (2015).

- .4 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1168-22, Adhesive and Sealant Applications

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordinate lines, levels and coursing with work of other Sections.
 - .2 Obtain built-in items prior to start of this work.
- .2 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with Contractor, Subcontractor, material supplier and Consultant to:
 - .1 Verify project requirements including specification and details for project.
 - .2 Confirm required mortar, grout and concrete testing; review batch control and grouting procedures.
 - .3 Co-ordination with related Work including, but not limited to, air/vapour membranes and insulation.
 - .4 Review cavity drainage requirements and methods for keeping mortar out of cavity spaces.
 - .5 Coordinate crack control measures.
 - .6 Review requirements for reinforcement at corners and wall intersections.
 - .7 Review membranes and membrane flashing materials and details used for construction.
 - .8 Confirm trowelled or tooled joints to concealed and exposed masonry faces.
 - .9 Review methods for controlling efflorescence during construction.
 - .10 Review hot and cold weather requirements.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Provide manufacturer's printed product literature, specifications and data sheet. Indicate masonry types, shapes, sizes, and textures.
 - .2 Cementitious Materials:
 - .1 Include brand, type, and name of manufacturer for site mixed mortar materials.
 - .2 Submit proposed mix proportions and sand analysis reports and compressive strength reports on the proposed mortar mix(es).
- .2 Shop Drawings: Submit shop drawings indicating the following:
 - .1 Indicate sizes, profiles, coursing, and locations of special shapes for concrete masonry units.
 - .2 Detail bending and placement of unit masonry reinforcing bars, including elevations of reinforced walls if required.
 - .3 Detail corner units, end dam units, and other special applications for fabricated flashings.

- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Conform to CAN/CSA A371, except as modified by this specification.
- .2 The masonry Subcontractor shall be a member in good standing with the Ontario Masonry Contractors' Association.
- .3 The masonry Subcontractor shall have a minimum of five years of experience on projects of similar size and magnitude and shall provide continuous active supervision by a journeyman mason while masonry work is in progress.
- .4 Masonry work shall be performed by experienced, qualified journeyman masons under the direct and continual full-time supervision of certified masons.
- .5 Before starting masonry work establish mix proportions based on the limitations set out in CAN/CSA A179, Table 3 or Table 4 for mortar and Table 5 for grout.
- .6 Test laboratory prepared samples of the proposed mortar(s) for compressive strength in accordance with CAN/CSA A179, by a laboratory approved by the Owner. The Owner will pay for the initial cost of mortar testing. Any re-testing required as a result of the original test failing will be borne by the Contractor.
- .7 Connectors and joint reinforcement shall conform to CSA A370.
- .8 Miscellaneous masonry accessories, and their use where not otherwise specified but shown or required for proper completion of the Work, shall conform to CSA A371.
- .9 Retain a Professional Engineer, registered in the Province of the work, for the design, fabrication, and erection of the angle support at each floor level for brick more than 9.36 m high in accordance with applicable Building Code and Contract Documents requirements including, but not limited to, the following:
 - .1 Seal and signature to shop drawings and design submittals.
 - .2 Field review of installed components.
 - .3 Completion of Letters or Commitment and Supervision specified in Section 01 35 00 - Delegated Design.
- .10 Regulatory Requirements: Provide fire resistance rated materials and construction identical to those of assemblies with fire resistance ratings determined by ULC Listings or, as indicated by the applicable building code.
- .11 Mock-Ups:
 - .1 Construct a minimum 1.2 m x 1.2 m of one exterior wall in location agreed upon by Consultant to establish a standard of construction, workmanship, and appearance. Show reinforcement, masonry connectors, flashing, jointing, coursing, mortar, and masonry pattern, unit face alignment, texture, and colour.
 - .2 Do not continue with work of this Section until Consultant has reviewed mock-up.
 - .3 Mock-up may form a part of the completed work when written acceptance is provided by the Consultant.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver masonry units on pallets or cubes, suitably protected from road grime and moisture absorption due to exposure to rain or melting snow.
- .2 Unload and store on dry, level areas, without direct contact with the ground.
- .3 Remove plastic wrappings from concrete masonry units and cover with waterproof coverings which will provide protection from the elements but allow for air circulation.
- .4 Deliver cement, lime, and mortar in dry condition with manufacturer's label intact and store under waterproof cover and protected from elements.
- .5 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Ambient Conditions: maintain materials and surrounding air temperature to:
 - .1 Minimum 4 degrees C prior to, during, and 48 hours after completion of masonry work.
 - .2 Maximum 32 degrees C prior to, during, and 48 hours after completion of masonry work.
 - .3 Follow weather protection requirements as indicated in CSA A371.
- .2 Provide adequate bracing for masonry during construction and until permanent lateral supports are in place.

Part 2 Products

2.1 CONCRETE MASONRY UNITS

- .1 Standard Concrete Masonry Units: to CSA A165.1 and as follows:
 - .1 Classification: H/15/A/M (standard).
 - .2 Size (Nominal): As indicated on Drawings.
 - .3 Basis-of-Design Manufacturer:
 - .1 Expocrete, An Oldcastle company.
- .2 Fire rated concrete block units: to CSA-A165 Series (CSA-A165.1) and as follows:
 - .1 Classification: H/15/B/M except as modified by fire resistance requirements specified below.
 - .2 Concrete Composition: Type L₂30S Concrete
 - .3 Fire Rating: as indicated on Drawings.

2.2 MORTAR AND GROUT MATERIALS

- .1 Use same brands of materials and source of aggregate for entire project.
- .2 Cement:

- .1 Portland Cement: to CSA-A3000, Type GU - General use hydraulic cement (Type 10) gray colour.
 - .1 Use low VOC products in compliance with SCAQMD Rule 1168.
- .2 Masonry Cement: to CAN/CSA A179, Type N.
- .3 Aggregate: supplied by one supplier.
 - .1 Fine Aggregate: to CAN/CSA A179, natural sand, manufactured sand, or silica sand.
 - .2 Coarse Aggregate: to CAN/CSA A179.
- .4 Water: clean and potable.
- .5 Lime:
 - .1 Hydrated Lime: to CAN/CSA A179, Type S
- .6 Colour Additives:
 - .1 Use colouring admixture not exceeding 10% of cement content by mass, or integrally coloured masonry cement, to produce coloured mortar to match approved sample. Admixtures to be approved prior to use. Use in accordance with the specific manufacturer's recommendations.
 - .1 Colour: selected from manufacturer's standard range.
- .7 Mortar Mixes
 - .1 Mortar for exterior masonry above grade:
 - .1 Loadbearing: type S based on proportion specifications.
 - .2 Non-Loadbearing: N based on proportion specifications.
 - .2 Mortar for interior masonry:
 - .1 Loadbearing: type S based on proportion specifications.
 - .2 Non-Loadbearing: N based on proportion specifications.
 - .3 Mortar for Parapet walls, chimneys, unprotected walls: type N based on proportion specifications, to CSA A179.
 - .4 Pointing Mortar: CSA A179, Type S using property specification with maximum two percent ammonium stearate or calcium stearate per cement weight.
 - .5 Parging mortar: type M to CSA A179.
 - .6 Mortar for foundation walls, manholes, sewers, pavements, walks, patios and other exterior masonry at or below grade: type M based on proportion specifications, CSA A179 table.
 - .7 Following applies regardless of mortar types and uses specified above:
 - .1 Mortar for grouted reinforced masonry: type S based on proportion specifications.
- .8 Mortar Mixing:
 - .1 Use pre-blended, pre-coloured mortar prepackaged under controlled factory conditions. Ingredients batching limitations to be within 1% accuracy.
 - .2 Mix mortar ingredients in accordance with CSA A179 in quantities needed for immediate use.

- .3 Maintain sand uniformly damp immediately before mixing process.
- .4 Add mortar colour in accordance with manufacturer's instructions. Provide uniformity of mix and colouration.
- .5 Do not use admixtures, including pigments, air entraining agents, accelerators, retarders, water repellent agents, or other admixtures; unless approved in writing by the Consultant.
- .6 Do not use anti-freeze compounds including calcium chloride or chloride based compounds.
- .7 Use a batch type mixer in accordance with CSA A179.
- .8 Pointing mortar: prehydrate pointing mortar by mixing ingredients dry, then mix again adding just enough water to produce damp unworkable mix that will retain its form when pressed into ball. Allow to stand for not less than one hour no more than two hours then remix with sufficient water to produce mortar of proper consistency for pointing.
- .9 Re-temper mortar only within two hours of mixing, when water is lost by evaporation.
- .10 Use mortar within 1 1/2 hours after mixing when the air temperature is 25 degrees C or higher, and within 2 1/2 hours after mixing when the air temperature is less than 25 degrees C.
- .9 Grout Mixes:
 - .1 Bond Beams: grout mix 20 MPa strength at 28 days; 200-275 mm slump; premixed type in accordance with CSA-A23.1
 - .2 Lintels: grout mix 20 MPa strength at 28 days; 200-250 mm slump; premixed type in accordance with CSA-A23.1.
 - .3 Grout: Minimum compressive strength of 20 MPa at 28 days. Maximum aggregate size and grout slump: CSA A179.
- .10 Grout Mixing:
 - .1 Mix batched and delivered grout in accordance with CSA-A23.1 transit mixed.
 - .2 Mix grout ingredients in quantities needed for immediate use in accordance with CSA A179 fine grout.
 - .3 Add admixtures in accordance with manufacturer's instructions; mix uniformly.
 - .4 Do not use calcium chloride or chloride based admixtures.
- .11 Mix Tests:
 - .1 Testing Mortar Mix:
 - .1 Test mortar in accordance with CSA A179, for mortar based on proportion specification. Test prior to construction and during construction for:
 - .1 Compressive strength.
 - .2 Consistency.
 - .3 Mortar aggregate ratio.
 - .4 Sand/cement ratio.
 - .5 Water content and water/cement ratio.

- .6 Air content.
- .7 Splitting tensile strength
- .2 Testing Grout Mix:
 - .1 Test grout in accordance with CSA A179, for grout based on proportion specification. Test prior to construction and during construction for:
 - .1 Compressive strength.
 - .2 Sand/cement ratio.
 - .3 Water content and water/cement ratio.
 - .4 Slump.

2.3 GALVANIZING

- .1 The following galvanizing requirements apply to steel anchors, ties, reinforcing and accessories where requirements are not otherwise specifically listed:
 - .1 Ties and Reinforcing:
 - .1 Mill Galvanized (Interior Use): In accordance with ASTM A116, Class 3
 - .2 Hot Dip Galvanized (Exterior, including inner wythe of exterior wall construction and High Humidity Use): In accordance with ASTM A153/A153M, Class B-2.
 - .2 Hot Dip Hardware and Bolts: In accordance with ASTM A153/A153M, Class B-2 regardless of location.
 - .3 Hot Dip Sheet Steel: In accordance with ASTM A653/653M, Coating Designation Z600, regardless of location.
 - .4 Structural Shapes and Pipes: In accordance with ASTM A123/A123M, Grade 85, regardless of location.

2.4 REINFORCEMENT

- .1 Bar reinforcement: Steel to CAN/CSA A371 and CSA G30.18, Grade 400 W; having recycle content eligible for contribution towards LEED Certification.
- .2 Masonry Joint Reinforcement: In accordance with to CAN/CSA A371 and ASTM A1064/A1064M, with corrosion protection in accordance with CSA S304 and CSA A370, and as follows:
 - .1 Interior Walls: Mill galvanized, carbon steel.
 - .2 Exterior Walls: Hot dip galvanized, carbon steel.
 - .3 Wire Size for Side Rods: W1.7 or 3.8 mm diameter.
 - .4 Wire Size for Cross Rods: W1.7 or 3.8 mm diameter.
 - .5 Spacing of Cross Rods, Tabs, and Cross Ties: At a maximum of 400 mm o/c.
 - .6 Lengths: A minimum of 3000 mm, with prefabricated corner and tee units.
- .3 Connectors: In accordance with to CSA A370 and CSA S304 with hot dip galvanized finish.

2.5 TIES AND ANCHORS

- .1 Ties and anchors specified in this section shall be designed in accordance with CSA A370 for non-conventional masonry connectors as follows:
 - .1 Deflection: Maximum 2 mm, including free play, when acted upon by a lateral load of 0.45 kN, in all possible positions of adjustment.
 - .2 Positive restraint at position of maximum adjustment.
 - .3 Free play of multi-component ties maximum 1.2 mm when assembled in all possible configurations.
 - .4 Anchors shall allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall.
- .2 Lateral Partition Supports (Top of Wall Anchors):
 - .1 Angle Support: Fabricated from 2.657 mm core metal thickness angled steel plate having 75 mm long legs fastened to deck structure to allow vertical movement of masonry assembly; mill galvanized; coordinate with Section 07 84 00 - Firestopping and Smoke seals for firestopping insulation and smoke seals.
 - .1 Basis-of-Design Materials:
 - .1 PTA 422, Blok Lok.
 - .2 Plate Support: Fabricated from 2.657 mm core metal thickness steel plate with 10 mm diameter metal 150 mm long welded to plate having closed end plastic tube fitted over rod that allows rod to move in and out of tube; hot dip galvanized after fabrication.
 - .1 Basis-of-Design Materials:
 - .1 PTA 420, Blok Lok.
- .3 Rigid T-Intersection Anchors: Fabricate from steel bars 38 mm wide x 6 mm thick x 600 mm long with ends turned up 50 mm or with cross pins at installers option; hot dip galvanized.
- .4 Anchor Bolts: Headed or L-shaped steel bolts in accordance with ASTM A307, Grade A; with ASTM A563/A563M hex nuts and, where indicated, flat washers; hot-dip galvanized in accordance with ASTM A153/A153M, Class C.
- .5 Post Installed Anchors: Provide chemical or torque controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete when tested in accordance with ASTM E488/E488M conducted by a qualified independent testing agency, and as follows:
 - .1 Indoor Locations: Carbon-steel components zinc-plated in accordance with ASTM B633, Class Fe/Zn 5.
 - .2 Outdoor and High Humidity Locations: Alloy Group 1 or 2 stainless steel bolts complying with ASTM F593/F738M and nuts complying with ASTM F594/ASTM F836M.
 - .3 Fastening Into Solid Concrete or Solidly Grouted Installation: Two component, injectable adhesive specifically manufactured for use in installing dowels or threaded anchor rods and inserts into new or existing concrete or grout, and as follows:

- .1 Epoxy Composition: Sealed packaging containing resin, hardener, cement and water; components.
- .2 Curing Time: Rapid set, high strength and stiffness; maximum time 45 minutes at 20°C.
- .3 Basis-of-Design Materials:
 - .1 HIT HY150 System, Hilti Inc., no Substitutions Accepted.
- .4 Fastening through Hollow Wall Installation: Two component, injectable adhesive specifically manufactured for use in installing dowels or threaded anchor rods and inserts, with cylindrical mesh screen tube into new or existing masonry cavity wall, and as follows:
 - .1 Epoxy Composition: Sealed packaging containing resin, hardener, cement and water.
 - .2 Curing Time: Rapid set, high strength and stiffness; maximum time 60 minutes at 20°C.
 - .3 Basis-of-Design Materials:
 - .1 HIT HY20 System, Hilti Inc., no Substitutions Accepted.
- .6 Toggle Bolts: Tumble wing type, class and style as required for supported construction.

2.6 FLASHING

- .1 Metal Flashing: Provide metal flashing materials in accordance with Section 07 62 00 - Sheet Metal Flashing and Trim.
- .2 Coordinate supply and installation of flexible flashing materials with Section 07 27 13 - Modified Bituminous Air and Vapour Barrier, provide only materials that are compatible with acceptable materials listed in Section 07 27 13 - Modified Bituminous Air and Vapour Barrier and that form the basis of the contract.
- .3 Butyl Rubber Base Flashing: minimum 1.2 mm thick butyl sheet rubber strips.
- .4 Sheet Steel Base Flashing: minimum 0.60 mm thick, to ASTM A653/A653M, formed as detailed, galvanized with Z275 zinc coating.
- .5 Modified Bitumen Base Flashing: SBS modified sheet membrane, minimum 1.0 mm thick self-adhering type or minimum 3.0 mm thick torch-applied type.
- .6 Through Wall and Flexible Flashings: Install flexible membranes where required to maintain flow direction to divert water away from face of building envelope.
 - .1 Basis-of-Design Materials:
 - .1 Bakor Blueskin TWF, Henry Company.
 - .2 Mighty Flash, Hohmann & Banard Inc.

2.7 ACCESSORIES

- .1 Firestopping: As specified under Section 07 84 00 - Firestopping and Smoke seals.
- .2 Sealants: As specified under Section 07 92 00 - Sealants, and as follows:
 - .1 Vertical Sealant: Colour to match brick.
 - .2 Horizontal Sealant: Colour to match mortar.

- .3 Joint Filler: Control Joint Fillers: Preformed rubber, neoprene or polyvinylchloride, size and profile to suit intended application and as indicated on drawings.
- .4 Bond Breaker Strips: #15 asphalt saturated, organic roofing felt in accordance with CSA A123.3.
- .5 Cavity wall insulation in accordance with Section 07 21 13 - Board Insulation.
- .6 Air and vapour barrier membrane in accordance with Section 07 27 13 - Modified Bituminous Air and Vapour Barrier. Coordinate through wall flashings listed in this section with products that form the basis of the contract.

2.8 CLEANING COMPOUNDS

- .1 Use low VOC products in compliance with SCAQMD Rule 1168.
- .2 Compatible with substrate and acceptable to concrete masonry manufacturer for use on products.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify surfaces and conditions are ready to accept work of this Section.
- .2 Examine work of other Sections upon which work of this section is dependent. Should discrepancies be found which affect the proper performance of the work of this section, do not commence work until such discrepancies have been resolved.
- .3 Perform work with minimal cutting and patching.

3.2 PREPARATION

- .1 Protect adjacent finished materials from damage due to masonry work.

3.3 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.4 INSTALLATION: GENERAL

- .1 Construction to conform to CAN/CSA A371.
- .2 Where mortar has started to harden at units requiring repositioning, remove and replace with fresh mortar.
- .3 Masonry horizontal and vertical joints to be 10 mm thick except where adjustments are necessary to maintain the bond pattern or to adjust coursing.

3.5 INSTALLATION: CONCRETE MASONRY UNITS

- .1 Standard concrete block units:
 - .1 Bond: running.

- .2 Jointing: concave where exposed or where paint or other finish coating is specified.
- .2 Cull out masonry units, in accordance with CSA A165 and reviewed range of colour samples, with chips, cracks, broken corners, excessive colour and texture variation.
- .3 Build in miscellaneous items such as bearing plates, steel angles, bolts, anchors, inserts, sleeves and conduits.
- .4 Construct masonry walls using running bond unless otherwise noted.
- .5 Build around frames previously set and braced. Fill behind hollow frames within masonry walls with mortar or grout and embed anchors.
- .6 Fit masonry closely against electrical and plumbing outlets so collars, plates and covers overlap and conceal cuts.
- .7 Install movement joints and keep free of mortar where indicated.
- .8 Hollow Units: spread mortar setting bed from outside edge of face shells. Gauge amount of mortar on top and end of unit to create full joints, equivalent to shell thickness. Avoid excess mortar.
- .9 Solid Units: apply mortar over entire vertical and horizontal surfaces. Avoid bridging of airspace between brick veneer and backup wall with mortar.
- .10 Ensure compacted head joints. Use full or face-shell joint as indicated.
- .11 Tamp units firmly into place.
- .12 Do not adjust masonry units after mortar has set. Where resetting of masonry is required, remove, clean and reset units in new mortar.
- .13 Tool exposed joints concave weathered/raked for interior work; strike concealed joints flush.
- .14 After mortar has achieved initial set up, tool joints.
- .15 Do not interrupt bond below or above openings.

3.6 TOLERANCES

- .1 Tolerances for standard concrete unit masonry tolerances in accordance with CSA A371, supplemented as follows:
 - .1 Maximum variation between units within specific job lot not to exceed 2 mm.
 - .2 No parallel edge length, width or height dimension for individual unit to differ by more than 2 mm.
 - .3 Out of square tolerance not to exceed 2 mm.

3.7 INSTALLATION: CONNECTORS AND REINFORCEMENT

- .1 Supply and install masonry connectors and reinforcement in accordance with CSA A370, CAN/CSA A371, CSA-A23.1 and CSA-S304.1 unless indicated otherwise.
- .2 Prior to placing concrete mortar or grout, obtain Consultant's approval of placement of reinforcement and connectors.

- .3 Supply and install additional reinforcement to masonry as indicated and as required for seismic loads in accordance with building code requirements.

3.8 REINFORCED LINTELS AND BOND BEAMS

- .1 Reinforce masonry beams, masonry lintels and bond beams as indicated.
- .2 Place and grout reinforcement in accordance with CSA-S304, CAN/CSA A371, and CSA A179.
- .3 Support and position reinforcing bars in accordance with CAN/CSA A371.

3.9 GROUTING

- .1 Grout masonry in accordance with CSA S304.1, CAN/CSA A371 and CSA A179 and as indicated.

3.10 ANCHORS

- .1 Supply and install metal anchors in accordance with CSA A370 and CAN/CSA A371 as indicated.

3.11 LATERAL SUPPORT AND ANCHORAGE

- .1 Supply and install lateral support and anchorage in accordance with CSA A370 and as indicated.

3.12 CONTROL AND EXPANSION JOINTS

- .1 Install control and expansion joint materials in unit masonry as masonry progresses; do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- .2 Form control joints in concrete masonry consisting of a complete vertical break free from mortar using one of the following methods:
 - .1 Break joint reinforcement at control joints, but extend bond beam reinforcing 400 mm into wall across control joint and wrap with 0.15 mm polyethylene bond breaker.
 - .2 Fit bond breaker strips into hollow contour in ends of concrete masonry units on one side of control joint; fill resultant core with grout and rake out joints in exposed faces for application of sealant.
 - .3 Install preformed control joint gaskets designed to fit standard sash block.
 - .4 Install interlocking units designed for control joints; install bond breaker strips at joint; keep head joints free and clear of mortar or rake out joint for application of sealant.
 - .5 Install temporary foam plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
 - .6 Refer to Drawings for control and expansion joint locations, and vertical reinforcing requirements; confirm location with Consultant before installation; confirm with Consultant where not shown on Drawings.

3.13 FIELD BENDING

- .1 Do not field bend reinforcement and connectors except where indicated or authorized by Consultant.

- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars and connectors which develop cracks or splits.

3.14 INSTALLATION: FLASHINGS

- .1 Build in flashings in masonry in accordance with CAN/CSA A371.
 - .1 Install flashings under exterior masonry bearing on foundation walls, slabs, shelf angles, and steel angles over openings, and at base of cavity wall and where cavity is interrupted by horizontal members or supports and as shown on drawings. Install flashings under weep hole courses and as indicated.
 - .2 In cavity walls and veneered walls, carry flashings from front edge of exterior masonry, under outer wythe, then up backing not less than 150 mm, and as follows:
 - .1 For masonry backing embed or bond flashing 25 mm in joint.
 - .2 For concrete backing, insert or bond flashing into reglets.
 - .3 For wood frame backing, staple flashing to walls behind water resistive paper, and lap joints.
 - .4 For gypsum board and glass fibre faced sheathing backing, bond to wall using manufacturer's recommended adhesive.
 - .3 Lap joints 150 mm and seal with adhesive.
- .2 Form flashing (end dams) at lintels, sills and wall ends to prevent water from travelling horizontally past flashing ends.
- .3 Install vertical flashing where outer veneer returns at window or door jambs, to prevent contact of veneer with inner wall.

3.15 REPAIR/RESTORATION

- .1 Upon completion of masonry, fill holes and cracks, remove loose mortar and repair defective work.

3.16 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection: as follows:
 - .1 Concrete masonry units will be sampled and tested by independent testing agency appointed and paid by Owner in accordance with CSA S304.1.
 - .2 Notify inspection agency minimum of 24 hours in advance of requirement for tests.

3.17 CLEANING

- .1 Concrete Unit Masonry:
 - .1 Progress Cleaning:
 - .1 Standard Concrete Unit Masonry:
 - .1 Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with

small piece of block. Clean wall surface with suitable brush or burlap.

- .2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Construction Waste Management.

END OF SECTION

Part 1 General

1.1 Definitions

- .1 The following Definitions shall apply in this Specification
- .2 Contract Documents
 - .1 The Contract Documents consist of the Drawings, Specifications and Reports which form part of the agreed Contract.
- .3 Consultant
 - .1 The Consultant is the Architect, SEOR, persons or entities engaged by the Owner. The term Consultant means the Consultant or the Consultant's authorized representative.
- .4 Contractor
 - .1 The term Contractor is defined to include any of the following: Construction Manager, General Contractor, Structural Steel Erector, Structural Steel Fabricator, Subcontractor or Supplier.
- .5 Owner
 - .1 The Owner is the person or entity identified as such in the Contract. The term Owner means the Owner or the Owner's authorized agent or representative, but does not include the Consultant.
- .6 SEOR
 - .1 The SEOR is defined as the Structural Engineer of Record for the Contract.

1.2 WORK INCLUDED

- .1 Comply with Division 1 - General Requirements and all documents referred to therein.
- .2 Provide all labour, materials, plant and equipment to complete the structural steel Work indicated in the Contract Documents and specified in this Section.
- .3 It is the responsibility of the Contractor to verify the availability of the steel sections specified in the Contract Documents at time of tender, and to immediately notify the Consultant if any of the steel sections are not readily available and need to be substituted. Substitutions made after tender will be at the expense of the Contractor.
- .4 It is the responsibility of the Contractor to verify that steel members which are shown to be curved or cranked in the Contract Documents, can be fabricated as shown without any reduction in the load carrying capacity of the member. If curved or cranked steel members cannot be fabricated as shown in the Contract Documents, the Contractor shall identify, at the time of tender, which steel members cannot be fabricated as shown in the Contract Documents, and to propose alternative steel sections for consideration by the Consultant. Any cost

associated with any alterations to such members identified after tender will be at the expense of the Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Concrete Reinforcement, Section 03 20 00
- .2 Cast-in-Place Concrete, Section 03 30 00, Grouting beneath column bases and bearing assemblies on concrete members–.
- .3 Cast-in-Place Concrete: Section 03 30 00 – Cast-in-Place Concrete.
- .4 Steel Deck, Section 05 31 00, Reinforcement of edges of openings in steel deck that are not larger than 450 mm in roof deck and 300 mm in floor deck
- .5 Painting, Section 09 91 00

1.4 REFERENCE STANDARDS, CODES AND ACTS

- .1 Conform to the requirements of the local building code identified on the Structural General Notes as amended by all subsequent Regulations issued to the date of this Specification and applicable acts of authorities having jurisdiction.
 - .1 All references to the Standards and publications noted below shall be to the edition referenced in the local building code identified on the Structural General Notes, or to the edition referenced in the latest published editions or revisions of all Standards published by the Canadian Standards Association issued to the date of this Specification, whichever is the later edition or revision.
 - .2 All references noted below, which are not referenced by the local building code or the Standards published by the Canadian Standards Association, shall be to the latest edition and revision published to the date of this Specification.
 - .3 Standards and publications referenced by the Standards noted below shall apply even if they are not included in the list. Where such reference is made, it shall be to that latest edition and revision published to the date of this Specification.
 - .4 ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel products.
 - .5 ASTM A143/A143M - Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
 - .6 ASTM F3125, Grade A325 - High Strength Structural Steel Heavy Hex Head Bolts, Heat Treated 825 MPa (120 ksi) minimum Tensile Strength for diameter $d \leq 1''\varnothing$ and 725 MPa (105 ksi) for diameter $d > 1''\varnothing$.
 - .7 ASTM F3125, Grade F1852 - High Strength Structural Steel Twist-Off Bolts, Heat Treated 825 MPa (120 ksi) minimum Tensile Strength for $d \leq 1''\varnothing$ and 725 MPa (105 ksi) for $d > 1''\varnothing$.

- .8 ASTM F3125, Grade A490 - High Strength Structural Heavy Hex Head Bolts, Alloy Steel Heat Treated 1035 MPa (150 ksi) Minimum Tensile Strength.
- .9 ASTM F3125, Grade F2280 - High Strength Structural Twist-Off Bolts, Alloy Steel Heat Treated 1035 MPa (150 ksi) Minimum Tensile Strength.
- .10 ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling.
- .11 ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- .12 ASTM A108 - Standard Specification for Steel Bar, Carbon and `Alloy, Cold-Finished
- .13 ASTM A500/A500M - Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- .14 ASTM A572/A572M - Standard Specification for High Strength Low Alloy Columbium – Vanadium Structural Steel.
- .15 ASTM A992/A992M - Standard Specification for Steel for Structural Shapes for Use in Building Framing.
- .16 ASTM F1554 - Standard Specification for Anchor Bolts, Steel 36, 55 and 105 ksi Yield Strength
- .17 ASTM F3043 Grades 1 and 2 (sizes 1" Ø, 1 ⅝"Ø and 1 ¼" Ø only) - High Strength Twist-Off Structural Bolt/Nut/Washer assemblies, Alloy Steel Heat Treated 1375 MPa (200 ksi) Minimum Tensile Strength. Limited to specific building locations and non-corrosive environmental conditions. F3043 Grade 1 assemblies may be installed only to the snug tight condition. F3043 Grade 2 assemblies may be used in snug-tight connections and may also be pre-tensioned in slip critical connections.
- .18 ASTM F3111 Grades 1 and 2 (sizes 1" Ø, 1 ⅝"Ø and 1 ¼" Ø only) - High Strength Heavy Hex Structural Bolt/Nut/ Washer assemblies, Alloy Steel Heat Treated 1375 MPa (200 ksi) Minimum Tensile Strength. Limited to specific building locations and non-corrosive environmental conditions. F3111 Grade 1 assemblies may be installed only to the snug tight condition. F3111 Grade 2 assemblies may be used in snug-tight connections and may also be pre-tensioned in slip critical connections.
- .19 ASTM F959/F959M - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
- .20 ASTM F436 - Standard Specification for Hardened Steel Washers.
- .21 ASTM A563 - Standard Specifications for Carbon and Alloy Structural Nuts.

- .22 ASTM A913/A913M - Standard Specification for High Strength Low Alloy Steel Shape Quality, Procedures by Quenching and Self Tempering Process
 - .23 ASTM A1085/A1085M - Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS.)
 - .24 ASTM F1136/F1136M - Standard Specifications for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
 - .25 AWS D1.1/D1.1M - Structural Welding Code – Steel.
 - .26 AWS A2/1-DC - Welding Symbol Chart
 - .27 CAN/CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
 - .28 CSA-S16 - Design of Steel Structures
 - .29 CSA-W47.1 - Certification of Companies for Fusion Welding of Steel Structures
 - .30 CSA-W48 - Filler Metals and Allied Materials for Metal Arc Welding
 - .31 CSA-W55.3 - Certification of Companies for Resistance Welding of Steel and Aluminum
 - .32 CSA-W59 - Welded Steel Construction (Metal Arc Welding)
 - .33 ISO 9002 - Model for Quality Assurance in Production and Installation
 - .34 SSPC (The Society for Protective Coatings) (formerly SSPC – Steel Structures Painting Council) Steel Structures Painting Manual
 - .35 CISC Guide for Specifying Architecturally Exposed Structural Steel, latest edition
 - .36 CISC Code of Standard Practice for Structural Steel.
 - .37 Standard Specification for Highway Bridges, American Association of State Highway and Transportation Officials (AASHTO).
 - .38 American Institute of Steel Construction (AISC) Code of Standard Practice for Steel Building and Bridges, Section 10, Architecturally Exposed Structural Steel.
 - .39 American Institute of Steel Construction (AISC) Commentary on the Code of Standard Practice for Steel Buildings and Bridges.
 - .40 American Institute of Steel Construction (AISC) supplements to the “Specification for Structural Steel for Buildings”
- .2 Where there are differences between the Contract Documents and the standards, codes or acts, the most stringent shall govern.

1.5 CISC CODE OF STANDARD PRACTICE FOR STRUCTURAL STEEL

- .1 The CISC's Code of Standard Practice for Structural Steel shall govern the Work, subject to the modifications noted below.
 - .1 Revise Clause 1.4 Responsibility for Design as follows:
 - .1 **1.4 - Responsibility for Design.** When the Owner provides the structural Drawings and Specifications, the Contractor shall not be responsible for determining the adequacy of the design nor liable for the loss or damage resulting from an inadequate design. *The SEOR shall be responsible for the overall behaviour of the structure, the sizing of steel members and their supports as required by the Building Code and the provision of connection forces indicated on the structural Drawings. The Contractor shall be responsible for the design and detailing of all connections and components, members and standardized assemblies. (See also Clause 5.6.)*
 - .2 Add the following to Clause 1.5, Responsibility for Erection Procedure:
 - .1 **1.5 - Responsibility for Erection Procedure.** The Contractor shall ensure that in the event the Fabricator's contract does not include the erection of the structural steel, the Erector shall be responsible for determining the erection procedure, for checking the adequacy of the connections for the uncompleted structure, for providing erection bracing or connection details and for coordinating the erection of the steelwork with the Fabricator.
 - .3 With respect to Clause 3.3 Revisions to the Contract Documents, revise Clause 3.3.4 as follows:
 - .1 **3.3.4 -** Unless specifically stated to the contrary, the issue of revision documents or changes indicated on submittal reviews is not authorization by the Owner to release these revisions for construction. Any and all revisions to the Contract shall be made in accordance with the provisions set out in the Contract Documents, and will be based on the Contractor's assessment of the impact of the proposed revisions on the Contract Price and schedule for completion of the Work.
 - .4 Revise Clause 3.4, Discrepancies as follows:
 - .1 **3.4 - Discrepancies.** In case of discrepancies between Contract Documents, the provisions of Standard Construction Document – CCDC2-2008 shall govern, unless agreed or instructed otherwise. In case of discrepancies between the structural documents and Documents of other Sections, the documents for the Section responsible for deriving the required information shall govern.
 - .5 Revise Clause 4.1.1 as follows:

- .1 4.1.1 - At the time tenders are called, the Contractor shall receive a complete set of the Contract Documents (*including Drawings and Specifications*) for all design disciplines and specialty Consultants engaged on the project. When appropriate, these documents shall include complete structural Drawings, conforming to the requirements for design drawings of the governing technical standard. Structural steel Specifications should include any special requirements controlling the fabrication and erection of the structural steel, surface preparation and coating, and should indicate the extent of non-destructive examination, if any, to be carried out.
- .6 Clause 4.1.2, delete the last two words in the last sentence.
- .7 Revise Clause 4.2 as follows:
 - .1 4.2 - **Architectural, Mechanical, Electrical and Additional Specialty Consultants Drawings.** Architectural, mechanical, electrical and additional specialty Consultants Drawings may be used as a supplement to the structural Drawings to define detail configurations and construction information.
- .8 Revise Clause 5.6 as follows:
 - .1 5.6 - **Review of Fabrication and Erection Documents.** Erection diagrams, standard and non-standard connection design details, shop details and fieldwork details shall be submitted for review by the SEOR in accordance with the provisions of the Contract Documents. The submittals will be reviewed and returned in accordance with the provisions of the Contract Documents. The documents will be reviewed on a sampling basis for general conformity with the Contract Documents only. The SEOR's review does not relieve the Contractor, Fabricator, Erector or their engineer(s) of any responsibility for same. (Note: The remainder of this clause, as noted in the Code of Standard Practice, is to be deleted.)
- .9 Revise Clause 6.7 as follows:
 - .1 6.7 - **Inspection of Steelwork.** Should the Owner wish to have an independent inspection and/or non-destructive examination of the steelwork, they shall reserve the right to do so in the Contract Documents. The Contractor shall notify the inspection and testing company of the progress of the Work so that timely inspection and testing may be arranged. The cost of this inspection and testing is the responsibility of the Owner. However, deficiencies in the Work of the Contractor requiring re-inspection and re-testing due to the frequency of the deficiency shall be the responsibility of the Contractor.

1.6 TOLERANCES

- .1 Fabricated members and erected structural steel tolerances shall conform to the ones specified in the typical details and CSA-S16.
- .2 Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.
- .3 Fabricating, shall be such that the effects of galvanizing, bending, cambering and the like, on the alignment of the completed members is minimized.

1.7 QUALIFICATIONS

- .1 Any organization undertaking to weld shall be certified by the CWB to the requirements of Division 1, or Division 2.1 of CSA-W47.1.
- .2 The Contractor shall ensure that the potential steel Subcontractors can successfully demonstrate that they have sufficient relevant experience of Work similar in size, scope, complexity and risk to that shown on the Contract Documents and described in this Section.
- .3 Design calculations shall be carried out by or under the direct supervision of a qualified Professional Engineer licensed in the Province having jurisdiction, with a minimum of 5 years Canadian experience in the design of structural steelwork, connections including design of weldments, or joist systems, as appropriate.
- .4 The Contractor shall ensure that engineers responsible for welding design, procedures and practice are certified in accordance with CSA W47.1, section 6.1.
- .5 The Contractor shall ensure that professional Engineers responsible for the design of steelwork, connections, joist systems and the like, are insured in accordance with section 74(1) of Regulation 941 of the Ontario Professional Engineers Act or shall be covered under the Contractor's General Liability Insurance Policy. Note: If the professional engineer is insured in accordance with Regulation 941 of the Ontario Professional Engineers Act, the alternative outlined in section 74(2) is not acceptable.

1.8 DESIGN

- .1 General
 - .1 Design connections for the loads indicated or implied in the Contract Documents in accordance with requirements of CSA-S16.
 - .2 If the Contractor requires additional information or clarification to aid in the design of the Work, this information shall be requested in a timely manner.
- .2 Connections
 - .1 The Contractor shall be solely responsible for the design and detailing of all connections between the steel members including, but not limited to

columns, beams, girders, trusses and braces, and between such members as spandrel angles and beams, hangers, stiffeners, etc., and their supporting members.

- .2 The Contractor shall also be responsible for the design and detailing of stiffeners, doubler plates and the like required to maintain the local strength and stability of a member and where these stiffeners and doubler plates are an integral part of the connection or where they affect the connection of other steel framing members. Examples include cranked sections, moment connections between columns and beams, connections to hollow structural sections and the like. Where connections are exposed to view, the detailing of stiffeners, double plates and the like is subject to review by the Consultant.
- .3 Use types of shop or field connections shown on the Contract Documents, or in the absence of such information, use the most appropriate type of connections given the applied loads and the arrangement of members.
- .4 Design connections to safely withstand the combined primary effects of axial force, shear, moment and torque and any secondary effects due to welding. Connections shall also safely withstand any temporary loads which may occur during the construction.
- .5 Shear connections shall not be less than one half the depth of the connected member.
- .6 Where no axial force is indicated for beam to column connections, connect beams framing into columns such that the combined capacities of the connection are able to resist a total horizontal force of 2% of the factored axial load in the column, in any direction. The column bracing force shall be proportioned and resisted by the members framing into the joint according to their relative axial stiffnesses, unless noted otherwise in the Contract Documents.
- .7 Unless noted otherwise in the Contract Documents, the design of all beams and girders is based on the assumption that fastener holes through flanges will not exceed 15% of the gross flange area. If the area of holes exceeds 15%, the member size shall be altered or reinforced accordingly. Documentation noting the alteration is to be submitted for review.
- .8 Design bracing member connections for field adjustability to accommodate maximum construction tolerances and to achieve bracing preloads where specified in the Contract Documents.
- .9 Design hanger connections where bolts are loaded in tension such that they may be locked after pretensioning.
- .10 Design connections for fastening together double angles, double rectangular plates or bars, and the like, used to resist compression, tension, or bending in such a way that the slenderness ratio of any

component, based on its least radius of gyration and the distance between interconnections, shall not exceed that of the built-up member. As a minimum, provide two intermediate battens or spacers along the length of all members.

- .11 The following types of connections are to be designed as slip-critical connections:
 - .1 Connections that utilize oversized holes;
 - .2 Connections that utilize slotted holes, except those where the applied load is normal to the long dimension of the slot.
 - .3 Connections subject to fatigue or frequent load reversal; and
 - .4 Connections where slippage cannot be tolerated, including;
 - .1 All moment connections (unless end plate type moment connections are used);
 - .2 Connections where welds and bolts share in transmitting shear forces at a common faying surface.
- .12 Bolts in the following types of connections are to be pretensioned in accordance with the requirements of S16;
 - .1 Slip-critical connections,
 - .2 Connections governed by seismic requirements,
 - .3 Connections for all elements resisting crane loads,
 - .4 Connections for members directly supporting running machines or other live loads that produce impact or cyclic load,
 - .5 Connections where bolts are subject to tensile loads.
 - .6 Connections using oversized or slotted holes unless specifically designed to accommodate movement.
- .13 Design connections that are exposed to weather so that moisture and foreign matter cannot be trapped or gain entry to the interior of hollow built up members.
- .14 Design connections that are susceptible to the accumulation of moisture so that moisture and foreign matter cannot be trapped within the connectors or members framing into the connection.
- .15 Design and detail connections so they do not encroach upon architectural clearance lines or finishes.
- .16 Where connections between beams and columns and the like result in a loss of bearing for the steel deck, design and provide support for the steel deck, as required.

- .17 Design and provide end bearing connections of inclined members such that the bearing plane between the inclined members and their supporting members is horizontal.
- .18 Design connections to cast in plates to provide for the maximum deviation that can occur in erection and based upon the following:
 - .1 Specified steel erection tolerances,
 - .2 Maximum permissible tolerances in the location of inserts cast into concrete, specified in Section 03 10 00 – Concrete Forming.
 - .3 Joists
 - .4 Design joists and anchorages for the loads indicated in the Contract Documents and CSA S16.
 - .5 Bracing and bridging shown on the Drawings is intended as a guideline only. Design and provide bracing and bridging as per the requirements of CSA S16.
 - .6 Design joist shoes based on the loads and assumed shoe depths noted on the Drawings. If joist shoes of different depths are provided, the Contractor is responsible for any and all revisions this may have on top of steel elevations and the like.
 - .7 Design the first compression web member subject to transverse shear, and its connections, at each end of joists, in accordance with CSA S16 Cl 16.5.7.3.
 - .8 Design roof joists, bridging and anchorages to safely resist net uplift forces indicated in the Contract Documents and, in any event, a minimum of 0.5 kPa.
 - .9 Design roof joists so that the joist stiffness is at least twice the critical stiffness defined in Commentary H, Equation (1) of the User's Guide - NBC 2010, Structural Commentaries (Part 4 of Division B).
 - .10 Design joists and connection to joists to safely resist horizontal forces introduced into top chords of joists by horizontal cross-bracing shown on the Drawings.
 - .11 Design and connect joists to furnish lateral support to the chords or flanges of supporting steel members. Design joists with joist bearing points offset (in plan), such that their reaction is transferred to the centerline of the supporting member. For joists exposed to view, design joists to frame into the supporting member at the same location, with a maximum gap between the ends of adjacent joists of 20 mm.
 - .12 Provide tie joists for all joists framing into columns, unless noted otherwise on the Drawings. Where tie joists frame into columns, extend top and bottom chords and connect to columns to safely

develop one percent of column axial load but not less than 25 kN in tension or compression.

- .13 Design anchorage of each line of bridging to abutting walls and other supporting structural steel members to safely resist forces indicated in the Contract Documents, or to at least develop the safe capacity of the bridging members in tension.
- .14 Limit roof joist deflection due to specified live loads to $L/360$ of span.
- .15 Where joists span parallel to load bearing walls, limit joist deflection to $2L/360$ of span, where L is measured perpendicular to the load bearing wall, from the centerline of the joist to the load bearing wall.
- .16 Design joists supporting masonry partitions so the deflection, when subjected to full live load, shall not exceed $L/600$, where L is the span of the supporting joists.
- .17 Design joists supporting moveable partitions so that the deflection when subjected to full live load including partitions stacked at any point, or fully extended shall not exceed that required by the manufacturer of the moveable partition.
- .18 Camber joists in accordance with the provisions of S16 unless noted otherwise in the Contract Documents.
- .19 Adjust stiffness and required camber of joists adjacent to masonry walls, columns, steel beams of shorter span, other joists with different loading or stiffness characteristics and the like to permit the proper fastening of the steel deck. As a guide, limit the deflection of the adjacent joist, under all dead loads, to $L/120$, where L is the span of the steel deck perpendicular to the joists.
- .20 Where ducts or services pass through joists, design and locate web members and bridging connections to accommodate the sizes and runs of ducts and services shown.

.3 Colour Coding

- .1 When different grades of steel are supplied, use a colour coding technique to aid in the shop and field identification of these different grades. Each member used shall bear its particular colour code as required by G40.21.

1.9 SUBMITTALS

.1 Quality Control Program

- .1 Include with the tender documents a copy of Fabricators and Erectors standard Quality Control Program.

- .1 Prior to commencement of the Work, the complete Quality Control Programs of the Fabricator and Erector, specific to the project, are to be submitted for review by the Consultant.
- .2 Qualifications of Professional Engineer
 - .1 Submit appropriate documentation for each professional engineer who will be responsible for the steelwork; including the erection and design of connections, weldments, joist systems and the like, verifying the minimum qualification requirements outlined in this specification.
- .3 Proof of Insurance
 - .1 Submit proof of adequate insurance coverage for each professional engineer who will be responsible for the steelwork, connections, joist systems and the like.
- .4 Shop Drawings
 - .1 General
 - .1 The Contractor shall ensure that professional engineer(s) responsible for the structural steelwork, connections, joist systems and the like shall either:
 - .1 Seal and sign all necessary shop drawings, or
 - .2 Submit a sealed and signed letter prior to commencement of shop drawing preparation stating that they have been retained by the steel Fabricator to carry out the design of steel connections, joist systems and the like AND shall submit a second letter after shop drawing preparation is complete stating that the design of the steelwork, for which they are responsible, has been completed in accordance with the Contract Documents and relevant building codes, standards and acts.
 - .2 Unless noted otherwise in the Contract Documents, provide adequate space on all shop drawings immediately above the drawings title block for the Consultant's Shop Drawing review stamp. Where requested by the Consultant, the stamp is to be inserted by this section directly into the shop drawing prior to submission. The stamp shall be positioned in the same location on each shop drawing, and in no case shall the allocated space be less than 63 mm x 75 mm. Request the details of these requirements from the Consultant no less than 2 weeks before the commencement of shop drawings.
 - .3 If the professional engineer(s) choose to seal and sign the shop drawings, as noted above, all shop drawings must be sealed and signed, except for erection diagrams which only contain design information (member sizes, forces, loads and the like) which is indicated on the Contract Documents. If any fieldwork details,

notes to the Erector or notifications are made on the erection diagrams, then they must be sealed and signed by the Contractor's engineer.

- .4 The structural Drawings shall not be reproduced in whole or in part, for use as shop, erection or setting drawings.
- .5 Well in advance of fabrication; submit structural steel connection design details shop, erection, and setting drawings for review by the Consultant. Submit fieldwork details for review by the Consultant.
- .6 Shop drawings shall be submitted for all structural steel Work and shall be submitted in complete packages so that individual parts and the assembled unit can be reviewed together. This section and the applicable drawings used in the development of the shop drawings shall be clearly referenced on each shop drawing to facilitate review. Detail member marks shall be cross referenced on the erection drawings to facilitate a quick identification of the members.
- .7 When shop drawings are revised and resubmitted, all revisions to the drawings shall be clearly identified by means of "bubbles", "clouds" or other obvious means.
- .8 All shop drawings submitted must clearly indicate the initials of the individual who checked the shop drawings before they were submitted for review.
- .9 Submit a 3D digital model (Tekla or REVIT) with each submission of erection or detailed piece drawings.
- .2 Connection Design Details
 - .1 Submit connection design details for review by the Consultant, prior to the submission of the detailed piece drawings.
 - .2 Connection design details shall be submitted for all standard and non-standard connections, and shall be referenced to the structural Drawings.
- .3 Erection Drawings
 - .1 Submit erection drawings for review prior to preparation of detailed piece drawings.
 - .2 Erection drawings shall be included with each submission of detailed piece drawings, connection details and calculations.
 - .3 Erection drawings shall clearly indicate or highlight the member marks that are being submitted for review.
 - .4 Erection drawings shall clearly show all setting out dimensions for the structural steel frame, including dimensions that have been

confirmed by Site measurement. Dimensions shall be tied to relevant grid lines or reference points.

- .5 Indicate on erection diagrams steel lintels and other structural shapes which are embedded in masonry or cast-in-place concrete and not connected to structural steel.
- .6 Erection drawings shall clearly show all AESS members and their respective Category.
- .7 When erection drawings are being submitted for “marks only” or for “reference only”, this shall be clearly indicated on the drawings or transmittal.

.4 Detailed Piece Drawings

- .1 Submit detailed piece drawings for all structural members.
- .2 As a minimum, show the following:
 - .1 layout;
 - .2 member sizes;
 - .3 connection details, including appropriate reference to connection design calculations;
 - .4 splice locations and details;
 - .5 truss details;
 - .6 holes;
 - .7 camber;
 - .8 finishes;
 - .9 grades of steel;
 - .10 bolt material and sizes;
 - .11 weld details, sizes and grade of electrodes;
 - .12 identify location and extent of all pretensioned bolts, slip critical bolts and class of surface preparation;
 - .13 clearly identify locations and details of all slip critical connections;
 - .14 architectural clearance lines and finishes where connections and the like may encroach with other Work.
- .15 Submit joist shop drawings for review by the Consultant.
- .16 As a minimum, show the following:
 - .17 specified design loads;
 - .18 material Specifications;
 - .19 member sizes;

- .20 dimensions;
 - .21 spacers;
 - .22 welds;
 - .23 joist shoes and related details;
 - .24 anchorages;
 - .25 bracings;
 - .26 bearings;
 - .27 field splices;
 - .28 bridging locations;
 - .29 camber;
 - .30 joist properties, including frequency, for checking floor vibration; and
- .5 Fieldwork Details
- .1 Submit details for all fieldwork in accordance with the requirements of Division 1 – General Requirements.
 - .2 The location of fieldwork details shall be clearly identified or referenced on the erection drawings.
 - .3 Prepare setting drawings showing dimensions and details for setting structural steel bearings, anchorages, assemblies and the like where they interface with other building components.
 - .4 Co-ordinate structural steel shop and erection drawings with shop drawings of other interfacing Work.
 - .5 Submit all non-prequalified welding procedures, stamped as approved by the Canadian Welding Bureau and correlated to the appropriate shop and erection drawings.
 - .6 Submit details of the method proposed to achieve and verify the specified tension to bracing members within the specified tolerances.
 - .7 Furnish inspection company with a copy of each shop, erection, and setting drawing bearing the Consultant's shop drawing stamp marked reviewed.
- .6 As-Built Drawings
- .1 Mark on a complete set of final drawings any changes, additions, or deletions that occur during construction as a result of the Contractor's Work, change orders or for any other reason.

- .2 For all shop drawings marked “Reviewed as Noted” or “Revise and Resubmit”, update and submit a record set of these drawings at the completion of the structural Work. Ensure that these drawings reflect the changes and are coordinated with the final drawings noted above.
 - .7 Submit a 3D digital model (Tekla or REVIT) with each submission of erection or detailed piece drawings.
- .5 Surveys
 - .1 Preconstruction Survey: Where interface with existing construction occurs, the existing construction shall be surveyed and such survey submitted before related shop drawings are prepared.
 - .2 Work by Others: Examine all Work prepared to receive Work of this Section and report any defects affecting installation to the Consultant for correction. Commencement of Work will be construed as complete acceptance of preparatory Work by others. This Section alone shall be responsible for checking of the dimensions and coordination of the structural steel Work with the Work of other Specification Sections.
 - .3 Submit surveys showing position of structural steel members. Submit survey results on any given floor before concrete is placed on the floor. As a minimum include the following:
 - .1 Location of centreline of all columns with respect to grids at each floor level;
 - .2 Elevation of tops of girders, joists, trusses and beams at ends, midspan and at cantilevered ends, at all floors and roof, before and after placing of concrete.
- .6 Calculations
 - .1 Submit calculations bearing the seal and signature of the qualified Professional Engineer licensed in the Province having jurisdiction and such further proof as may be necessary to show that non-standard connections and steel joist systems and the like conform to the requirements set forth in this section.
- .7 Cambering Procedures
 - .1 Submit detailed cambering procedures for beams, girders, trusses, joists and the like for review prior to start of fabrication.
- .8 Erection Procedures
 - .1 Erection procedures and erection bracing are the sole responsibility of the Contractor.
 - .2 Well in advance of erection, submit procedures, methods, sequences of erection, temporary shoring, guying, erection bracing and equipment proposed for use in erecting structural steel. The erection procedure shall

be supplemented by drawings and sketches to identify the location of the stabilizing elements. The procedure shall bear the seal and signature of the qualified licensed Professional Engineer licensed in the Province having jurisdiction.

.9 Substitution

- .1 It is the Contractor's responsibility to verify the availability of the steel sections shown on the structural Drawings at time of tender, and to immediately notify the Consultant if any of the sections are not readily available and need to be substituted. Substitutions after the time of tender will be at the cost of the Contractor.
- .2 If the Contractor wishes to make other substitutions for steel materials or sizes indicated in the Contract Documents, submit proposals with the tender including calculations for review by the Consultant.

.10 Mill Test Certificates

- .1 Submit to the Consultant copies of mill test certificates covering chemical and physical properties of steel used in this Work, including mill test reports for all structural bolts, a minimum of 4 weeks prior to commencing fabrication.

.11 Colour Code

- .1 Submit colour code proposed or other agreed methods to identify various grades of structural elements.

.12 Non-destructive Testing

- .1 Submit all in-house non-destructive testing results of shop and field Work together with inspector/technician certification status and test procedures used.

Part 2 Products

2.1 MATERIALS

- .1 Provide only new material manufactured in North American mills free from defects impairing strength and durability. New materials shall be in accordance with the Standards referenced in this Section. Where sections identified are not available from the mills noted or where the Contractor chooses to use sections produced by other mills, provide new materials of minimum strength and minimum quality as indicated in the Contract Documents. For sections that are not produced by North American mills, the Contractor shall submit written requests for review of the alternate mill to the Consultant before proceeding with material procurement. The Consultant reserves the right to require physical test data (in addition to the mill test reports) proving that the steel from the proposed mill meets the requirements specified in the Contract Documents. Provide such data for each 100 tonnes of material supplied.
- .2 Structural Steel:

- .1 Structural wide flange shapes (W) to conform to CAN/CSA-G40.20/G40.21 grade 350W.
- .2 Structural welded wide flange shapes (WWF) to conform to CAN/CSA-G40.20/G40.21 grade 350W.
- .3 Angles, plates and channels (L, C) to conform to CAN/CSA-G40.20/G40.21 grade 300W.
- .4 Hollow structural sections (HSS) to conform to CAN/CSA-G40.20/G40.21 grade 350W.
- .3 Anchor Rods: Conform to 300W threaded rod conforming to CSA G40.21-M, unless noted otherwise in the Contract Documents.
- .4 Bolts, Nuts and Washers: Conform to ASTM F3125. Galvanized A325 bolts over 22mm diameter shall have a dry lubricant on threads such as Johnson's Stick Wax #140 or approved equivalent before installation.
- .5 High Strength Bolts: High strength bolts shall be of Canadian or United States manufacture and shall conform to the provisions of the Research Council on Structural Connections (RCSC) "Specifications for Structural Joints Using ASTM F3125, Grades A325 & A490", latest edition.
- .6 Welded Stud Shear Connectors: Headed studs shall be manufactured by Nelson Stud Welding, Inc. (or approved equivalent) and shall be made from mild steel conforming to ASTM A108 grade 1010 through 1020. Headed studs shall be welded per manufacturer's recommendations; mechanical properties of headed studs shall be in accordance with AWS D1.1.
- .7 Deformed Bar Anchors: Shall be Nelson, flux filled deformed bar anchors, type D2L, or approved equivalent.
- .8 Shop Paint/Primer:
 - .1 The shop primer or paint shall be compatible with spray fireproofing, intumescent paint and/or the top coat paint system specified in the Contract Documents or elsewhere, where applicable.
 - .2 Shop Paint: To CISC/CPMA 1-73a or SSPC Paint 15.
 - .3 Shop Primer: To CISC/CPMA Standard 2-75.
- .9 Minimum coating thickness for Hot Dip Galvanizing shall conform to ASTM A123/123M.
- .10 Inorganic Zinc-Rich Primer: Zinc Clad II as supplied by The Sherwin-Williams Company (2 to 4 mils dry film thickness), or approved equivalent.
- .11 Organic Zinc-Rich Primer: Zinc Clad 200 as supplied by The Sherwin-Williams Company (3 to 5 mils dry film thickness), or approved equivalent.

- .12 Epoxy Paint: Macropoxy 646 Fast Cure Epoxy as supplied by Sherwin-Williams Company (4 to 6 mils dry film thickness) or approved equivalent.
- .13 Zinc-Rich Touch-up Paint: Zinc Clad 5 as supplied by The Sherwin-Williams Company) or approved equivalent.

Part 3 Execution

3.1 FABRICATION

- .1 Prior to fabrication of structural steel, take field measurements where connections are to be made to existing Work, open up all areas to allow the installation of the new structural Work, as well as the connection of new Work to the existing Work. Take any and all necessary field measurements. Modify installation methods and methods for connecting to suit Site conditions found and to the approval of the Consultant.
- .2 Provide holes up to 12 mm in diameter, as required, to permit the attachment of other materials. Ensure cross sectional area of section is not reduced by more than 10% at any point on its length.
- .3 Provide 20 mm ($\frac{3}{4}$ ") drain holes in closed sections to prevent water build-up during erection. Ensure drain holes remain free to drain throughout construction and are not plugged by subsequent construction activities.
- .4 Splices, other than those shown in the Contract Documents, shall not be permitted in members without the Consultant's approval. If approval is given to permit welded splices, they shall be non-destructively tested at no extra cost to the Owner.
- .5 Unless noted otherwise in the Contract Documents, provide a 10 mm cap plate for all hollow members. Provide continuous seal weld around cap plate.
- .6 Seal all hollow built-up members exposed to weather with continuous seal welds, incorporating structural welds where indicated in the Contract Documents or as required.
- .7 Where masonry walls are shown built into structural steel columns and beams in the Contract Documents, provide and install masonry anchors on columns at 600 mm on centres and anchors on beams at 1500mm on centres.
- .8 Thickness of baseplates 100 mm or greater is nominal and allows for a maximum reduction of 6 mm for milling to the requirements of CSA S16. Identify grade of steel for these plates which may not conform to clause 2.1.2.3
- .9 Cambers
 - .1 Provide the camber indicated in the Contract Documents to trusses, joists, beams and girders in such a manner as to provide a uniform parabolic profile. Ensure that the method used to provide camber does not reduce the safe load carrying capacity or cause distortion of the members.
 - .2 Camber stated on the Drawings is the required camber after erection.

.10 Openings

- .1 Conform to the requirements indicated in the Contract Documents for location, size, and reinforcement of openings through structural steel.
- .2 No openings other than those indicated on the structural Drawings will be permitted without the Consultant's approval.

.11 Bending Steel Sections

- .1 Bend sections to the geometry noted on the Contract Documents in such a manner as to provide a smooth uniform profile. Ensure that the method used to bend the steel sections does not reduce the safe load carrying capacity or cause distortion of the members.

.12 Cutting of Heavy Sections

- .1 Where ASTM A6/A6M Groups 4 or 5 rolled shapes or plates 50 mm or thicker are to be jointed by partial or full penetration welds in tension, preheating shall be required for all thermal cutting operations. Preheat shall be sufficient to prevent cracking but in no case less than 65°C. Weld access holes and copes shall be ground to a smooth radius after cutting and testing for cracks by the magnetic particle method. All cut edges shall be free of sharp notches and gouges.

.13 Holes & Cutting

- .1 All holes shall be accurately drilled or punched. Burning or drifting unfair holes will not be permitted. Holes that must be enlarged shall be reamed. Holes for the attachment of Work by other Sections shall be provided as required. Drift pins shall be allowed only to bring together the several parts for connection.
- .2 Holes shall be provided in members to permit connections to the Work of other Sections or contracts.
- .3 The use of manual gas-cutting in the shop shall be used only if automatic or semi-automatic methods are not possible. Cope for pipes and ducts as indicated in the Contract Documents.

.14 Bolting

- .1 Drive bolts accurately into the holes without damaging the threads and heads. Bolts heads and nuts shall rest squarely against metal surfaces.
- .2 Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, provide beveled washers to give full bearing to the thread or nut.
- .3 Bolt threads of unfinished bolts shall be upset to prevent the nuts from backing off.
- .4 Label and ship anchor rods and base plates in sets indicating size and locations of columns and deliver in ample time prior to the start of related concrete Work. Furnish templates together with instructions for setting of

anchor rods. Ascertain that anchor rods and other embedded items are set properly during the progress of the Work. Provide 75 mm x 75 mm x 7 mm plate washers between top of base plate and bottom of anchor rod nuts.

.15 Welding of Structural Steel

.1 Pre-weld Inspection

.1 The surface to be welded and the filler material to be used shall be subject to inspection by quality control personnel before welding is performed.

.2 Method and Type

.1 All welding shall be electric arc welding and shall comply in all respects with the codes and Specifications noted in this Section, incorporating the Specifications for design, fabrication, and inspection of welded structures and the qualifications of welders and supervisors. The heat, input, length of weld, and sequence weld and cooling process shall be controlled to prevent distortions.

.2 For weldments comprised of plates in more than one plane and whose configuration could cause restraint to uniform cooling of the weldment, conform to detailed welding procedures prepared by the Contractor's Engineer.

.3 For weldments comprised of plates thicker than 50 mm or of heavy shapes groups 4 & 5, take adequate precaution to control welding and cooling processes in order to control thermal shrinkage stresses. Use stress relieving techniques where necessary. Each welder shall mark his identification symbol on this Work. Where such plates or shapes are spliced or connected using CJP groove welds, the steel shall be supplied with CVN testing.

3.2 ERECTION

.1 General

.1 Refer to erection procedures and construction sequencing indicated in the Contract Documents.

.2 Bracing members and anchor rods shown in the Contract Documents are for the finished structure and may not be adequate to resist forces present during construction.

.3 Maintain erection bracing until completion of entire structure including floor and roof decks and slabs, masonry walls and/or other elements which are part of the lateral load resisting system.

.4 Carry out erection operations, including installation of any temporary guying and shoring required, ensuring that the existing structure or

- members already erected are not loaded in excess of their safe load carrying capacity.
- .5 Erection bracing must be adequate to restrict lateral drift per storey to an appropriate amount to ensure the steel erection can be completed within the necessary tolerances.
 - .6 During construction, forces or reactions in the steel frame members and their connections might exceed those on which the design is based. Determine the magnitude of such forces and reactions and take such measures as are necessary to ensure that the safety and stability of the structure is maintained until the entire structure, including floor and roof slabs is complete.
 - .7 Nuts on bolts shall be prevented from working loose by use of lock washers, lock nuts, jam nuts, thread burring or other approved methods.
 - .8 Runoff tabs shall be removed where required by the governing technical standard, or where they interfere with clearances required by other disciplines or would be exposed to view in the completed building.
 - .9 Where steel bars or strap anchors are shown connected to structural steel members in the Contract Documents, weld these bars/anchors to the steel members in a manner to fully develop the strength of the bars/anchors.
 - .10 Note that erection of structural steel may be dependent on the Work and progress of related Sections. For example, portions of the roof structure may have to be erected after roof mechanical units are in place. Co-ordinate this Work with the appropriate Sections.
 - .11 Report to the Consultant where members cannot be erected within the specified tolerances without modification or special procedures. Take corrective measures to the Consultant's approval.
 - .12 Leave in place all temporary erection safety cables which have been installed at the bottom chord of the joist members.
- .2 Pre-Steel Erection Conference
- .1 At least 60 days prior to the commencement of steel erection, the Contractor shall hold a pre-erection conference to review the detailed requirements and staging for the steel erection.
 - .2 The Contractor shall require responsible representatives of every party who is concerned with the steel erection to attend the conference, including but not limited to the following:
 - .1 The Contractor
 - .2 Steel Erector
 - .3 Steel Erector's Surveyor
 - .4 Steel Deck Contractor

- .5 All Inspection and Testing Agencies
- .6 Consultant
- .7 Owner's Representative
- .3 Minutes of the meeting shall be recorded and distributed to all parties concerned within 5 days of the meeting.
- .4 The minutes shall include a detailed outline of the steel erection procedure including a schedule of milestone dates for erection staging surveying and sign-offs which will represent the agreements reached by all parties involved.
- .3 Sequence of Construction
 - .1 During winter months the pouring of some slabs on deck may be delayed. The Contractor is to provide any additional guying or bracing to compensate for the temporary loss of diaphragm action and additional dead load, as deemed necessary.
 - .2 Equipment: Operate all machinery, apparatus and staging required for the erection of steelwork in a safe manner. Install, maintain and remove without damage to the other Work, scaffolding, erection bracing and other equipment, etc. as may be necessary or required.
 - .3 Bracing: Securely brace the frame during erection to safely resist all dead loads, lateral loads and other erection stresses. Fully tighten all bolts as soon as possible as the Work progresses. Design erection bracing or guying to limit lateral floor-to-floor displacement to an appropriate amount to ensure steel erection can be completed within necessary tolerances.
 - .4 Errors: Immediately report to the Consultant any errors in shop fabrication or deformations resulting from handling and transportation that prevent the proper assembly and fitting of parts. Make suggestions for corrective Work and obtain approval of the method of correction. Approved corrections shall be made expeditiously at no additional cost to the Owner.
 - .5 Column Base Plates: Column base plates shall be supported and aligned on steel shims or setting bolts. After the supported members have been plumbed and properly positioned, the anchor nuts shall be tightened, in preparation for grouting. Wedges and shims shall be cut off flush with the edges of plates and shall be left in place. All base plates greater than 600 mm (2'0") in any dimension shall be set on steel angle seats or shim packs. Base plates larger than 900 mm (3'0") shall be set on steel angle seats only.
 - .6 Leveling Plates: Leveling plates shall be set to the established lines and elevations. Provide steel shims as required for proper positioning of column/baseplate.
- .4 Bolting and Welding of Structural Steel

- .1 Splices: Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact. Splices will be permitted only where indicated on the Contract Drawings or the reviewed shop drawings.
- .2 Driftpins: These may be used only to bring together the several parts, and shall not be used in such a manner as to distort or damage the steel. Poor matching of holes shall be corrected by drilling to the next larger size and the use of larger size bolts. Plug welding and redrilling will not be permitted, unless a specific instance arises and is approved by the Consultant.
- .3 Hammering: Hammering which may injure or distort the members will not be permitted.
- .4 Additional Material: If the Contractor furnishes additional material for the purpose of erection or if the erection method requires that material be added to certain members, the required modifications and the additional metal parts shall be paid for by the Contractor.
- .5 Bracing
 - .1 Install permanent bracing members by applying a nominal tension such that they will be initially under tension in the completed building.
 - .2 When the structural steel is plumb and level, erect the frame bracing so that, at the time of installation, bracing members are under a stress of 35 MPa plus or minus 6 MPa. Tensioning by drifting will not be permitted.
- .6 Bearing on Concrete or Masonry
 - .1 Set steel baseplates and bearing assemblies true and level at the proper elevation so that upon grouting, they will have full bearing. Unless noted otherwise by the grout supplier, do not vibrate the formwork or baseplate during grout placement. Grout shall be placed on one side only and pushed back under the baseplate with strapping.
 - .2 When directed by the Consultant, lift at least 10 percent grouted bases so that the adequacy of grouting can be examined. If defects are found, more bases will have to be raised.
- .7 Joists
- .8 Anchor joists in accordance with CSA S16 and to safely resist net uplift forces.
- .9 Supply special shoes or steel shims as required to bring joists to required bearing level.
- .10 Provide suitable temporary anchorage until such time as the permanent anchorage system can maintain the joists in their correct position.
- .11 Where joists are exposed or where the ceiling is attached directly to the bottom chord, keep under surface of joists to a true level plane by careful attention to the manufacture, packing under joist bearing and other means necessary.

- .12 Where the Contract Documents call for electrical and mechanical services recessed between joists, space and arrange joists and bridging to permit installation of services.
- .13 Provide ceiling extensions for joist bottom chords as required.
- .14 Lintels
 - .1 Unless a reinforced block or concrete lintel is noted, provide loose steel lintels, to the details shown in the Contract Documents, over openings and recesses including those for mechanical or electrical services in masonry walls or partitions.
- .15 New Steel Work to the Existing Building
 - .1 Prior to proceeding with any Work at the existing building, verify that existing members being connected are of the size and section indicated on the Drawings. If they are not inform the Consultant immediately. Do not proceed until the Consultant has given instructions.
 - .2 Make Site measurements as required to verify dimensions of existing Work before proceeding with the Work. The Contractor shall be responsible for costs incurred due to proceeding without verifying Site dimensions.
 - .3 Adequately shore existing structure to ensure that no movements or damage occurs until the permanent structure shown in the Contract Documents is installed.
- .16 Erection of Large Steel Building Frames Having No Expansion Joints
 - .1 Erect structural steelwork to conform with CSA S16 and any additional requirements as specified in the Contract Documents.
 - .2 Erect the structural steelwork so that the framing is plumb when the mean temperature of the steel frame is at 20°C. Since the building is large and has no expansion joint, some members may be required to be erected out of plumb if the erection is carried out at temperature greatly differing from that noted above.
 - .3 Provide the Consultant with the procedures proposed to achieve this requirement.
 - .4 Make adequate provisions for erection stresses and for sufficient erection bracing to keep the structural steel in true alignment in its designated position, until completion of the entire structure, including floor and roof decks and/or other elements which are part of the wind resisting system. Any bracing members shown in the Contract Documents are those required for the finished structure and may not be sufficient for erection purposes. Design erection bracing so that it will not restrict any anticipated movements of the frame.
 - .5 Do not install the connections of the permanent braced frames until the adjacent columns are plumb.

3.3 PROTECTION

.1 Cleaning Steel

- .1 Clean structural steel and joists in accordance with table below:
- .2 Clean surfaces within 50 mm (2") of any field weld location of materials that would prevent proper welding or produce objectionable fumes while welding Work is being performed.

.2 Painting

- .1 Except where steel is to be galvanized, shop paint structural steel and joists in accordance with the table below:

Environment	Preparation	Primer/Paint	Remarks
Inside Vapour Barrier	SSPC-SP3 Power Tool Cleaning	CISC/CPMA 1-73a	
Inside Vapour Barrier (joists not exposed to view)	SSPC-SP2 Hand Tool Cleaning	CISC/CPMA 1-73a or SSPC Paint 15	
Inside Vapour Barrier (steel exposed to view)	SSPC-SP6 Commercial Blast Cleaning	CISC/CPMA 2-75	
Inside Vapour Barrier (joists exposed to view)	SSPC-SP7 Brush-Off Blast Cleaning	CISC/CPMA 2-75	
High Humidity	SSPC-SP6 Commercial Blast Cleaning	Zinc-rich primer	.
Outside Vapour Barrier (steel)	SSPC-SP6 Commercial Blast Cleaning	Zinc-rich primer	
Outside Vapour Barrier (joists)	SSPC-SP7 Brush-Off Blast Cleaning	[Zinc-rich Touch-Up Paint]	
Outside Vapour Barrier – All remaining steel		Galvanize	Note additional requirements for galvanizing elsewhere in the Specification.

Environment	Preparation	Primer/Paint	Remarks
Outside Vapour Barrier – Steel exposed to salt water	SSPC-SP10 Near White Blast Cleaning	Zinc-rich primer and epoxy paint	
Chemical Exposures	SSPC-SP10 Near White Blast Cleaning	Zinc-rich primer and epoxy paint	

- .2 Do not paint steel items inside the vapour barrier that are to be encased in concrete and surfaces that are to have concrete placed against them or that are to be covered in cementitious fireproofing.
- .3 Where shear connectors are to be field welded through the low flute of the steel deck, the top surface of the top flange, which is to receive the shear studs, is to be unpainted and free of heavy rust, mill scale, sand, or other foreign materials which will interfere with the stud welding operation.
- .4 Joists shall have one coat of protective paint of a type standard with the manufacturer.
- .5 Except where steel is to be galvanized, immediately after cleaning, apply a shop coat paint or primer to steelwork, to dry surfaces by spray, to a minimum dry film thickness of 2 mils (50 μm). Allow to dry in dust free areas.
- .6 Upon completion of erection, clean with mechanical brush and apply primer to welds, bolts and at locations where original primer is damaged.
- .3 Galvanizing
 - .1 In accordance with ASTM A123/A123M, fully galvanize structural steel, structural steel lintels, masonry shelf angles, exterior stairs and other steel materials exposed to weather including connection material and inserts. In addition, all exposed structural steel and connections throughout the Wash Bay are to be galvanized.
 - .2 Where the galvanizing process may distort the members, submit procedures for review by the Consultant and make good to tolerances noted in the Contract Documents.
 - .3 Galvanize members after shop welding has been completed.
 - .4 Do not weld to galvanized steel members. Where welding is necessary, remove galvanizing by grinding.
 - .5 Identify at time of tender any splices that are required due to the size, length or weight constraints imposed by the galvanizing process.

- .6 High strength bolts grade A490M shall not be galvanized.
- .4 Cold Weather Protection
 - .1 During cold weather, protect members from damage due to water freezing in confined areas.
- .5 Corrosion
 - .1 Protect milled surfaces to prevent corrosion prior to erection.

3.4 QUALITY CONTROL

- .1 Visual Inspection
 - .1 As a minimum, carry out visual inspection of all shop and field welds in accordance with CSA W59.
- .2 Non-Destructive Testing (NDT)
 - .1 Non-destructive testing shall be carried out by radiography, magnetic particle or ultra sonic methods, whichever is more appropriate.
 - .2 In addition to visual inspection, the Contractor is to include the following requirements for non-destructive testing:
 - .3 Any deficient welds identified by means of NDT, shall be repaired at the Contractor's expense.
 - .4 Welds found deficient in dimensions, but not in quality may be enlarged by additional welding. Any weld found deficient in quality shall be removed by chipping or gouging and the weld shall be remade.
 - .5 Include for full NDT of all shop welded connections in the first two joists fabricated.
 - .6 Include for full NDT of all shop welded splices.
 - .7 Include for an additional 20% random NDT of remaining shop welded connections.
- .3 Additional Testing for Steel Produced by "Other Mills".
 - .1 Physical samples of the finished structural steel material shall be taken at the Consultant's discretion for verification or determination of either the mechanical properties and or the chemical composition. All physical samples tested shall meet the requirements set out in CAN/CSA G40.20 and G40.21.
- .4 General
 - .1 Bring to the attention of the Consultant any defects in the Work or departures from the Contract Documents which may occur during construction. The Consultant will decide upon corrective action and give recommendations in writing.

- .2 The Consultant's general review during construction and inspection and testing by Independent Inspection and Testing Companies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

3.5 NOTIFICATION

- .1 Prior to commencing significant segments of the Work, give the Consultant and Independent Inspection and Testing Companies appropriate notification so as to afford them reasonable opportunity to review Work previously completed. Failure to meet this requirement may be cause for the Consultant to classify the Work as defective.

3.6 INSPECTION AND TESTING

- .1 The Owner will appoint the Independent Inspection and Testing Companies to make inspections or perform tests as the Consultant directs. The Independent Inspection and Testing Company shall be responsible only to the Consultant, and shall make only such inspections or tests as the Consultant may direct.
- .2 When defects are revealed, the Consultant may request, at the Contractor's expense, additional inspection or testing to ascertain the full extent of the defect.
- .3 Inspection and testing may also include the non-destructive testing of the full butt welds, testing of headed studs on beams and on connections to be cast into concrete.

3.7 DEFECTIVE MATERIALS AND WORK

- .1 Where evidence exists that defective Work has occurred or that Work has been carried out incorporating defective materials, the Consultant may have tests, inspections or surveys performed, analytical calculations of structural strength made and the like in order to help determine whether the Work must be replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor's expense, regardless of their results, which may be such that, in the Consultant's opinion, the Work may be acceptable.
- .2 All testing shall be conducted in accordance with the requirements of the Building Code, except where this would, in the Consultant's opinion, cause undue delay or give results not representative of the rejected material in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.
- .3 Materials or Work which fail to meet specified requirements may be rejected by the Consultant whenever found at any time prior to the Total Performance of the Work regardless of previous inspection. If rejected, defective materials or Work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the Owner.

END OF SECTION 05 12 00

Part 1 General

1.1 SUMMARY

- .1 This Section Includes:
 - .1 Requirements regarding the appearance and surface preparation of Architecturally-Exposed Structural Steel (AESS). Refer to Division 5, Structural Steel Sections for all other requirements regarding steel work not included in this section. This section applies to any members noted on Architectural and Structural drawings as AESS.
- .2 Related Requirements:
 - .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the Section.
 - .2 05 31 00 - Steel Deck
 - .3 Section 05 50 00 - Metal Fabrications
 - .4 Section 09 91 00 - Painting

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American National Standards Institute (ANSI) / American Institute of Steel Construction (AISC):
 - .1 ANSI/AISC 303-22, Code of Standard Practice for Structural Steel Buildings and Bridges
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A123/123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A780/A780M-20, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - .3 American Welding Society (AWS):
 - .1 AWS D1.1/D1.1M:2000, Structural Welding Code-Steel.
 - .4 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .5 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 1.40-97, Anticorrosive Structural Steel Alkyd Primer. (Withdrawn)
 - .2 CAN/CGSB 1.108-M89, Bituminous Solvent Type Paint. (Withdrawn)
 - .3 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating. (Withdrawn)
 - .4 CAN/CGSB 85.10-99, Protective Coatings for Metals. (Withdrawn)
 - .6 Canadian Institute of Steel Construction (CISC):
 - .1 CISC/CPMA Standard 1-73a 1975, A Quick-Drying One-Coat Paint for Use on Structural Steel.

- .2 CISC/CPMA Standard 2-75 1975, A Quick-drying Primer for Use on Structural Steel
- .3 CISC Code of Standard for Structural Steel, 8th Edition, 2015.
- .7 The Society for Protective Coatings (SSPC) / National Association of Corrosion Engineers (NACE International):
 - .1 Coating Materials Guidelines.
 - .2 Surface Preparation Guidelines:
 - .1 SSPC SP1, Solvent Cleaning, Includes Editorial Revision (2016).
 - .2 SSPC-SP5/NACE No.1, White Metal Blast Cleaning.
 - .3 SSPC-SP6/NACE No.3, Commercial Blast Cleaning.
 - .4 SSPC-SP10/NACE No.2, Near-White Blast Cleaning.
 - .5 SSPC QP6, Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components).
- .8 Master Painter's Institute (MPI):
 - .1 Architectural Painting Specification Manual.
- .9 The National Association Metal Manufacturers (NAAMM):
 - .1 NAAMM AMP 500-06, Metal Finishes Manual
 - .2 NAAMM AMP 555-92, Code of Standard Practice for the Architectural Metal Industry, (Including Miscellaneous Iron).
- .2 Definitions of Categories: In accordance with CISC Code of Standard Practice for Structural Steel, the following Categories shall be used when referring to AESS:
 - AESS 1: Basic Elements
Suitable for "basic" elements which require enhanced workmanship.
 - AESS 2: Feature Elements View at a Distance > 6 m
Suitable for "feature" elements viewed at a distance greater than six metres. The process involves basically good fabrication practices with enhanced treatment of weld, connection and fabrication detail, tolerance for gaps, and copes.
 - AESS 3 Feature Elements View at a Distance ≤ 6 m
Suitable for "feature" elements where the designer is comfortable allowing the viewer to see the art of metalworking. Welds are generally smooth but visible; some grind marks are acceptable. Tolerances are tighter than normal standards. The structure is normally viewed closer than six metres and is frequently subject to touching by the public.
 - AESS 4 Showcase Elements
Suitable for "showcase or dominant" elements where the designer intends the form to be the only feature showing in an element. All welds are ground and filled edges are ground square

and true. All surfaces are sanded/filled. Tolerances of fabricated forms are more stringent – generally one-half of the standard tolerance. All surfaces are to be “glove” smooth.

AESS C: Custom Elements

Suitable for elements which require a different set of Characteristics than specified in Categories 1, 2, 3, or 4.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Conference: The General Contractor shall schedule and conduct conference at the project site to comply with requirements of Division 1 - Project Meetings. As a minimum, the meeting shall include the General Contractor, Fabricator, Erector, the finish-painting subcontractor, and the Consultant. Coordinate requirements for shipping, special handling, attachment of safety cables and temporary erection bracing, touch up painting and other requirements for AESS.
- .2 Coordinate installation of anchors for AESS members that connect to the work of other trades. Furnish setting drawings, templates, and directions for installing anchors, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to the project site in time for installation. Anchorage concepts shall be as indicated on drawings and approved on final shop drawings.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 General: Submit each item below according to the Conditions of the Contract and Division 1 Specification Sections.
- .2 Product Data for each type of product specified.
- .3 Shop Drawings detailing fabrication of AESS components.
 - .1 Provide erection drawings clearly indicating which members are considered as AESS members.
 - .2 Include details that clearly identify all of the requirements listed in the Fabrication Article and the Erection Article of this specification. Provide connections for exposed AESS consistent with concepts shown on the architectural or structural drawings.
 - .3 Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length and type of each weld. Identify grinding, finish and profile of welds as defined herein.
 - .4 Indicate type, size, finish and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tensioned shear/bearing connections. Indicate to which direction bolt heads should be oriented.
 - .5 Clearly indicate which surfaces or edges are exposed and what class of surface preparation is being used.
 - .6 Indicate special tolerances and erection requirements as noted on the drawings or defined herein.

- .4 Qualification data for firms and persons specified in the 'Quality Assurance' Article to demonstrate their capabilities and experience. Include lists of completed projects names and address, names and addresses of Consultants and owners, and other information specified. For each project, submit photographs showing detail of installed AESS.

1.5 QUALITY ASSURANCE

- .1 Fabricator Qualifications: In addition to those qualifications listed in Division 5 Section 'Structural Steel,' engage a firm experienced in fabricating AESS similar to that indicated for this Project with a record of successful in-service performance, as well as sufficient production capacity to fabricate AESS without delaying the Work.
- .2 Erector Qualifications: In addition to those qualifications listed in Division 5 Structural Steel Sections, engage an experienced Erector who has completed AESS work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- .3 Comply with applicable provisions of the following specifications and documents:
 - .1 AISC 303 Code of Standard Practice for Steel Buildings and Bridges, latest edition,
 - .2 Section 10 as amended herein.
- .4 Mock-ups: At least four weeks prior to fabricating AESS, the contractor shall construct mock-ups to demonstrate aesthetic effects as well as qualities of materials and execution. Mock-ups shall be built by the Contractor or Subcontractor responsible for the Project Work. Build mock-ups to comply with the following requirements, using all conditions and materials indicated for completed unit of Work.
 - .1 Locate mock-ups on-site or in the fabricator's shop as directed by Consultant. Mock-ups shall be full-size pieces unless the Consultant approves smaller models.
 - .2 Notify the Consultant 7 days in advance of the dates and times when mockups will be available for review.
 - .3 Demonstrate the proposed range of aesthetic effects regarding each element listed under the fabrication heading below.
 - .4 Mockup will have finished surface (including surface preparation and paint system).
 - .5 Obtain Consultant's approval of mockups before start of fabrication of final units.
 - .6 Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 - .7 Approved mockups in an undisturbed condition at the time of Substantial Performance may become part of the completed Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver AESS to Project site in such quantities and at such times to ensure continuity of installation.

- .2 Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Use special care in handling to prevent twisting or warping of AESS members.
- .3 Erect pre-painted finish pieces using padded slings or other methods such that they are not damaged. Provide padding as required to protect while rigging and aligning member's frames. Weld tabs for temporary bracing and safety cabling only at points concealed from view in the completed structure or where approved by the Consultant during the pre-installation meeting. Methods of removing temporary erection devices and finishing the AESS members shall be approved by the Consultant prior to erection.

1.7 SITE CONDITIONS

- .1 Existing Conditions:
 - .1 Field Measurements: Where AESS is indicated to fit against walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

Part 2 Products

2.1 MATERIALS

- .1 General: Meet requirements Division 5 Structural Steel Sections as amended below.
- .2 High-Strength Bolts, Nuts, and Washers: Per Division 5 Structural Steel Sections heavy hex heads and nuts provide rounded bolt heads with twist-off bolts. Provide standard carbon steel mechanically galvanized finish.

2.2 PRIMERS

- .1 Compatibility: The General Contractor shall submit all components/procedures of the paint system for AESS as a single coordinated submittal. As a minimum, identify required surface preparation, primer, intermediate coat (if applicable) and finish coat. All of the items shall be coordinated with the finish coat specified in Division 9.
- .2 Primer: Fabricator's standard alkyd red oxide, rust inhibiting primer.
- .3 Primer: Fast curing, universal modified alkyd, rust inhibiting shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- .4 Primer: Acrylic water-soluble shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- .5 Primer: Fast-curing two-part epoxy. Primer shall comply with all federal standards for VOC, lead and chromate levels.

- .6 Primer: Organic, epoxy/zinc-rich, meeting class B surface requirements for slip-critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- .7 Primer: Inorganic zinc-rich meeting class B surface requirements for slip-critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- .8 Galvanizing Repair Paint: High-zinc-dust-content paint for galvanizing welds and repair-painting galvanized steel, with dry-film coating not less than 90-percent zinc dust by weight.

2.3 FABRICATION

- .1 Fabricate and assemble AESS in accordance with AESS Category 3 - Feature Elements View at a Distance ≤ 6 m.
- .2 Fabricate and assemble AESS in the shop to the greatest extent possible. Locate field joints in AESS assemblies at concealed locations or as approved by the Consultant. Detail AESS assemblies to minimize field handling and expedite erection.
- .3 Fabricate AESS with exposed surfaces smooth, square and of surface quality consistent with the approved mock up. Use special care in handling and shipping of AESS both before and after shop painting.
- .4 In addition to special care used to handle and fabricate AESS, employ the following fabrication techniques.
 - .1 Fabrication Tolerance: Fabricate steel to one half the normal tolerance as specified in the Code of Standard Practice, Section 10.
 - .2 Welds ground smooth: Fabricator shall grind welds of AESS smooth. For groove welds, the weld shall be made flush to the surfaces each side and be within $+1.6$ mm, of plate thickness.
 - .3 Contouring and blending of welds: Where fillet welds are indicated to be ground-contoured, or blended, oversize welds as required and grind to provide a smooth transition and to match profile on approved mock-up.
 - .4 Continuous Welds: Where welding is noted on the drawings, provide continuous welds of a uniform size and profile.
 - .5 Minimize Weld Show Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
 - .6 Coping and Blocking Tolerance: Maintain a uniform gap of $3.1 \text{ mm} \pm 0.8 \text{ mm}$ at all copes and blocks.
 - .7 Joint Gap Tolerance: Maintain a uniform gap of $3.1 \text{ mm} \pm 0.8 \text{ mm}$.
 - .8 Piece Marks Hidden: Fabricate such that piece marks are fully hidden in the final structure or made with such media to permit full removal after erection.
 - .9 Mill Mark Removal: Fabricator shall deliver steel with no mill marks (stenciled, stamped, raised etc) in exposed locations. Mill marks shall be omitted by cutting of mill material to appropriate lengths where possible.

Where not possible, the fabricator can fill and/or grind to a surface finish consistent with the approved mock up.

- .10 Grinding of sheared edges: Fabricator shall grind all edges of sheared, punched or flamecut steel to match approved mockup.
- .11 Rolled Members: Member specified to be rolled to a final curved shape shall be fully shaped in the shop and tied during shipping to prevent stress relieving. Distortion of the web or stem, and of outstanding flanges or legs of angles shall be visibly acceptable to the Consultant from a distance of 6096 mm under any lighting condition determined by the Consultant. Tolerances for the vertical and horizontal walls of rectangular HSS members after rolling shall be the specified dimension +/- 13 mm.
- .12 Seal weld open ends of round and rectangular hollow structural section with 9.5 mm closure plates. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AECS is exposed to weather.

2.4 SHOP CONNECTIONS

- .1 Bolted Connections: Make in accordance with Division 5 Structural Steel Sections. Provide bolt type and finish as noted herein and align bolt heads as indicated on the approved shop erection drawings.
- .2 Weld Connections: Comply with AWS D1.1 and Division 5 Structural Steel Sections. Appearance and quality of welds shall be consistent with the mock up. Assemble and weld built-up sections by methods that will maintain alignment of members without warp exceeding the tolerance of this section.

2.5 SHOP PRIMING

- .1 Shop-prime steel surfaces, except the following:
 - .1 Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 51 mm.
 - .2 Surfaces to be field welded.
 - .3 Surfaces to be high-strength bolted with slip critical connections, if primer does not meet the specified AISC slip coefficient.
- .2 Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC Specifications as follows:
 - .1 SSPC-SP 1 "Solvent Cleaning"
 - .2 SSPC-SP 2 "Hand Tool Cleaning." (This level of surface preparation will not be adequate for most paint systems for AECS construction.)
 - .3 SSPC-SP 3 "Power Tool Cleaning." (This level of surface prep is the minimum for most AECS projects. It may be acceptable for alkyd primers and acrylic or alkyd finish coats, particularly in interior applications.)
 - .4 SSPC-SP 6 "Commercial Blast Cleaning." (This level of surface prep adds significantly to the total cost of the steel. It is required for epoxy primers to allow adequate bonding to the steel. Recommended for locations where a rust inhibitive primer will be used in an exterior

application. It is also required where polyurethane finish coats will be used over the primer.)

- .5 Coordinate the required blast profile with the approved paint submittal prior to beginning surface preparation.
- .3 Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - .1 Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - .2 Apply two coats of shop primer to surfaces that are inaccessible after assembly or erection.

2.6 GALVANIZING

- .1 Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to AESS indicated for galvanizing according to ASTM A123/A123M. Fabricate such that all connections of assemblies are made in the field with bolted connections. Provide galvanized finish on members and assemblies within the range of color and surface textures presented in the mock ups.

2.7 FINISHES

- .1 Provide LEED compliant coatings for VOC ratings.
- .2 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m² to CSA-G164.
- .3 Shop Primers: Provide primers that are compatible with paint systems specified.
- .4 Touch-up galvanized surfaces with zinc rich coating, to ASTM A780/A780M: NPFC-MIL-P-21035 zinc rich paint, minimum DFT 8 mils.
- .5 Painting: in accordance with Section 09 91 00 – Painting. Colour as indicated on Drawings.

Part 3 Execution

3.1 EXAMINATION

- .1 The erector shall check all AESS members upon delivery for twist, kinks, gouges or other imperfections which might result in rejection of the appearance of the member. Coordinate remedial action with fabricator prior to erecting steel.

3.2 PREPARATION

- .1 Provide connections for temporary shoring, bracing and supports only where noted on the approved shop drawings. Temporary connections not shown shall be made at locations not exposed to view in the final structure or as approved by the Consultant. Handle, lift and align pieces using padded slings and/or other protection required to maintain the appearance of the AESS through the process of erection.
- .2 Coordinate installation of anchors for AESS members that connect to the work of other trades. Furnish setting drawings, templates, and directions for installing

anchors, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to the project site in time for installation. Anchorage concepts shall be as indicated on drawings and approved on final shop drawings.

3.3 ERECTION

- .1 Set AESS accurately in locations and to elevations indicated, and according to AISC specifications referenced in this Section.
- .2 In addition to the special care used to handle and erect AESS, employ the following erection techniques:
 - .1 AESS Erection tolerances: Erection tolerances shall meet the requirements of standard frame tolerances for structural steel per Chapter 7 of the AISC Code of Standard Practice.
 - .2 AESS Erection Tolerances: Erection Tolerances shall meet the requirements of Chapter 10 of the AISC Code of Standard Practice.
 - .3 Welds ground smooth: Erector shall grind welds smooth in the connections of AESS members. For groove welds, the weld shall be made flush to the surfaces of each side and be within + 1.6 mm of plate thickness.
 - .4 Contouring and blending of welds: Where fillet welds are indicated to be ground contoured, or blended, oversize welds as required; grind to provide a smooth transition and to match profile on approved mock-up.
 - .5 Continuous Welds: Where noted on the drawings, provide continuous welds of a uniform size and profile.
 - .6 Minimize Weld Show Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
 - .7 Bolt Head Orientation: All bolt heads shall be oriented as indicated on the contract documents. Where bolt-head alignment is specified, the orientation shall be noted for each connection on the erection drawings. Where not noted, the bolt heads in a given connection shall be oriented to one side.
 - .8 Removal of field connection aids: Run-out tabs, erection bolts and other steel members added to connections to allow for alignment, fit-up, and welding in the field shall be removed from the structure. Field groove welds shall be selected to eliminate the need for backing bars or to permit their removal after welding.
 - .9 Welds at run-out tabs shall be removed to match adjacent surfaces and ground smooth. Holes for erection bolts shall be plug welded and ground smooth.
 - .10 Filling of weld access holes: Where holes must be cut in the web at the intersection with flanges on W shapes and structural tees to permit field welding of the flanges, they shall be filled. Filling shall be executed with proper procedures to minimize restraint and address thermal stresses in group 4 and 5 shapes.
- .3 Field Welding: Weld profile, quality, and finish shall be consistent with mock-ups approved prior to fabrication.

- .4 Splice members only where indicated.
- .5 Obtain permission for any torch cutting or field fabrication from the Consultant. Finish sections thermally cut during erection to a surface appearance consistent with the mock up.
- .6 Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts. Replace connection plates that are misaligned where holes cannot be aligned with acceptable final appearance.

3.4 FIELD CONNECTIONS

- .1 Bolted Connections: Install bolts of the specified type and finish in accordance with Division 5 section "Structural Steel."
- .2 Welded Connections: Comply with AWS D1.1 for procedures, and appearance. Refer to Division 5 Structural Steel Sections for other requirements.
 - .1 Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp. Verify that weld sizes, fabrication sequence, and equipment used for AESS will limit distortions to allowable tolerances.
 - .2 Obtain Consultants approval for appearance of welds in repaired or field modified work.

3.5 FIELD QUALITY CONTROL

- .1 Structural requirements: The Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports. Refer to Division 5 Structural Steel Sections for detailed bolt and weld testing requirements.
- .2 AESS acceptance: The Consultant shall observe the AESS steel in place and determine acceptability based on the mockup. The Testing Agency shall have no responsibility for enforcing the requirements of this section.

3.6 ADJUSTING AND CLEANING

- .1 Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint shall be completed to blend with the adjacent surfaces of AESS. Such touch up work shall be done in accordance with manufacturer's instructions as specified in Section 09 91 00 - Painting.
- .2 Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

Part 1 General

1.1 Definitions

- .1 The following Definitions shall apply in this Specification:
- .2 Contract Documents
 - .1 The Contract Documents consist of the Drawings, Specifications and Reports which form part of the agreed Contract.
- .3 Consultant
 - .1 The Consultant is the Architect, SEOR, persons or entities engaged by the Owner. The term Consultant means the Consultant or the Consultant's authorized representative.
- .4 Contractor
 - .1 The term Contractor is defined to include any of the following: Construction Manager, General Contractor, Structural Steel Erector, Structural Steel Fabricator, Subcontractor or Supplier.
- .5 Owner
 - .1 The Owner is the person or entity identified as such in the Contract. The term Owner means the Owner or the Owner's authorized agent or representative but does not include the Consultant.
- .6 SEOR
 - .1 The SEOR is defined as the Structural Engineer of Record for the Contract.

1.2 WORK INCLUDED

- .1 Comply with Division 1, General Requirements and all documents referenced therein.
- .2 Provide all labour, materials, plant and equipment to complete the steel deck work including, but not limited to, the following:
 - .1 Steel deck and accessories, including all gauge metal closures;
 - .2 Framing for openings up to and including 450 mm in roof deck and 300mm in floor deck; and
 - .3 Shear stud connectors.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Concrete Reinforcement, Section 03 20 00
- .2 Cast-in-Place Concrete, Section 03 30 00
- .3 Structural Steel, Section 05 12 00 Support framing for openings larger than 450 mm in roof deck, 300 mm in floor deck and deck edge supports where loss of bearing for the steel deck occurs.

1.4 REFERENCE STANDARDS, CODES, AND ACTS

- .1 Conform to the requirements of the local building code identified on the Structural General Notes as amended by all subsequent Regulations issued to the date of this Specification and applicable acts of authorities having jurisdiction.
- .2 All references to the Standards and publications noted below shall be to the edition referenced in the local building code identified on the Structural General Notes, or to the edition referenced in the latest published editions or revisions of all Standards published by the Canadian Standards Association issued to the date of this Specification, whichever is the later edition or revision.
- .3 All references noted below, which are not referenced by the local building code or the Standards published by the Canadian Standards Association, shall be to the latest edition and revision published to the date of this Specification.
- .4 Standards and publications referenced by the Standards noted below are to apply even if they are not included in the list. Where such reference is made, it shall be to that latest edition and revision published to the date of this Specification.
 - .1 ASTM A36/A36M - Carbon Structural Steel.
 - .2 ASTM A108 - Steel Bar, Carbon and Alloy, Cold-Finished.
 - .3 ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .4 CSA-S136 - Design of Cold-Formed Steel Structural Members.
 - .5 CSA-W47.1 - Certification of Companies for Fusion Welding of Steel Structures.
 - .6 CSA-W48 - Filler Metals and Allied Materials for Metal Arc Welding.
 - .7 CSA-W55.3 - Certification of Companies for Resistance Welding of Steel and Aluminum.
 - .8 CSA-W59 - Welded Steel Construction (Metal Arc Welding).
 - .9 CSSBI 10M - Standard for Steel Roof Deck.
 - .10 CSSBI 12M - Standard for Composite Steel Deck.
 - .11 CSSBI B13 - Design of Steel Deck Diaphragms
 - .12 FM (Factory Mutual) - Roof Assembly Classifications.
 - .13 SDI (Steel Deck Institute) - Design Manual for Composite Decks, Form Decks, Roof Decks, Cellular Metal Floor Deck with Electrical Distribution.
 - .14 SSPC (The Society for - Steel Structures Painting Manual. Protective Coatings)
 - .15 ULC (Underwriters Laboratories of Canada) – List of Equipment and Materials for:
 - .1 ITS - Intertek Testing Services - Certification Listings.

- .16 Where there are differences between the Specifications and Drawings and the codes, standards, or acts, the most stringent shall govern.
- .5 Standards referenced by the standards noted above shall apply even if they are not included in the list. Where such references are made, they shall be to the latest edition and revision published.

1.5 QUALIFICATIONS

- .1 Organizations and welders undertaking to weld under this Contract shall be certified by the Canadian Welding Bureau under the requirements of W47.1 as applicable.
- .2 The Contractor shall ensure that the manufacturer and the steel deck erector shall each demonstrate a minimum of 10 years of relevant experience with the steel deck systems specified in the Contract Documents.
- .3 Design calculations shall be carried out by or under the direct supervision of a qualified Professional Engineer licensed in the Province having jurisdiction, with a minimum of 5 years Canadian experience in the design of steel deck.

1.6 DESIGN

- .1 Design steel deck in accordance with the requirements of the Building Code.
- .2 The minimum steel core thickness shall be 0.76 mm except that for steel deck which is considered architecturally exposed to view the minimum steel core thickness shall be 0.91 mm.
- .3 Design floor deck such that the live load deflection of deck shall not exceed $l/360$ of the span.
- .4 Design roof deck such that the live load deflection of deck shall not exceed $l/300$ except when deck supports non-structural services or finishes that are identified as being susceptible to damage. In this case, design roof deck such that deflection of deck shall not exceed $l/360$ of the span.
- .5 Design roof deck such that deflection does not exceed $l/300$ of the span when supporting a 1.3 kN point load acting over a 300 mm strip of deck.
- .6 Design deck anchorage to the supporting structure to safely resist the net uplift forces indicated in the Contract Documents. Design anchorages for deck supporting concrete slabs for net uplift during construction.
- .7 Wherever structural framing permits, steel deck shall be designed and fabricated to span continuously over at least four supports (three spans).
- .8 Determine structural properties of the concrete slab and composite construction in accordance with requirements of The Building Code.
- .9 Design and install composite deck and metal edge and closure strips to safely support construction and other loads before the composite action of the deck system takes place, without excessive deflection. Design and detail temporary intermediate supports for the composite deck where required. Identify areas

where this is required and submit shop drawings showing the proposed temporary support detail.

- .10 Design framing for openings through the deck up to a maximum width of 300 mm in floor deck and 450 mm in roof deck measured perpendicular to the span of the deck.
- .11 Detail metal edge and closure strips to prevent the loss of grout when the deck is concreted.
- .12 Headed studs have been designed to ensure composite action between the steel framing members and the slab on deck floor system. The design of these studs has been based on an assumed steel deck profile where the average flute width is at least twice the height of the deck.

1.7 Submittals

- .1 Shop Drawings
 - .1 Submit shop and erection drawings and load tables for review by the Consultant.
 - .2 Unless noted otherwise in the Contract Documents on all shop drawings provide adequate space immediately above the drawing's title block for a Consultant's Shop Drawing review stamp. Where requested by the Consultant, the stamp is to be inserted by this section directly into the shop drawing prior to submission. The stamp shall be positioned in the same location on each shop drawing, and in no case shall the allocated space be less than 63mm x 75 mm. Request the details of these requirements from the Consultant no less than 2 weeks before the commencement of shop drawings.
 - .3 Each drawing submitted shall bear the signature and stamp of a qualified Professional Engineer licensed in the Province having jurisdiction.
 - .4 The structural Drawings shall not be reproduced, in whole or in part, for use as shop drawings.
 - .5 As a minimum, the shop drawings shall show the following:
 - .1 Types of deck and their locations, including the setting out points for the deck;
 - .2 Sufficient detail sections showing the deck's orientation to support members to facilitate erection of deck;
 - .3 Design loads, including diaphragm forces;
 - .4 Connections to supports including welding details and details for pins and screws if appropriate;
 - .5 Net uplift pressures, including pressures during construction;
 - .6 Openings and their reinforcement, coordinated with the mechanical and electrical contractor's sleeving drawings;

- .7 Base steel thickness;
 - .8 Surface protective coating;
 - .9 Metal edge and closure strips;
 - .10 Acoustic details, if applicable;
 - .11 Locations of shoring (if required) and the shoring loads imposed on the structures below;
 - .12 Locations, size, type, and welding requirements of welded stud shear connectors;
 - .13 Diaphragm shear stiffness factor, as required; and
 - .14 Areas where insufficient bearing on supporting steel members will be provided due to steel connections, vertical bracing connections or the like. Coordinate with Section 05 12 00 – Structural Steel for additional bearing details required in these locations.
- .6 Provide the inspection company with a copy of each reviewed drawing bearing the Consultant's shop drawing review stamp.
- .2 Calculations
- .1 Submit calculations bearing the seal and signature of the qualified Professional Engineer licensed in the Province having jurisdiction and such further proof as may be necessary to show that the steel deck and all related accessories conform to the requirements set forth in this Section.
- .3 As-Built Drawings
- .1 Mark on a complete set of final drawings any changes, additions, or deletions that occurred during construction.
 - .2 For all shop drawings marked "Reviewed as Noted" or "Revise and Resubmit", update and submit a record set of these drawings at the completion of the structural Work. Ensure that these drawings reflect the changes and are coordinated with the final drawings noted above.
- .4 Mill Test Reports
- .1 Submit all mill test reports covering chemical and physical properties of materials used in this Work a minimum of 4 weeks prior to commencing fabrication.
- .5 Surveys
- .1 Submit surveys showing position of structural elements in their as-built condition. Coordinate the location of survey points described below with those noted in Section 05 12 00 – Structural Steel.
 - .2 At a minimum, submit the following:

- .1 Elevation of deck at all columns, centre of bays, midway between columns along gridlines and at cantilever ends, on all floors, as follows:
- .2 Location of slab edges at all perimeter columns and midway between columns along the perimeter; and
- .3 Dates of all surveys

Part 2 Materials

2.1 STEEL DECK

- .1 Sheet Steel: ASTM A653/A653M, Structural Quality; with Z180 (G60) or ZF75(A25) minimum coating for steel deck not considered architecturally exposed to view or weather. Deck which is considered architecturally exposed to view or weather or deck in high humidity areas shall have Z275 (G90) minimum coating.
- .2 The composite steel deck and concrete slab shall comply with the fire-rating requirements.
- .3 Provide steel deck profile with interlocking side joints.
- .4 Related Deck Accessories: Metal closure strips, wet concrete stops, cover plates, cant strips.
- .5 Stud Shear Connectors: ASTM A108, Grade 1015. Headed studs shall be welded per manufacturer recommendations.
- .6 Mechanical Fasteners: Fasteners shall have knurled shank; minimum 12 mm diameter steel washers; electroplated zinc coating conforming to ASTM B633, Sc. 1, Type III; meeting CSSBI design requirements, such as Hilti X-EDNK22 THQ12, X-EDN19 THQ12, or X-ENP-19 L15 fasteners. For use on open web steel joists with top flange thicknesses between 3 mm to 6 mm, use Hilti X-EDNK22 THQ12 fasteners. For open web steel joists or beams with a top flange thickness of 5 mm to 10 mm use Hilti X-EDN19 THQ12 fasteners. For flanges equal to or greater than 6 mm, use Hilti X-ENP-19 L15 fasteners. Verify performance and applicability of application with the manufacturer by performing test fastenings prior to the installation of the deck.
- .7 Side Lap Connectors: Sidelap connectors to connect steel deck units at overlaps can consist of Hilti SLC 01 for gauges 18 to 26 or the Hilti SLC 02 for gauges 16 to 22.
- .8 Welding Materials: Type required for materials being welded.
- .9 Shop and Touch-Up Primer: SSPC-Paint 15 or the Manufacturer's standard, complying with SSPC-Paint 15.

Part 3 Execution

3.1 INSTALLATION

- .1 General

- .1 Install steel deck to manufacturer's written instructions and to CSSBI requirements.
 - .2 Install steel deck such that it is free of dirt, scale, foreign matter, dents, or deformations. Deck, which is considered architecturally exposed to view, that is dented or deformed is subject to acceptance by the Consultant.
 - .3 Lap ends of deck units not receiving concrete slab a minimum of 50 mm and only over supporting members.
 - .4 Where steel deck spans parallel to beams that are to have studs added to top flange, arrange bottom flutes to be centred over beams. If this is not possible, interrupt decking so that studs can be placed on beams to allow composite action to take place.
 - .5 Bear deck on masonry and concrete support surfaces with 150 mm minimum bearing. Align and level the deck.
 - .6 Bear deck on steel supports with 75 mm minimum bearing. Align and level the deck.
 - .7 Fasten steel deck to supporting members to safely resist the forces indicated in the Contract Documents but with not less than 19 mm (3/4") diameter fusion welds at 300 mm on center at intermediate supports and 19 mm (3/4") diameter fusion welds at 150 mm on center at end supports parallel with the deck flute and at each transverse flute.
 - .8 Weld to CSA-W59
 - .9 Mechanically clinch male/female side laps to resist the forces indicated in the Contract Documents but at not more than 600 mm (24") on center maximum.
 - .10 Make fusion welds of deck to supporting members well within bearing width of supporting members.
 - .11 Provide gauge metal closures along edges of all deck parallel to span where deck is not otherwise continuously supported, at all changes in direction of the span of the deck, at all discontinuities of sloped deck, and at all openings through concrete slabs on steel deck.
 - .12 Level and align cellular deck within [3 mm] horizontally and vertically. Butt ends, allow for maximum 3 mm gap. Install sheet steel covers over gaps wider than 3 mm. Tape and seal joints watertight.
- .2 Openings Through Deck
- .1 Obtain opening and sleeving information from Subcontractors responsible for the related Work of other Sections before proceeding with the work. Coordinate with the Work of other Sections as necessary.
 - .2 Indicate openings and reinforcement for openings on fabrication and erection drawings.

- .3 Cut openings and reinforce edges as required for pipes, ducts, and the like. The maximum size of an unreinforced opening is 150 mm square or in diameter. Reinforce openings having a dimension over 150 mm but not exceeding 300 mm in floor deck or 450 mm in roof deck. The location of holes through decking shall be to the approval of the Consultant.
- .4 Where possible, leave deck intact and use block outs to form concrete edges at openings. Cut deck after concrete has reached a minimum of 70% of its 28 day specified strength.
- .3 Supports from Deck
 - .1 No hangers or brackets supporting mechanical and electrical services, artwork, ceilings, bulkheads, lighting and the like from the roof deck are permitted, unless the deck is designed specifically for the imposed loads.
- .4 Welded Stud Shear Connectors
 - .1 Weld headed studs to the supporting structural steel through the steel deck as per the requirements of CSA Standard W59, except where studs are required to be welded to the steel in the shop.
 - .2 Where stud shear connectors are shop welded to supporting steel members, accurately layout and predrill holes in the deck to facilitate installation of the deck in the field. The use of torch cutting of holes is not permitted.
- .5 Protection
 - .1 Immediately after any deck which does not receive a concrete slab is permanently secured in place, touch up top surface of deck with primer, where the shop applied coating is damaged during installation or by welding of the deck in place.
- .6 Closures
 - .1 Seal off spaces between flutes with closures of neoprene or closed cell expanded p.v.c. at partitions, walls, and other locations indicated in the Contract Documents. At exterior walls, provide insulated closures.
 - .2 Where steel deck rests on exterior masonry walls, fill web spaces with closures as recommended by manufacturer.
 - .3 Where flutes are at right angles to exterior walls, and deck exposed on underside extends beyond these walls, install interior and exterior closures. In addition, provide roofer with sufficient quantity of glass fibre pads to close off topside flutes directly over face of wall or use closures as recommended by manufacturer.
 - .4 Where flutes run at right angles to interior partitions, fill web spaces with double run of steel closures or as recommended by manufacturer.

- .5 Where flutes are parallel to interior partitions, install steel closure flashings to provide neat juncture between two materials or as recommended by manufacturer.
- .6 Closures are not required between interior partitions and underside of deck in areas having suspended ceiling, unless specified by the Consultant.
- .7 Attach metal cell closures at locations required to contain poured concrete.

3.2 QUALITY CONTROL

- .1 Implement a system of quality control to ensure that the minimum standards specified in this Section are attained.
- .2 Bring to the attention of the Consultant any defects in the Work or departures from the Contract Documents which may occur during construction. The Consultant will decide upon corrective action and give recommendations in writing.
- .3 The Consultant's general review during construction and inspection and testing by independent inspection and testing agencies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of its contractual responsibility.

3.3 NOTIFICATION

- .1 Prior to commencing significant segments of the Work, give the Consultant and Independent Inspection and Testing Companies appropriate notification so as to afford them reasonable opportunity to review the Work. Failure to meet this requirement may be cause for the Consultant to classify the Work as defective.

3.4 INSPECTION AND TESTING

- .1 The Owner will appoint the Independent Inspection and Testing Company to make inspections or perform tests as the Consultant directs. The Independent Inspection and Testing Company shall be responsible only to the Consultant, and shall make only such inspection or tests as the Consultant may direct.
- .2 Inspection and testing will include the testing of stud shear connectors.

3.5 DEFECTIVE MATERIALS AND WORK

- .1 Where evidence exists that defective Work has occurred or that Work has been carried out incorporating defective materials, the Consultant may have tests, inspections, or surveys performed such as concrete core strength tests, analytical calculations of structural strength, and the like, in order to help determine whether the Work must be replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the

Contractor's expense, regardless of their results, which may be such that, in the Consultant's opinion, the Work may be acceptable.

- .2 All testing shall be conducted in accordance with the requirements of the Building Code, except where this would in the Consultant's opinion cause undue delay or give results not representative of the rejected Products in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.
- .3 Products or Work which fails to meet the specified requirements may be rejected by the Consultant whenever found at any time prior to the Total Performance of the work regardless of previous inspection. If rejected, defective materials or Work shall be removed and replaced or repaired to the satisfaction of the Consultant, promptly, at no expense to the Owner.

END OF SECTION 05 31 00

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 This section includes but not limited to, the following components:
 - .1 Studs subjected to lateral loads.
 - .2 Top and bottom tracks.
 - .3 Bridging and bracing.
 - .4 Top and bottom track connections to main structure, including fabrications to accommodate main structure deflections; top of wall anchor allowing for dead load deflections during construction and live load deflections after construction.
 - .5 Head, sill and jamb members at wall openings.
 - .6 Framing component connections.

.2 Related Requirements:

- .1 Section 01 35 00 – Delegated Design Submittals.
- .2 Section 03 30 00 – Cast-In-Place Concrete.
- .3 Section 06 10 00 – Rough Carpentry: Blocking for wall supported fixtures and fittings.
- .4 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier.
- .5 Section 08 11 13 – Steel Doors and Frames.
- .6 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

.1 Definitions:

- .1 Minimum Uncoated Steel Thickness: Minimum uncoated thickness of lightweight steel framing shall be not less than 95% of the thickness used in the design for the framing system:
 - .1 Lesser thicknesses may be permitted at bends arising from the cold forming process.
 - .2 Metal thicknesses listed in this section are minimum uncoated steel thickness; exclusive of any subsequent coatings or treatments.
- .2 Delegated Design Professional Engineer: The professional engineer hired or contracted to the fabricator or manufacturer to design specialty elements, produce delegated design submittals and shop drawings to meet the requirements of the Project; who is registered in the province of the Work; and who is not the Consultant.
- .3 Letters of Commitment and Compliance: Documents prepared by the delegated design professional engineer as recommended by Professional Engineers Ontario, Responsibilities for Engineering Services for Building Projects.

.2 Reference Standards:

- .1 American Society for Testing and Materials International (ASTM):

- .1 ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
- .2 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .3 ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .4 ASTM C955-18e1, Standard Specification for Cold-Formed Steel Structural Framing Members.
- .5 ASTM F3125/F3125M-23, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating. (Withdrawn).
- .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian Sheet Steel Building Institute (CSSBI):
 - .1 CSSBI 51-06, Lightweight Steel Framing Design Manual – 2nd Edition.
 - .2 CSSBI SSF 03-17, Care and Maintenance of Prefinished Sheet Steel Building Products.
 - .3 CSSBI Technical Bulletin Vol. 7, No. 2, Changing Standard Thicknesses for Canadian Lightweight Steel Framing Applications (2011).
 - .4 CSSBI S5-19, Guide Specification for Wind Bearing Steel Studs.
- .5 Canadian Standards Association (CSA Group):
 - .1 CSA A370-14(R2018), Connectors for Masonry.
 - .2 CSA-G164-18 (R2023), Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No. 1 (2020).
 - .3 CSA S16:19 Design of Steel Structures, Includes Errata (2019) and Errata (2023).
 - .4 CSA S136-16, North American Specification for the Design of Cold Formed Steel Structural Members.
 - .5 CSA W47.1:19, Certification of Companies for Fusion Welding of Steel.
 - .6 CSA W55.3-08 (R2023), Certification of Companies for Resistance Welding of Steel and Aluminum.
 - .7 CSA W59-18 (R2023), Welded Steel Construction, Includes Errata (2020).
- .6 The Master Painters Institute (MPI):
 - .1 Architectural Painting Specification Manual
 - .2 MPI # 18, Organic Zinc Rich Primer.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate work of this Section with work of other sections that may have items supported by or built into axially load bearing lightweight structural steel framing systems including; but not limited to doors, windows, architectural woodwork, pre-manufactured casework, building signage, plumbing fixtures, and electrical fixtures and panels.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Product Data: Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit product data for mechanical fasteners, indicating sizes, shear, and pull-over loading capacity where applicable. Provide data indicating thickness and type of corrosion protection coating.
- .2 Shop Drawings: Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate design loads, member sizes, materials, design thickness exclusive of coatings, coating specifications, connection and bracing details, screw sizes and spacing, and anchors.
 - .2 Indicate locations, dimensions, openings and requirements of related work.
 - .3 Indicate welds by welding symbols as defined in CSA W59.
- .3 Submittals shall bear the seal of a professional engineer registered in the Province of the Work.
- .4 Delegated Design Submittals: Submit delegated design professional engineer's design notes and calculations upon request of the Consultant.
 - .1 Submit Letter of Commitment, signed and sealed by the professional engineer required by the Work of this Section in compliance with Section 01 35 00 – Delegated Design; professional engineer shall define applicable responsibilities in the completed Letter of Commitment and Letter of Compliance in compliance with the intent of the Building Code. Submit in conjunction with Shop drawings.
 - .2 Prior to declaration of Substantial Performance, submit Trade Contractor's design engineer to certify substantial compliance with the system design by submitting a Letter of Compliance, signed and sealed by the retained professional engineer required by the Work of this Section in compliance with Section 01 35 00 – Delegated Design.
- .5 Evaluation Reports:
 - .1 Submit steel framing manufacturer third-party evaluation report for the products reviewed to the local building code or its model code.
- .6 Qualifications: Submit evidence of welder qualifications specified in this Section.
- .7 Prior to declaration of Substantial Performance, submit Trade Contractor's design engineer to certify substantial compliance with the system design by submitting a Letter of Compliance, signed and sealed by the retained professional engineer required by the Work of this Section.

- .8 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Welding shall be performed by company certified by the Canadian Welding Bureau to CSA W47.1 for the type of work being performed; welding shall conform to CSA W59.
- .2 Clearly mark steel thickness exclusive of coating by embossing, stamping with indelible ink or by colour coding.
- .3 Provide minimum 72 hours notice to Consultant prior to commencement of work of this Section; increase notice period where time period spans weekends or statutory holidays.
 - .1 Do not conceal lightweight steel framing system until reviewed by Consultant.
- .4 Use manufacturers that manufacture Products in accordance with CSSBI Manufacturer Certification Requirements for Cold Formed Steel Framing Members.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Protect steel studs during transportation, site storage and installation in accordance with CSSBI Sheet Steel Facts SSF 03.
- .2 Handle and protect galvanized materials from damage to zinc coating.
- .3 Store materials flat, blocked off the ground in a manner to prevent kinking or permanent set.
- .4 Bent, kinked or twisted studs and track will be rejected.
- .5 Packaging Waste Management
 - .1 Separate waste materials for recycling in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 PERFORMANCE / DESIGN CRITERIA

- .1 Design wall framing system to resist wind loads and building loads in accordance with Section 01 35 00 – Delegated Design.
- .2 Perform design, fabrication and erection of the work of this Section based on Limit States Design principles using factored loads and resistances, determined in accordance with CSA S136.
- .3 Conform to the requirements of indicated fire resistance ratings.
- .4 Design wall framing system capable of withstanding design loads within limits and under design loads indicated on Drawings, and as follows:
 - .1 Dead Loads: Weights of materials and construction.

- .2 Lateral Loads: Design for wind loads using post disaster importance factors listed in the Building Code for deflection and strength, modified by the appropriate exposure, gust and pressure (internal and external) factors in accordance with Building Code structural commentaries.
- .3 Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 70°C.
- .4 Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure upward and downward movement of 13 mm; or larger gap as may be required to accommodate structural movement.
- .5 Design deflection detail so that free floating vertical members are restrained from horizontal movement by means of continuous bridging, nested or boxed tracks, or sliding or flexible web connections.
- .6 Maximum allowable deflection under one in 50 year sustained wind loading shall be as follows:
 - .1 Behind metal cladding – stud deflection limited to L/360.
- .7 Allow for movement of the structure; design lightweight steel framing end connections to accommodate floor and roof deflections such that framing are not loaded axially; limit free play and movement in connections perpendicular to the plane of framing to ± 0.50 mm relative to the building structure.
- .8 Design connections between light steel framing members using bolts, welding or sheet metal screws.
- .9 Design bridging to prevent member rotation and member translation perpendicular to the minor axis, and as follows:
 - .1 Design for secondary stress effects due to torsion between lines of bridging.
 - .2 Collateral contribution of sheathing materials may be used to help restrain member rotation and translation perpendicular to the minor axis for wind bearing framing. Design exterior wall framing to accommodate horizontal deflection without allowing for collateral contribution of sheathing materials.
 - .3 Design bridging at 1530 mm centres maximum, closer spacing may be required by design to satisfy structural requirements; spaced at even intervals over the span of the member.
- .5 Stud, sill and top track sizes and thicknesses, and fastening details indicated in this Section and on the Drawings shall be considered as minimums only, spacing indicated as maximum permissible, except where changes are required to meet design criteria, and as follows:
 - .1 Design head, sill and jamb members to frame openings larger than 100 mm in any dimension.
 - .2 Design components or assemblies to accommodate specified tolerances of the structure.

- .3 Sill and Top Tracks:
 - .1 Double track system, outer track flanges with depth to suit vertical deflection and width of studs.
 - .2 Sill tracks, minimum 33 mm deep flanges and width of studs.
- .4 Movement Connection Clips: Purpose made clip designed to allow structural member vertical movement and to transfer wind suction or pressure to structural frame.
- .5 Maximum design spacing of stud members shall not exceed 305 mm centres. confirm stud spacing with Engineer prior to application.
- .6 Maximum spacing for top and bottom track connections to the structure shall not exceed 812 mm centres.
- .7 Minimum design thickness for wall framing members shall be as follows:
 - .1 64 mm: 0.836 mm
 - .2 92 mm: 0.836 mm
 - .3 101 mm: 0.836 mm
 - .4 140 mm: 0.836 mm
 - .5 152 mm: 0.836 mm
 - .6 184 mm: 0.91 mm
 - .7 203 mm: 1.12 mm
 - .8 Minimum thickness for walls supporting masonry veneer shall be 1.22 mm regardless of minimum thickness indicated above, or thicker as required to suit design conditions.
- .8 Bridging Channel: 1.22 mm minimum.
- .9 Clip Angles: 1.52 mm minimum.
- .6 Clearly mark steel thickness exclusive of coating by embossing, stamping with indelible ink or by colour coding.

2.2 MATERIALS

- .1 Steel: to CSA S136, fabricated from ASTM A653/A653M, Grade 230 steel.
- .2 Zinc coated steel sheet: quality to ASTM C955 and ASTM A653/A653M, with CP-60 Z180 for exterior wall assemblies designation coating. Consultant will accept hot dipped aluminum zinc alloy with AZM 150 designation coating in accordance with ASTM A792/A792M provided that corrosion protection meets or exceeds requirements established by ASTM A653/A653M.
- .3 Fasteners and Welding Materials:
 - .1 Welding materials conforming to CSA W59; electrodes minimum 480 MPa tensile strength.
 - .2 Bolts and nuts conforming to ASTM A307, with washers and hot-dip galvanized finish.
 - .3 Metal to Metal: Sheet metal screws conforming to ASME B18, with minimum 0.008 mm thick galvanized coating and #8 Ø; self-drilling, self-threading, case hardened type; hex, pan, and low-profile head profile type to suit application; length sufficient to penetrate not less than three fully exposed threads beyond joined materials.

- .4 Metal to Concrete: Hilti drilled insert, minimum 8 mm Ø; do not use Powder Actuated Fasteners.
- .5 Metal to Structural Steel: Secure track to structural steel over 8 mm thickness with Hilti DX fastening system with ENH2-21L15MX nails.
- .6 Concrete-to-Steel Top Track Corrugated Ties: Corrugated steel conventional strip tie; 22 mm wide x 100 mm total length including 20 mm up stand x 0.76 mm nominal core metal thickness, hot dip galvanized; corrugations 2.5 mm deep x 10 mm apart; meeting requirements of CSA A370:
 - .1 Basis-of-Design Materials:
 - .1 Conventional Corrugated Strip Tie, Fero Corporation.
- .7 Drilled Inserts: Steel, cadmium plated or hot dipped galvanized, sizes as indicated on Drawings.
- .4 Touch up primer: zinc rich, to CAN/CGSB 1.181.
- .5 Moisture Barrier: Insulating moisture resistant 6 mm thick foam strip x width of framing member, length as required.
 - .1 Basis-of-Design Materials:
 - .1 Ethafoam 222, The Dow Chemical Company.
- .6 Thermal Insulation: as indicated in Section 07 21 13 – Board Insulation.
- .7 Shims: Load bearing, high density multi-monomer plastic, non-leaching.

2.3 STEEL STUD DESIGNATIONS

- .1 Colour code: to CSSBI Technical Bulletin Vol.7, No. 2.

2.4 METAL FRAMING

- .1 Framing Components: Provide framing components in metal core thickness, profiles and spacing as determined by delegated design professional engineer including; but not limited to, the following:
 - .1 C-shaped, punched wall framing with stiffened flanges
 - .2 U-shaped un-punched track without stiffened flanges
 - .3 Headers and jambs; columns, posts and beams using manufacturer's proprietary shapes having stiffened flanges
 - .4 Vertical deflection clips using manufacturers proprietary bypass or head clips; as appropriate to installation, capable of accommodating upward and downward vertical movement of primary structure using a positive mechanical attachment to wall framing web
 - .5 Slotted or double deep leg deflection track using manufacturer's proprietary system allowing free vertical movement under primary structural elements
 - .1 Basis-of-Design Materials:
 - .1 BlazeFrame DSL or MaxTrak Slotted Deflection Track as required, ClarkDietrich
 - .6 Leg Dimension: as required by delegated design professional engineer.

- .7 Minimum Thickness: as required by delegated design professional engineer.
- .8 Floor joist framing and rim track
- .9 Roof joists framing.
- .10 Roof rafter framing.
- .11 Ceiling joist framing.
- .2 Framing Accessories: Provide accessories of manufacturer's standard thickness and configuration including; but not limited to, the following:
 - .1 Supplementary framing.
 - .2 Drift clips.
 - .3 Bracing, bridging, and solid blocking.
 - .1 Basis-of-Design Materials:
 - .1 Spazzer 5400 Bridging Bar (SPZS), ClarkDietrich;
 - .4 Web stiffeners
 - .1 Basis-of-Design Materials:
 - .1 Quick Twist Web Stiffener (QTWS), ClarkDietrich
 - .5 Anchor clips
 - .1 Basis-of-Design Materials:
 - .1 Holdown (CD Series) or Moment Clip (MC Series), ClarkDietrich;
 - .6 End clips.
 - .7 Foundation clips.
 - .8 Gusset plates.
 - .9 Stud kickers, knee braces, and girts.
 - .10 Joist hangers and end closures.
 - .1 Basis-of-Design Materials:
 - .1 Universal Joist Hanger (UJH), ClarkDietrich
 - .11 Hole reinforcing plates.
 - .12 Backer plates.

2.5 SOURCE QUALITY CONTROL

- .1 Ensure mill reports covering material properties are reviewed by Consultant.

Part 3 Execution

3.1 GENERAL

- .1 Do welding in accordance with CSA W59.
- .2 Certification of companies: CSA W47.1 for fusion welding and CSA W55.3 for resistance welding.
- .3 Do work to CSSBI S5.

3.2 ERECTION

- .1 Erect components to requirements of reviewed shop drawings.
- .2 Anchor tracks securely to structure at 800 mm on centre maximum, unless lesser spacing prescribed on shop drawings.
- .3 Erect studs plumb, aligned and securely attached with two screws minimum, welded in accordance with manufacturer's recommendations.
- .4 Seat studs into bottom tracks and two piece telescoping top track.
- .5 Install 50 mm minimum telescoping track at top of walls where required to accommodate vertical deflection.
 - .1 Nest top track into deflection channel minimum of 30 mm and maximum of 40 mm.
 - .2 Do not fasten tracks together.
 - .3 Stagger joints.
- .6 Install studs at not more than 50 mm from abutting walls, openings, and each side of corners and terminations with dissimilar materials.
- .7 Brace steel studs with horizontal internal bridging at 1500 mm maximum.
 - .1 Fasten bridging to steel clips fastened to steel studs with screws or by welding.
- .8 Frame openings in stud walls to adequately carry loads by use of additional framing members and bracing as detailed on shop drawings.
- .9 Touch up welds with coat of zinc rich primer.

3.3 ERECTION TOLERANCES

- .1 Plumb: not to exceed 1/500th of member length.
- .2 Camber: not to exceed 1/1000th of member length.
- .3 Spacing: not more than +/- 3.0 mm from design spacing.
- .4 Gap between end of stud and track web: not more than 4.0 mm.

3.4 CUTOUTS

- .1 Maximum size of cutouts for services as follows:

Member Depth	Across Member Depth	Along Member Length	Centre to Centre Spacing (mm)
92	40 max.	105 max.	610 min.
102	40 max.	105 max.	610 min.
152	64 max.	114 max.	610 min.
- .2 Limit distance from centerline of last unreinforced cutout to end of member to no less than 305 mm.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section Includes Metal Fabrications as indicated on drawings.
- .2 Related Requirements:
 - .1 Section 01 35 00 – Delegated Design
 - .2 Section 03 30 00 – Cast-in-Place Concrete
 - .3 Section 04 22 00 – Unit Masonry
 - .4 Section 05 31 00 – Steel Deck
 - .5 Section 05 51 29 – Metal Stairs and Ladders
 - .6 Section 06 10 00 – Rough Carpentry
 - .7 Section 06 40 00 – Architectural Woodwork
 - .8 Section 09 21 16 – Gypsum Board Assemblies
 - .9 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A53/A53M-22, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A153/A153M-23, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .4 ASTM A269/A269M-22, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - .5 ASTM A276/A276M-24, Standard Specification for Stainless Steel Bars and Shapes.
 - .6 ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .7 ASTM A385/A385M-22, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
 - .8 ASTM A500/A500M -23: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - .9 ASTM A501/A501M -21: Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - .10 ASTM A570-79, Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality. (Withdrawn)
 - .11 ASTM A591/A591M-98, Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight [Mass] Applications. (Withdrawn 2005)

- .12 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .13 ASTM A666-23, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
- .14 ASTM A780/A780M-20, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- .15 ASTM B177/B177M-11(2021), Standard Guide for Engineering Chromium Electroplating.
- .16 ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- .17 ASTM B221M-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- .18 ASTM B632/B632M-18, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
- .19 ASTM E935 -21: Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
- .20 ASTM F593-22, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- .21 ASTM F3125/F3125M-23, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 Canadian Standards Association (CSA Group):
 - .1 CSA G40.20-13/G40.21-13(R2023), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel. Includes Update No. 1 (2014)
 - .2 CSA G164-18 (R2023), Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No. 1 (2020).
 - .3 CSA G189-1966(R2003), Sprayed Metal Coatings for Atmospheric Corrosion Protection.
 - .4 CSA S16:19, Design of Steel Structures, Includes Errata (2019) and Errata (2023).
 - .5 CSA W47.1:19, Certification of Companies for Fusion Welding of Steel.
 - .6 CSA W48:23, Filler Metals and Allied Materials for Metal Arc Welding.
 - .7 CSA W55.3-08 (R2023), Certification of companies for resistance welding of steel and aluminum.
 - .8 CSA W59-18 (R2023), Welded Steel Construction, Includes Errata (2020).
 - .9 CSA W178.1-18 (R2023), Certification of Welding Inspection Organizations.

- .10 CSA W178.2-18 (R2023), Certification of Welding Inspectors.
- .4 National Association of Architectural Metal Manufacturers (NAAMM):
 - .1 NAAMM AMP 500-06, Metal Finishes Manual.
 - .2 NAAMM AMP 521-01 (R2012), Pipe Railing Manual.
 - .3 NAAMM AMP 555-92, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
- .5 Naval Publications and Form Center (NPFC):
 - .1 NPFC-MIL-P-21035, Paint High Zinc Dust Content, Galvanizing Repair (Metric) (2021).
- .6 Process Industry Practices: PIP STF05501, Fixed Ladders and Cage Fabrication Details
- .7 The Society for Protective Coatings (SSPC) / National Association of Corrosion Engineers (NACE International):
 - .1 Surface Preparation Guidelines:
 - .1 SSPC SP3, Power Tool Cleaning (2018).
 - .2 SSPC-SP5/NACE No. 1, White Metal Blast Cleaning.
 - .3 SSPC-SP6/NACE No. 3, Commercial Blast Cleaning.
 - .4 SSPC-SP7/NACE No. 4, Brush off Blast Cleaning.
- .8 Underwriters Laboratories ECOLOGO Certification Program (UL):
 - .1 UL 2760, Surface Coatings - Recycled Water-Borne Coatings (formerly CCD-048).
 - .2 UL 2768, Architectural Surface Coatings (formerly CCD-047).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
 - .2 Provide one electronic copy of WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada and indicate VOC content for:
 - .1 Finishes, coatings, primers and paints.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:

- .1 Indicate materials, finishes, profiles, core thicknesses, connections, joints, sizes of sections, method of anchorage, number of anchors, supports, fasteners, rivets, welds, reinforcement, details, and accessories.
- .2 For items where design is delegated to fabricator, provide shop drawings signed and sealed by the professional engineer registered in Province of Work, responsible for the design as indicated in Section 01 35 00 - Delegated Design.
- .3 Submittals shall bear the seal of a professional engineer registered in the Province of the Work.
- .4 Submit delegated design professional engineer's design notes and calculations upon request of the Consultant.
- .5 Submit Letter of Commitment, signed and sealed by the professional engineer required by the Work of this Section in compliance with Section 01 35 00 – Delegated Design Submittals; professional engineer shall define applicable responsibilities in the completed Letter of Commitment and Letter of Compliance in compliance with the intent of the Building Code. Submit in conjunction with Shop drawings.
- .6 Submit evidence of welder qualifications specified in this Section.
- .7 Prior to declaration of Substantial Performance, submit subcontractor's design engineer to certify substantial compliance with the system design by submitting a Letter of Compliance, signed and sealed by the retained professional engineer required by the Work of this Section in compliance with Section 01 35 00 – Delegated Design Submittals.
- .8 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- .2 Welding: Qualify procedures and personnel according to the following:
 - .1 Welders shall be qualified by Canadian Welding Bureau for classification of work being performed.
 - .2 The fabricator shall be certified to CSA W47.1, Division 1 or 2.1.
 - .3 Do welding inspection to CSA W178.1 and W178.2.
 - .4 Resistance welding: to CSA W55.3.
 - .5 Fusion welding: to CSA W59.
- .3 Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
- .4 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .5 Detail and fabricate metal fabrications in accordance with the NAAMM AMP 555.

- .6 Perform Work to the highest standard of modern shop and field practice, by personnel experienced in this Work. Accurately fit joints and intersecting members in true planes with adequate fastening. Build and erect the Work plumb, true, square, straight, level, accurate to the sizes shown, and free from distortion or defects.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Exercise due care in storing, handling and erecting all materials and support all materials properly at all times so that no piece will be bent, twisted or otherwise damage structurally or visibly.
- .2 Correct damaged material and where the Consultant deems damage irreparable, replace the affected items at no additional expense to the Consultant or Owner.
- .3 Apply protective covering to face of all exposed finished metalwork before it leaves shop, covering to remain until item installed.
- .4 Fabricate large assemblies so they can be safely and easily transported and handled to their place of installation.
- .5 Packaging Waste Management:
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Coordinate this Work with the remainder of the Work and exercise the necessary scheduling to ensure that all Work is carried out and all items incorporated during the appropriate construction phase.
- .2 Provide instructions and drawings to other trades for setting bearing plates, anchors bolts, and other members that are built in to work of other trades.
- .3 Protect other Sections of the Work from damage by this Section of the Work.

Part 2 Products

2.1 MATERIALS

- .1 Steel sections and plates: to CSA-G40.20/G40.21, Grade 300W.
- .2 Hollow Structural Sections: In accordance with CSA G40.20/G40.21, Grade 350W, Class C.
- .3 Steel pipe: to ASTM A53/A53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads, galvanized finish.
- .4 Steel Tubing: ASTM A500/500M, Grade B or ASTM A501/501M.
- .5 Welding materials: to CSA W59.
- .6 Welding electrodes: to CSA W48 Series.
- .7 Fasteners: Bolts, nuts, washers, rivets, lock washers, anchor bolts, machine screws, and machine bolts.

- .1 Unfinished fasteners: In areas not exposed to public, use unfinished bolts conforming to ASTM A307, Grade A, with hexagon heads and nuts. Supply bolts of lengths required to suit the thickness of the material being joined, but not projecting more than 6 mm beyond nut, without the use of washers.
- .2 Finished fasteners:
 - .1 In areas exposed to public use, bolts, nuts, washers, rivets, lock washers, anchor bolts, machine screws and machine bolts to be hot dip galvanized in accordance with ASTM A153/A153M or CSA-G164.
 - .2 For joining stainless steel components use stainless steel fasteners of same type.
- .8 Structural bolts: to ASTM F3125/F3125M.
- .9 Stainless steel fasteners, washers and nuts: to ASTM F593, 18-8 austenitic stainless steel (Grade 8 - B8/B8A), sized as required for purpose intended, or as otherwise indicated. Cold finished: Condition B, cold worked, per ASTM A276/A276M.
- .10 Grout: non-shrink, non-metallic, non-corrosive flowable, 15 MPa at 24 hours.

2.2 FABRICATION

- .1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.
- .2 Use self-tapping shake-proof flat, round, or oval headed screws on items requiring assembly by screws or as indicated.
- .3 Where possible, fit and shop assemble work, ready for erection.
- .4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush. Seal exterior steel fabrications to provide corrosion protection in accordance with CSA S16.
- .5 Welding is to conform to CSA W59 and the fabricator certified to CSA W47.1. Include for welding inspection in the Contract.
- .6 File or grind all exposed welds smooth and flush. Repair or fill all pits, cracks and holes. Grind and polish all handrails to a smooth, even surface. Smooth all inside corners, returns.
- .7 Insulate when necessary to prevent electrolysis due to metal to metal contact or metal to masonry or concrete contact. Use bituminous paint or other approved method.
- .8 Provide fastenings, including anchor bolts, bolts, lag screws, expansion bolts, straps, brackets, etc. required for the fabrication and erection of work of this Section.

2.3 FINISHES

- .1 Provide LEED compliant coatings for VOC ratings.
- .2 Prior to priming steel, prepare all surfaces in conformance with SSPC SP-3 – Power Tool Cleaning for non-exposed locations and any overhead steel not subject to contact, SSPC SP-5 – White-metal Blast Cleaning for exposed

architectural finished locations, and SSPC SP7- Brush of Blast Cleaning for hand and guard rails. Adjust blast grit to suit primer coat thickness specified in Section 09 91 00 – Painting.

- .3 Hot dip galvanizing: galvanize steel, where indicated, to ASTM A123/A123M, minimum zinc coating of 600 g/m². (Severe, unprotected exposures).
- .4 Electrolytic galvanizing: galvanize steel, where indicated, to ASTM A591/A591M, minimum zinc coating of 180 g/m². (Non-severe, unprotected exposures).
- .5 Wipe coat galvanizing: galvanize steel, where indicated to CSA G189, minimum zinc coating of 75 g/m². (Non-severe, protected exposures)
- .6 Shop Primers: Provide primers that are compatible with paint systems specified.
- .7 Touch up galvanized surfaces with zinc rich coating, to ASTM A780/A780M: NPFC-MIL-P-21035 zinc rich paint, minimum DFT 8 mils.
- .8 Zinc Rich Paint: Conforming to NPFC-MIL -P-21035 zinc rich paint.
 - .1 Clean metal to equivalent of commercial sand blast SSPC-SP6, remove sandblast in residue.
 - .2 Apply one coat of zinc rich paint to surfaces exposed after assembly to minimum dry film thickness of 60 µm (2.5 mil). Apply coating immediately after cleaning and over primer.
- .9 Isolation Coating: Apply an isolation coating to contact surfaces in contact with cementitious materials, wood materials and dissimilar metals except stainless steel.
- .10 Paint: Prepare the Work and paint in accordance with CSA-S16, primed ready for site finish as specified in Section 09 91 00 – Painting. Leave surfaces to be welded unpainted.

2.4 ROUGH HARDWARE

- .1 Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required. Fabricate items to sizes, shapes, and dimensions required.

2.5 MISCELLANEOUS FABRICATIONS

- .1 Miscellaneous Framing and Supports: Provide steel framing and supports for applications indicated that are not a part of structural steel framework, as required to complete work.
- .2 Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitred joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
- .3 Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.

- .4 Miscellaneous Steel Trim: Provide shapes and sizes indicated for profiles shown. Unless otherwise indicated, fabricate units from structural steel shapes, plates, and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings, and anchorages as required for coordination for assembly and installation with other work.

2.6 PIPE BOLLARDS

- .1 Fabricate pipe bollards from Schedule 40 steel pipe and as indicated on Drawings.
- .2 Concrete Fill: comply with requirements of Section 03 30 00 - Cast-in-Place Concrete.
- .3 Fabricate interior bolt down pipe bollards from 152 mm nominal outside diameter, Schedule 40 steel pipe.
- .4 Paint bollards after fabrication, colour as indicated on Drawings.
- .5 Provide dome top bollard covers for exterior bollards.
 - .1 Material: 3.2 mm thick high density polyethylene (HDPE).
 - .2 Colour: as indicated on Drawings.
 - .3 Acceptable Materials:
 - .1 Post Guard, Sure Guard.

2.7 GUARDRAIL AND POSTS

- .1 Fabricate guardrails from 3.43 mm thick 305 mm wide x 76 mm deep galvanized steel w-beam with post bolt slots at 3810 mm o.c. or as required by Manufacturer. Flare end sections and offset support blocks as required by Manufacturer.
- .2 Provide W150 x 14 posts galvanized steel and as indicated on Drawings.
- .3 Coordinate with Electrical to provide exterior receptacles for block heaters.
- .4 Basis of Design Materials:
 - .1 W-Beam Rail and Post and Offset Block, Ontario Bollards, Total Protection Specialists

Part 3 Execution

3.1 INSTALLATION

- .1 Install Work in accordance with manufacturer's/fabricator's written instructions and Contract Documents.
- .2 Do welding work in accordance with CSA W59 unless specified otherwise.
- .3 Supply finished items to be built in to those trades along with instructions for proper installation.
- .4 Apply architectural metal work using hidden mechanical fasteners. Installation shall be by skilled Architectural metal workers experienced in highest quality work.

- .5 Fasteners to draw adjoining sections together in proper, true alignment, and are capable of field adjustment.
- .6 All fasteners, mountings to be non-loosening and installed so that they will be hidden at completion.
- .7 Install all Work to true, straight lines, accurate to profile, all properly aligned.
- .8 Isolate dissimilar metals in a manner approved by the Consultant to prevent electrolytic action or corrosion.
- .9 Install finish hardware supplied under other Sections required for completion of components of this Section.
- .10 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .11 Provide suitable means of anchorage acceptable to Consultant such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .12 Make field connections with high tensile bolts to CSA-S16 and weld to prevent loosening.
- .13 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .14 Touch-up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection with primer.
- .15 Repair galvanized areas damaged by welding, flame cutting or during handling, transport or erection in accordance with ASTM A780/A780M. Touch-up with organic zinc-rich paint to NPFC-MIL-P-21035 zinc rich paint, minimum DFT 8 mils.

3.2 PIPE BOLLARDS

- .1 Anchor exterior bollards in place with concrete footings. Support and brace bollards in position in footing excavations until concrete has been placed and cured.
- .2 Fill bollards solidly with concrete, mounding top surface.
- .3 Install bollard covers on exterior bollards.
- .4 Anchor interior bollards in place with bolt anchors.

3.3 GUARDRAILS AND POSTS

- .1 Install guardrails and posts as indicated on Drawings.
- .2 Set posts in concrete as indicated on Drawings.

3.4 MISCELLANEOUS ITEMS

- .1 Provide steel angle frame, hanging rods and bracing for supporting bulkheads and shelving.
- .2 Provide bracket backing supports for vanities.
- .3 Steel angle masonry supports as detailed.

- .4 Supply and install miscellaneous metal items as indicated or specified, or as otherwise required for a complete job, in accordance with the design intent of the project.

3.5 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section Includes the following:
 - .1 Handrails and railings attached to metal stairs.
- .2 Related Requirements:
 - .1 Section 01 35 00 – Delegated Design
 - .2 Section 03 30 00 – Cast-in-Place Concrete
 - .3 Section 05 50 00 – Metal Fabrications
 - .4 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American National Standard Institute (ANSI) / American Ladder Institute (ALI):
 - .1 ALI A14.3-2018, American National Standard (ASC) for Ladders-Fixed-Safety Requirements.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A53/A53M-22, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A185/A185M-07, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete. (Withdrawn 2013)
 - .3 ASTM A276/A276M-24, Standard Specification Stainless Steel Bars and Shapes.
 - .4 ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .5 ASTM A312/A312M-22a, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - .6 ASTM A480/A480M-23b, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
 - .7 ASTM A500/A500M-23, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - .8 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .9 ASTM A780/A780M-20, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - .10 ASTM B209/B209M -21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .11 ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

- .12 ASTM B221M-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- .13 ASTM B241/B241M-22, Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
- .14 ASTM E935 -21, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
- .15 ASTM E985 -00(2006): Standard Specification for Permanent Metal Railing Systems and Rails for Buildings (Withdrawn 2015).
- .16 ASTM F3125/F3125M-23, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 105 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
- .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian Standards Association (CSA Group):
 - .1 CSA-A3000:23, Cementitious Materials Compendium.
 - .2 CSA-G40.20-13/G40.21-13 (R2023), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel, Includes Update No. 1 (2014).
 - .3 CSA-G164-18 (R2023), Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No.1 (2020).
 - .4 CSA W47.1:19, Certification of companies for fusion welding of steel.
 - .5 CSA W48 Series
 - .6 CSA W59-18 (R2023), Welded Steel Construction, Includes Errata (2020).
- .5 National Association of Architectural Metal Manufacturers (NAAMM):
 - .1 NAAMM AMP 500-06, Metal Finishes Manual.
 - .2 NAAMM AMP 510-92, Metal Stair Manual.
 - .3 NAAMM AMP 521-01(R2012), Pipe Railing Manual.
 - .4 NAAMM MBG 531-09, Metal Bar Grating Manual.
 - .5 NAAMM MBG 533-09, Welding Standards for Fabrication of Steel, Stainless Steel and Aluminum Bar Grating.
- .6 Naval Publications and Form Center (NPFC):
 - .1 NPFC-MIL-P-21035, Paint High Zinc Dust Content, Galvanizing Repair (Metric) (2012).
- .7 Process Industry Practices: PIP STF05501, Fixed Ladders and Cage Fabrication Details
- .8 Steel Structures Painting Council (SSPC):
 - .1 Systems and Specifications Manual, Volume 2 (2021).
- .2 Definitions:
 - .1 Usage Classifications: NAAMM AMP 510 provides four usage classifications for finishing of metal stair and railing systems as follows:

- .1 Industrial Class: NAAMM Industrial Class stairs are purely functional in character, design for interior or exterior locations for industrial or fire escape applications, primarily for use by building occupants only; not including stairs integral with industrial equipment.
- .2 Service Class: NAAMM Service Class stairs are intended for use in enclosed stairways and to provide a secondary or emergency means of travel between floors or levels in a multi-storey building, primarily for use by building occupants, tenants and the public.
- .3 Commercial Class: NAAMM Commercial Class stairs are intended for use in enclosed stairways to provide primary means of travel between floors or levels in a multi-storey institutional or commercial building where appearance and finish are important considerations.
- .4 Architectural Class: NAAMM Architectural Class stairs are intended to serve as an architectural feature and can be located in either an open area or in an enclosed stairway in an institutional or commercial building where appearance and finish are of prime importance.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
 - .2 Provide electronic copy of WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada and indicate VOC content for:
 - .1 Finishes, coatings, primers and paints.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate finishes, accessories, construction details, profiles, sizes of steel sections and thickness of steel sheet.
 - .2 Indicate fasteners, welds and connection details between stringers; treads; risers; headers; newels; platforms; struts, columns and hangers; railings; handrails; brackets; reinforcements; anchors; and welded and bolted connections.
 - .3 Drawings to include plans, sections, elevations and dimensions.

- .3 Delegated design submittals: Submit shop drawing and submittals bearing stamp and signature of a qualified professional engineer registered in Province of the Work.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Use a fabricator experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
 - .2 Welders shall be qualified by Canadian Welding Bureau for classification of Work being performed.
 - .3 Welding of load supporting components shall be performed by companies certified by Canadian Welding Bureau in accordance with CSA W47.1.
- .2 Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
- .3 Retain a Professional Engineer, registered in the Province of the work, for the design, fabrication, and erection of the work of this Section in accordance with applicable Building Code and Contract Documents requirements including, but not limited to, the following:
 - .1 Seal and signature to shop drawings and design submittals.
 - .2 Field review of installed components.
 - .3 Completion of Letters of Commitment and Supervision specified in Section 01 35 00 - Delegated Design.
- .4 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Store materials in a location and manner to avoid damage; stack materials to prevent bending or applying stress to components; keep handling of materials on-site to a minimum.
- .2 Store components and materials in clean, dry location, away from uncured concrete or masonry; cover with waterproof paper, tarpaulin or polyethylene sheeting in a manner that permits air circulation inside of covering.
- .3 Correct damaged material and where damage is deemed irreparable by the Owner, replace the affected item at no additional expense to the Owner.
- .4 Apply protective covering to face of all exposed finished metalwork before it leaves shop, covering to remain until item installed and ready for final finishing.
- .5 Fabricate large assemblies so they can be safely and easily transported and handled to their place of installation.
- .6 Packaging Waste Management

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 PERFORMANCE/DESIGN CRITERIA

- .1 Provide delegated design in accordance with Section 01 35 00 - Delegated Design.
- .2 Design Requirements:
 - .1 Design metal stair, balustrade and landing construction and connections in accordance with Building Code as indicated for vertical and horizontal live load requirements.
 - .2 Detail and fabricate stairs to NAAMM Metal Stairs Manual.
 - .3 Design grating treads in accordance with NAAMM Metal Bar Grating Manual.
 - .4 Design pipe railings in accordance with NAAMM Pipe Railing Manual.
 - .5 Perform work in accordance with ASTM E985, Permanent Metal Railing Systems and Rails for Buildings.

2.2 MATERIALS

- .1 Carbon Steel:
 - .1 Steel sections and plates: to CSA-G40.20/G40.21, Grade 300W.
 - .2 Hollow Structural Sections (HSS): In accordance with CSA G40.20/G40.21, Grade 350W, Class C.
 - .3 Steel plate: to CSA-G40.20/G40.21, Grade 300W.
 - .4 Metal bar grating: to NAAMM MBG 531, steel, Type W-19-4, with checkered plate nosings.
 - .5 Steel pipe: to ASTM A53/A53M, standard weight, schedule 40 seamless black.
 - .6 Steel tubing: to ASTM A500/A500M, 6 mm wall thickness, sizes and dimensions as indicated.
- .2 Welding materials: to CSA W59.
- .3 Welding electrodes: to CSA W48 Series.
- .4 Bolts: to ASTM A307.
- .5 High strength bolts: to ASTM F3125/F3125M.

2.3 PIPE/TUBING BALUSTRADES

- .1 Construct balusters and handrails from steel pipe and steel tubing as detailed on Drawings to commercial class as defined by NAAMM AMP 510.
- .2 Cap and weld exposed ends of balusters and handrails.
- .3 Provide texture change within the last 300 mm of the handrail in accordance with accessible guidelines.

- .4 Terminate at abutting wall with end flange.
- .5 Fabricate railings in accordance with NAAMM AMP 521 to finish as follows:
 - .1 Fabrication Tolerance: Fabricate steel to one half the normal tolerance as specified in the CISC/AISC Code of Standard Practice Section 10.
 - .2 Welds Ground Smooth: Fabricator shall grind welds of exposed steel smooth; make groove welds flush to the surfaces each side and be within +1.5 mm, -0 mm of plate thickness.
 - .3 Contour and blend of welds where fillet welds are ground contoured, or blended, oversize welds as required and grind to provide a smooth transition and to match profile on accepted sample.
 - .4 Continuous weld where noted of uniform size and profile.
 - .5 Minimize weld show through at locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
 - .6 Maintain a uniform gap of 3 mm \pm 0.8 mm at copes and blocks.
 - .7 Maintain a uniform gap tolerance of 3 mm \pm 0.8 mm at connections.
 - .8 Fabricate exposed steel so that piece marks are fully hidden in the final structure or made with media to permit full removal after erection.
 - .9 Deliver steel with no mill marks (stencilled, stamped, raised) in exposed locations; cut off mill material to appropriate lengths where possible; fill or grind to a surface finish consistent with the accepted sample where cutting is not possible.
 - .10 Grind edges of sheared, punched or flame-cut steel to match accepted sample.
 - .11 Rolled members shall be fully shaped in the shop and tied during shipping to prevent stress relieving; distortion of the web or stem, and of outstanding flanges or legs of angles will be visibly acceptable to the Consultant when viewed from a distance of 6100 mm under any lighting condition; tolerances for the vertical and horizontal walls of rectangular HSS members after rolling shall be \pm 13 mm.
 - .12 Seal weld open ends of round and rectangular hollow structural section with 10 mm closure plates; provide continuous, sealed welds at angle to gusset plate connections and similar locations where exposed steel is exposed to weather.
- .6 Fabricate work square, true straight and accurate to required size, with joints closely fitted and properly secured.
- .7 Where work of other Sections is attached to work of this section, prepare work by drilling and tapping holes as required facilitating installation of such work.

2.4 ACCESS LADDERS

- .1 Provide premanufactured ladder **or** manufacture on site as indicated.
- .2 Construct access ladders in accordance with local OH&S safety codes.
- .3 Roof Access Ship Ladder:
 - .1 Width: in accordance with Ontario Building Code
 - .2 Slope: as indicated on Drawings.

- .3 Rise: uniform risers in accordance with Ontario Building Code
- .4 Tread: minimum 100 mm wide with 20 mm overlap. At top landing form tread 100 mm wide, level with landing.
- .5 Construct with 2.78 mm minimum bent plate or steel channel stringers and grating treads, welded.
- .6 Rail Stanchions: 50 mm diameter HSS tube
- .7 Include 32 mm outside Ø pipe handrails both sides.
- .8 Rail Design; provide a single handrail on both sides of the ladder. The distance between rails, from center to center, to be not less than 540 mm. Stanchions supporting handrails should be positioned at right angles to stringers. The rail to be 250 mm above the pitch line for ladders of 65° slope and 100 mm above the pitch line for ladders of 75° slope. At the top of a ships ladder, handrails should widen out to a minimum width of 610 mm centre to centre clearances; The minimum clear space on the user side of a companion way ships ladder, measured at right angles to the strings, to be 1200 mm. The front edge of the first step down from platform level to be a minimum of 250 mm from any vertical wall or other obstruction.
- .9 Usage Classification: Service
- .10 Finish: Galvanized

2.5 FABRICATION

- .1 Fabricate stairs in accordance with NAAMM AMP 510.
- .2 Fabricate railings in accordance with NAAMM AMP 521.
- .3 Fabricate gratings to NAAMM MBG 531.
- .4 Weld connections where possible, otherwise bolt connections. Countersink exposed fastenings, cut off bolts flush with nuts. Make exposed connections of same material, colour and finish as base material on which they occur.
- .5 Accurately form connections with exposed faces flush; mitres and joints tight. Make risers of equal height.
- .6 Grind or file exposed welds and steel sections smooth.
- .7 Shop fabricate stairs in sections as large and complete as practicable.
- .8 Insulate dissimilar materials to prevent electrolysis arising from metal to metal contact or metal to masonry or concrete contact; use bituminous paint or other acceptable method acceptable to Consultant.

2.6 FINISHES

- .1 Provide LEED compliant coatings for VOC ratings.
- .2 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m² to CSA-G164.
- .3 Shop Primers: Provide primers that are compatible with paint systems specified.
- .4 Touch-up galvanized surfaces with zinc rich coating, to ASTM A780/A780M: NPFC-MIL-P-21035 zinc rich paint, minimum DFT 8 mils.
- .5 Painting: in accordance with Section 09 91 00 – Painting.

2.7 SHOP PAINTING

- .1 Clean surfaces in accordance with Steel Structures Painting Council Manual Volume 2.
- .2 Apply one coat of shop primer except interior surfaces of pans.
- .3 Apply two coats of primer of different colours to parts inaccessible after final assembly.
- .4 Use primer as prepared by manufacturer without thinning or adding admixtures. Paint on dry surfaces, free from rust, scale, and grease. Do not paint when temperature is below 7 degrees C.
- .5 Do not paint surfaces to be field welded.

2.8 ACCESSORIES

- .1 Sealant: in accordance with Section 07 92 00 – Sealants.

Part 3 Execution

3.1 PREPARATION

- .1 Provide anchorage devices and fasteners to other Sections where necessary for securing metal stairs to in place construction; include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- .2 Perform cutting, drilling, and fitting required for installing metal stairs.
- .3 Field check and verify that structural framing, enclosures, weld plates, blocking, and pocket sizes and locations are placed in accordance with reviewed shop drawings.
- .4 Report discrepancies to Contractor and Consultant, and recommend corrective action by responsible parties.
- .5 Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- .6 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates and instructions for installation.

3.2 INSTALLATION OF STAIRS

- .1 Install in accordance with NAAMM, Metal Stair Manual.
- .2 Install grating treads, stringers, landings, hanger assemblies, closures, balustrades, handrails, and guards, level, plumb, square, complete, accurately fitted, with tight joints and intersections, in the proper locations and positions, structurally sound, securely fastened, and free from detrimental defects. Weld connections between handrails and balusters and in lengths of handrails. Weld balustrades to steel stairs or steel plates as required. Secure wall handrails to walls.
- .3 Install plumb and true in exact locations, using welded connections wherever possible to provide rigid structure. Provide anchor bolts, bolts and plates for connecting stairs to structure.

- .4 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .5 Do welding work in accordance with CSA W59 unless specified otherwise.
- .6 Touch up shop primer to bolts, welds, and burned or scratched surfaces at completion of erection.
- .7 Repair damage to adjacent materials caused by metal stairs and ladders installation.

3.3 INSTALLATION OF GUARDRAILS, RAILING AND HANDRAILS

- .1 Install guardrails, railings, and handrails as indicated, including all sleeves, anchors and connections. Prepare steel, and shop prime exposed components. Field prime as required to maintain cover of exposed steel.
- .2 Install in accordance with NAAMM, Metal Stair Manual.
- .3 Adjust railings prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:
 - .1 Anchor posts in concrete by means of pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with non-shrink, non-metallic grout, mixed and placed to comply with anchoring material manufacturer's directions.
 - .2 Anchor posts and rail ends to steel with welded connections, unless otherwise indicated.
 - .3 Anchor posts and rail ends into concrete and masonry with steel round flanges welded to post and rail ends, and anchored into wall construction with expansion shields and bolts.
 - .4 Install removable railing sections where indicated in slip-fit metal sockets cast into concrete. Accurately locate sockets to match post spacing.
- .4 Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 50 mm clearance from inside face of handrail and finished wall surface. Locate brackets at spacing not less than 1.5 m o.c., unless otherwise indicated. Secure wall brackets and wall return fittings to building construction as follows:
 - .1 Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - .2 For concrete and solid masonry anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.
 - .3 For hollow masonry anchorage, fasten brackets directly on masonry wall using toggle bolts.
 - .4 For steel framed gypsum board assemblies, fasten brackets to wood blocking using lag bolts or to metal blocking using self-tapping screws, of size and type required to support structural loads.

- .5 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .6 Touch up shop primer to bolts, welds, and burned or scratched surfaces at completion of erection.

3.4 CLEANING

- .1 Perform cleaning as soon as possible after installation to remove construction and accumulated environmental dirt.
- .2 Remove protective coverings and clean metal work using cleaning solutions and methods to suit the metal and its finish at completion of work.
- .3 Protect adjacent materials and finishes from damage or discolouring during cleaning.
- .4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes:
 - .1 Rooftop equipment bases and support curbs.
 - .2 Wood blocking, cants, wall backing, and nailers.
 - .3 Wood furring and grounds.
 - .4 Sheathing.
 - .5 Plywood backing panels.
- .2 Related Requirements:
 - .1 Section 06 40 00 – Architectural Woodwork
 - .2 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .3 Section 07 52 00 – Modified Bituminous Membrane Roofing
 - .4 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .5 Section 07 92 00 – Sealants
 - .6 Section 09 91 00 – Painting
 - .7 Section 10 28 10 – Toilet and Bath Accessories

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME B18.2.1-2012 (R2021), Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Hea Hex, Lobed Head, and Lag Screws (Inch Series), Includes Errata (2013).
 - .2 ASME B18.6.1-1981 (R2016), Wood Screws (Inch Series).
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A153/A153M-23, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .2 ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
 - .3 ASTM A563/A563M-23, Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric).
 - .4 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
 - .5 ASTM B117-19, Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - .6 ASTM C954-22, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
 - .7 ASTM D1761-20, Standard Test Methods for Mechanical Fasteners in Wood and Wood-Based Materials.

- .8 ASTM D5055-19e1, Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists.
- .9 ASTM D5456-21e1, Standard Specification for Evaluation of Structural Composite Lumber Products.
- .10 ASTM E1333-22, Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber.
- .11 ASTM F1482-21, Standard Practice for Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring.
- .12 ASTM F1667/F1667M-21a, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- .3 American Wood Preservers Association (AWPA):
 - .1 AWPA Book of Standards, 2023.
 - .2 AWPA M2 Standard for the Care of Preservative-Treated Wood Products
- .4 California Air Resources Board (CARB):
 - .1 Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products (2007).
- .5 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .6 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-11.3-M87, Hardboard. (Withdrawn)
 - .2 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type. (Withdrawn)
 - .3 CAN-CGSB 71.26-M88, Adhesive for Field-Gluing Plywood to Lumber Framing for Floor Systems. (Withdrawn)
- .7 Canadian Hardwood Plywood and Veneer Association (CHPVA)
- .8 Canadian Standards Association (CSA Group):
 - .1 CAN/CSA A123.2-03 (R2023), Asphalt-Coated Roofing Sheets, Includes Update No. 1 (2006)
 - .2 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
 - .3 CSA-G164-18 (R2023), Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No 1 (2020).
 - .4 CAN/CSA O80 Series:21 – Wood Preservation, Includes Administrative Update (2022) and Errata (2022).
 - .5 CSA O112 Series-M1977 (R2006), CSA Standards for Wood Adhesives (Withdrawn).
 - .6 CSA O121-17 (R2022), Douglas Fir Plywood.
 - .7 CSA O141:23, Canadian Standard Lumber.
 - .8 CSA O151-17 (R2022), Canadian Softwood Plywood.
 - .9 CSA O153:19, Poplar Plywood.
 - .10 CSA-O325:21, Construction Sheathing (Adopted NIST PS 2-18, with Canadian deviations). Includes Administrative Update (2021).

- .11 CSA O437 Series-93(R2011), Standards on OSB and Waferboard (Withdrawn).
- .12 CSA T530-99, Commercial Building Standard for Telecommunications Pathways and Spaces. (Adopted ANSI/TIA/EIA-569-A)
- .9 Forest Stewardship Council (FSC):
 - .1 FSC-STD-01-001-V5-2 EN, 2015 FSC Principle and Criteria for Forest Stewardship.
 - .2 FSC-STD-20-002-V3-0, 2009, Structure, Content and Local Adaption of Generic Forest Stewardship Standards.
 - .3 FSC Accredited Certified Bodies.
- .10 National Lumber Grades Authority (NLGA):
 - .1 NLGA SPS 2-2019, Special Products Standards on Machine Graded Lumber.
 - .2 Standard Grading Rules for Canadian Lumber 2017.
- .11 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.
 - .2 SCAQMD Rule 1168-22, Adhesive and Sealant Applications.
- .12 Sustainable Forestry Initiative (SFI) & Forest Implementation:
- .13 Underwriters' Laboratories of Canada (ULC):
 - .1 ULC 102.2, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies. (ULC S102.2)
- .14 Western Red Cedar Lumber Association (WRCLA)

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
 - .2 Submit SDS sheets or official manufacturer literature stating no urea-formaldehyde was used in the manufacturing of composite wood.
- .2 Product Data:
 - .1 Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit 100 mm x 300 mm samples of cedar to receive finish, to the Consultant for review.
- .4 Material Certificates:
 - .1 For dimensional lumber specified to comply with minimum allowable unit stresses, indicate species, grade, and design values for each use.

- .2 For exposed items, omit grade stamp and provide certificates as to species, grade, stress grade, seasoning, moisture content, and other evidence as required to show compliance with the specifications.
- .5 Site Quality Control Submittals: Prior to covering exterior sheathing and shear walls, request structural engineer to review nailing patterns and provide confirmation report to Consultant.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.4 QUALITY ASSURANCE

- .1 Lumber shall be graded and stamped by an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood, particleboard, OSB and wood based composite panels in accordance with CSA and ANSI standards.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver wood products bundled or crated to provide adequate protection during transit. Inspect wood products for damage upon delivery and remove and replace damaged materials.
- .2 Store materials a minimum of 150 mm off the ground on blocking. Keep materials under cover and dry. Provide for air circulation within and around stacks and under temporary coverings.
- .3 Protect sheet materials to prevent breaking of corners and damage to surfaces.
- .4 Packaging Waste Management
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 MATERIALS

- .1 Materials of this section are to be Forest Stewardship Council or SFI graded wood.

2.2 PANEL MATERIALS

- .1 Sheathing
 - .1 Fire Rated Plywood Panels to CSA O325, FSC Certified, Class A fire retardant produced under Performance Standard PS-1, certified by the American Plywood Association.
 - .1 Basis-of-Design Materials:
 - .1 Purekor Fire Retardant Plywood.
 - .2 Plywood panels to CSA O325, thickness as indicated on drawings.
 - .3 Interior sheathing shall be ULC labelled fire resistant, provide grade stamp or certification as noted for fire retardant pressure treated lumber.

- .2 Pressure Preservative Treated Plywood:
 - .1 Plywood Grade: exterior grade sheathing.
 - .2 Treatment: In accordance with CAN/CSA O80 Series.
 - .3 Product: amine copper quat (ACQ) or copper Azole (CA).
 - .4 Retention:
 - .1 Above ground application: minimum of 4.0 kg/m³.
 - .2 Ground Contact Application: minimum of 6.4 kg/m³
 - .5 Water-borne preservative treated wood shall have maximum moisture content of 19% after treatment.

2.3 CEDAR

- .1 Cedar: Western Red Cedar graded to meet NLGA Grading Standards, paragraph 200 and WRCLA.
 - .1 Grade: A clear and better (NLGA paragraph 200b).
 - .2 Size (Nominal): 51 x 76 mm
 - .3 Pattern: S4S Square Edges
 - .4 Moisture Content: kiln dried
 - .5 Exposed surfaces: smooth face
 - .6 Finish: Water repellent, fungus and mildew resistant, resistant to ultraviolet (UV) light and as follows:
 - .1 Miniwax 350 VOC Helmsman, Satin Spar Urethane.
- .2 Moisture Content: kiln dried to less than 15% moisture content, confirm moisture content and provide testing results to Consultant prior to application.

2.4 MISCELLANEOUS LUMBER

- .1 Provide lumber for support or attachment of other construction, including furring, strapping, blocking, nailing strips, ground, rough bucks, cants, curbs, fascia, backing sleepers, and similar members.
- .2 Select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work for blocking and nailers.
- .3 Fabricate miscellaneous lumber from dimension lumber of sizes indicated, and into shapes shown on drawings.
- .4 Moisture Content: 19% maximum for lumber items not specified to receive wood preservative treatment.
- .5 Grade: for dimension lumber sizes provide No. 2 or Standard grade lumber per NLGA. For board-sized lumber, provide sheathing grade, S2S.
- .6 Kiln dry lumber materials to 8% moisture content or less.

2.5 WOOD PRESERVATIVE

- .1 Where lumber or plywood is indicated as preservative treated or is specified to be treated, treated in accordance with CAN/CSA O80.9M and AWWA.
- .2 Wood preservatives containing arsenic or chromium are not permitted.

- .3 Pressure treat above ground items with waterborne preservatives to minimum retention of 4.0 kg/m³. After treatment, kiln-dry lumber and plywood to maximum moisture content of 19% and 15% respectively. Treat indicated items and the following:
 - .1 Wood cants, nailing strips, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapour barriers, and waterproofing.
 - .2 Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry and concrete.
 - .3 Wood framing members less than 460 mm above grade.
 - .4 Wood floor plates installed over concrete slabs directly in contact with earth.
- .4 Pressure treat wood members in contact with ground or freshwater with waterborne preservatives to minimum of 6.4kg/m³
- .5 Fire-Retardant Treatment: to CAN/CSA O80.9M, CAN/CSA O80.20M and CAN/CSA O80.27M, pressure impregnated, and as follows:
 - .1 Flame Spread Classification: FSC 25 maximum.
 - .2 Smoke developed of not more than: 75.
- .6 Complete fabrication of treated items before treatment where possible. If cut after treatment apply field treatment to cut surfaces.
- .7 Wood Preservatives: Maximum allowable VOC limit 350 g/L in accordance with SCAQMD Rule #1113 - Architectural Coatings.

2.6 FASTENERS

- .1 Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Where rough carpentry is exposed to weather (during or after construction), in ground contact, pressure preservative treated, or in area of high relative humidity, provide fasteners with hot dip zinc coating complying with ASTM A153 or of Type 304 stainless steel.
- .2 Nails, spikes and staples: to CSA B111, hot dipped galvanized for exterior work and pressure preservative and fire retardant treated materials. Provide stainless steel fasteners to ASTM F1667, No. 316 for cedar lumber.
- .3 Power Driven Fasteners: Fasteners with a CCMC or ICC-ES evaluation report acceptable to authorities having jurisdiction.
- .4 Nailing discs: flat caps, minimum 25 mm diameter, minimum 0.4 mm thick, sheet metal or fibre, formed to prevent dishing. Bell or cup shapes not acceptable.
- .5 Through Bolts and Anchor Bolts: ASTM A307, Grade A; with ASTM A563 hex nuts and where indicated flat washers, hot dip galvanized to ASTM A153.
- .6 Wood Screws: ASME B18.6.1 or as specified on Drawings.
- .7 Lag Screws: ASME B18.2.1
 - .1 All lag screws to be machined threaded, not cast threaded.
 - .2 Pre-drilled hole sized in wood members for lag screws to be in accordance with CSA O86.

- .3 Lag screws are acceptable only where specifically indicated on the Drawings. Do not substitute lag screws for self-tapping wood screws.

2.7 FASTENER FINISHES

- .1 Galvanizing: to CSA-G164, use galvanized fasteners for exterior work, interior highly humid areas, pressure-preservative, and fire-retardant treated lumber.

2.8 ACCESSORIES

- .1 Sealants: in accordance with Section 07 92 00 – Sealants.
 - .1 Maximum allowable VOC limit 250 g/L in accordance with SCAQMD Rule 1168.
- .2 General purpose adhesive: to CSA O112 Series.
 - .1 Maximum allowable VOC limit 70 g/L in accordance with SCAQMD Rule 1168.
- .3 Surface Applied Wood Preservative:
 - .1 Containing minimum 19.6% Disodium octaborate tetrahydrate and 1.0% dodecyl dimethyl ammonium chloride in propylene glycol and water in accordance with CAN/CSA-O80.
 - .2 Apply minimum of two coats applied in accordance with manufacturers written instructions.
 - .3 Basis-of-Design Materials:
 - .1 Boracol 20-2BD, Sasco Products Ltd.
- .4 Insulating strip: rubberized, moisture resistant, 3 mm thick cork or closed cell neoprene strip, 12 mm wide, with self sticking permanent adhesive on one face, lengths as required.
- .5 Rough Hardware (bolts, nuts, washers, etc.): Hot dip galvanized in conformity to CSA G164 or Grade A low carbon steel, conforming to ASTM A307.
- .6 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer.
- .7 Expanding foam sealant:
 - .1 Acceptable Materials:
 - .1 GREAT STUFF PRO™, Dow Canada
 - .2 Hilti (Canada) Ltd. CF Filler Foams.
 - .3 Froth Pak, DuPont

Part 3 Execution

3.1 INSTALLATION

- .1 Comply with requirements of Building Code supplemented by following paragraphs.
- .2 Install members true to line, levels and elevations, square and plumb.

- .3 Construct continuous members from pieces of longest practical length.
- .4 Do not splice structural members between supports unless noted otherwise.
- .5 Install spanning members with "crown-edge" up.
- .6 Select exposed framing for appearance. Install lumber and panel materials so that grade-marks and other defacing marks are concealed or are removed by sanding where materials are left exposed.
- .7 Install blocking at locations indicated to support washroom accessories.
- .8 Install wall sheathing in accordance with manufacturer's printed instructions.
- .9 Install blocking, plates and backing for all components mounted on gypsum board walls, ceilings, and bulkheads requiring support.
 - .1 Components include, but not limited to: architectural woodworking components, door frames and hardware, windows, displays, lockers, handrails, mirrors, white boards and tack boards, washroom partitions and accessories, boot racks, curtains, interior signage, window treatments, manufactured specialties, mechanical and electrical devices, and items indicated as N.I.C. and requiring support.
 - .2 Center supporting members on fastening line of supported component.
 - .3 Supporting members to extend one stud spacing to each side of the supported component.
- .10 Install furring to support siding applied vertically where there is no blocking and where sheathing is not suitable for direct nailing.
 - .1 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .11 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- .12 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized steel fasteners.
- .13 Install sleepers as indicated.
- .14 Use dust collectors and high quality respirator masks when cutting or sanding wood panels.
- .15 Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- .16 Comply with AWPA M4 and revisions specified in CSA O80 Series, supplementary requirements to AWPA M2 for applying field treatment to cut surfaces of preservative-treated lumber.

3.2 POWER, TELECOMMUNICATIONS AND DATA PANEL BOARDS

- .1 Install 19 mm fire rated fir plywood boards on all walls in telephone and data rooms receiving wiring and equipment; minimum 1220 mm x 2440 mm panels on periphery walls over 300 mm wide, mounted 150 mm off of finished floor.

3.3 ERECTION

- .1 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .2 Countersink bolts where necessary to provide clearance for other work.
- .3 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section Includes:
 - .1 Shop manufactured architectural woodwork in accordance with Architectural Woodwork Standards (NAAWS).
 - .2 Cabinet hardware.
- .2 Related Requirements:
 - .1 Section 05 50 00 – Metal Fabrications
 - .2 Section 06 10 00 – Rough Carpentry
 - .3 Section 07 92 00 – Sealants
 - .4 Section 09 21 16 – Gypsum Board Assemblies
 - .5 Section 09 65 00 – Resilient Flooring
 - .6 Section 09 91 00 – Painting
 - .7 Section 09 99 99 – Material List
 - .8 Section 10 28 10 – Toilet and Bath Accessories
 - .9 Division 22 – Plumbing and Drainage Sections
 - .10 Division 26 – Electrical
 - .11 Division 27 – Communications
 - .12 Division 28 – Electronic Safety and Security

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American National Standards Institute (ANSI):
 - .1 NPA A208.1-2009, Particleboard.
 - .2 NPA A208.2-2009, Medium Density Fiberboard (MDF) for Interior Applications.
 - .3 ANSI/NEMA LD 3-2005, High-Pressure Decorative Laminates. (HPDL).
 - .4 ANSI/HPVA HP-1-2020, Standard for Hardwood and Decorative Plywood.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A240/A240M-23a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM A480/A480M-23b, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - .3 ASTM A666-23, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - .4 ASTM C615/C615M-23, Standard Specification for Granite Dimension Stone.

- .5 ASTM D1037-12(2020), Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
- .6 ASTM D2555–17a, Standard Practice for Establishing Clear Wood Strength Values.
- .7 ASTM D2559–12a (R2018) Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions.
- .8 ASTM D2832-92(2016), Standard Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.
- .9 ASTM D3574-17, Standard Test Methods for Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams.
- .10 ASTM D3930–08(2023), Standard Specification for Adhesives for Wood-Based Materials for Construction of Manufactured Homes.
- .11 ASTM D4300-23, Standard Test Methods for Ability of Adhesive Films to Support or Resist the Growth of Fungi.
- .12 ASTM D5116-17, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
- .13 ASTM D5672/D5672M-22, Standard Test Method for Testing Flexible Cellular Materials Measurement of Indentation Force Deflection Using a 25-mm (1-in.) Deflection Technique.
- .14 ASTM E1333-22, Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber.
- .3 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI):
 - .1 North American Architectural Woodwork Standards (NAAWS), Most Recent Edition.
- .4 California Air Resources Board (CARB):
 - .1 Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products (2007).
- .5 Canada Green Building Council (CaGBC)
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .6 Canadian Hardwood Plywood and Veneer Association (CHPVA)
- .7 Canadian Standards Association (CSA Group):
 - .1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
 - .2 CAN/CSA O80 Series:21 – Wood Preservation, Includes Administrative Update (2022) and Errata (2022).
 - .3 CSA O112.9:21, Evaluation of Adhesives for Structural Wood Products (Exterior Exposure), Includes Administrative Update (2022).
 - .4 CSA O112.10-08 (R2022), Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure), Includes Update No. 1 (2010), Update No. 2 (2010).
 - .5 CSA O115-M1982 (R2001), Hardwood and Decorative Plywood.

- .6 CSA O121-17 (R2022), Douglas Fir Plywood.
- .7 CSA O141:23, Canadian Standard Lumber.
- .8 CSA O151-17 (R2022), Canadian Softwood Plywood.
- .9 CSA O153:19, Poplar Plywood.
- .8 Forest Stewardship Council (FSC):
 - .1 FSC-STD-40-005 (Version 3-1 EN), Requirements for Sourcing FSC Controlled Wood.
- .9 International Organization for Standardization (ISO):
 - .1 ISO 4586 Series:2018 - High-pressure decorative laminates (HPL, HPDL) - Sheets based on thermosetting resins (usually called laminates).
 - .2 ISO 14040:2006, Environmental Management-Life Cycle Assessment - Principles and Framework.
 - .3 ISO 14041:1998, Environmental Management-Life Cycle Assessment - Goal and Scope Definition and Inventory Analysis.
- .10 National Hardwood Lumber Association (NHLA):
 - .1 Rules for the Measurement and Inspection of Hardwood and Cypress 2019.
- .11 National Lumber Grades Authority (NLGA):
 - .1 Standard Grading Rules for Canadian Lumber 2017.
- .12 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.
 - .2 SCAQMD Rule 1168-22, Adhesive and Sealant Applications.
- .13 Sustainable Forestry Initiative (SFI) & Forest Implementation:
- .14 Underwriters Laboratories of Canada (ULC):
 - .1 ULC 102, Standard Method for Surface Burning Characteristics of Building Materials and Assemblies (ULC S102).
- .2 Definitions:
 - .1 Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including visible surfaces in open cabinets or behind glass doors, and interior faces of doors and drawer fronts, bottom of upper cabinets when 1220 mm or more above finished floor, sides of all modular components regardless of their position in the assembled casework, and any surface visible from above.
 - .2 Semi-exposed Surfaces of Casework: Surfaces behind opaque doors or drawer fronts, including interiors and sides of drawers and bottoms of wall mounted casework, horizontal surface of toe set back.
 - .3 Concealed Surfaces of Casework: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, bottoms of drawers, and ends of cabinets installed directly against and completely concealed by walls or other cabinets; tops of wall cabinets and utility cabinets.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Show location of each item, dimensioned plans and elevations, large scale details, attachment devices, and other components.
 - .2 Show details of construction, profiles, jointing, fastening and other related details.
 - .3 Provide seaming diagram for solid surface finishes.
 - .4 Show materials, thicknesses, finishes and hardware.
 - .5 Show locations and sizes of cut-outs and holes for plumbing fixtures and other items installed in architectural woodwork.
- .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit two finished samples, 610 mm x 610 mm of each finish to be applied at the factory, to the Consultant for approval. Where materials are being matched, verify that specified materials match existing prior to submitting samples.
 - .2 Alternative cabinet hardware from that specified shall be submitted to the Consultant for approval.
 - .3 Reviewed samples shall become the standard for the work.
- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Project Record Sheet: Submit to the Consultant two copies of the project record sheet identifying the project title and address, Owner, Consultant, and Architectural Woodwork Subcontractor. Indicate materials and finishes used for architectural woodwork and whether shop finished, or site finished and by whom. Include type and source of all cabinet hardware and any special items used under architectural woodwork.
- .2 Submit in accordance with Section 01 78 00 – Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Architectural Woodwork Standards (NAAWS) and Errata shall be used to establish the minimum level of quality for this project.
- .1 Wood used as part of this work shall be FSC (Forest Stewardship Council) certified or SFI certified.
- .2 Execute the work of this Section by a member of AWMAC with five years' experience in work of comparable complexity and scope.
- .3 Any reference to Custom or Premium grade in this specification shall be as defined in the NAAWS.
- .4 Any item not given a specific quality grade shall be Custom grade as defined in the NAAWS.

- .5 A copy of the NAAWS shall be made readily available for reference purposes on the job site.
- .6 References in this specification to part and item numbers mean those parts and items contained within the NAAWS.
- .7 Perform the Work in accordance with the definition of 'Good Workmanship' as defined in the NAAWS.
- .8 Remove and replace finish carpentry Work which does not conform to the NAAWS.
- .9 Guarantee and Inspection Service (GIS)
 - .1 Architectural woodwork shall be manufactured and/or installed to the current AWMAC Architectural Woodwork Standards and shall be subject to an inspection at the factory and/or site by an appointed AWMAC Certified Inspector. Inspection costs shall be included in the tender price for this project. (Contact your local AWMAC Chapter for details of inspection costs). Shop drawings shall be submitted to the AWMAC Chapter office for review before work commences. Work that does not meet the AWMAC Architectural Woodwork Standards, as specified, shall be replaced, reworked and/or refinished by the architectural woodwork contractor, to the approval of AWMAC, at no additional cost to the owner.
 - .2 If the woodwork contractor is an AWMAC Manufacturer member in good standing, a two year AWMAC Guarantee Certificate will be issued. The AWMAC Guarantee shall cover replacing, reworking and/or refinishing deficient architectural woodwork due to faulty workmanship or defective materials supplied and/or installed by the woodwork contractor, which may appear during a two year period following the date of issuance.
 - .3 If the woodwork contractor is not an AWMAC Manufacturer member they shall provide the owner with a two year maintenance bond, in lieu of the AWMAC Guarantee Certificate, to the full value of the architectural woodwork contract.
 - .4 For more information about AWMAC and the GIS Program visit the AWMAC website at www.awmac.com and contact the Ontario AWMAC Chapter office.
- .10 Materials and installation shall be in metric measurements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with the NAAWS. Control the temperature and humidity in accordance with NAAWS recommendations, before, during, and after delivery, during storage, and during and after installation as required.
- .2 Provide protective coverings of suitable material for plastic laminate items, taking special precautions to protect corners.
- .3 Do not permit delivery of millwork to the site until the area is sufficiently dry so that woodwork shall not be damaged by excessive changes in ambient humidity.
- .4 Packaging Waste Management

- .1 Separate waste materials for recycling in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Comply with the NAAWS requirements for care and storage for optimum temperature and humidity conditions. Maintain a minimum 430 lx (40 f.c.) illumination on surfaces and areas where work is being installed.
- .2 Where work is indicated to be fitted to other construction, check dimensions of other construction by field measurement before fabrication; show recorded field measurements on final Shop Drawings. Coordinate fabrication schedule with construction schedule and progress to avoid delay of Work.
- .3 Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication without field measurements. Coordinate other construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.8 WARRANTY

- .1 Provide manufacturer's standard ten year warranty for solid surfacing against defects in materials and workmanship; including material and labour to repair or replace defective materials.
- .2 Provide two year AWMAC GIS Guarantee or Maintenance Bond.

Part 2 Products

2.1 MATERIALS

- .1 Materials of this section are to be Forest Stewardship Council or SFI graded wood.
- .2 Basis-of-Design Materials: Materials and colours listed below form the Basis-of-Design materials for this project.
- .3 Materials other than named products Basis-of-Design materials may be acceptable to the Consultant; submit information in accordance with Section 01 62 00 – Product Options and Substitutions no later than seven days prior to bid closing date and as follows:
 - .1 Proposed alternates shall match colour range, texture and performance characteristics of named products, and shall not require a change to colour board for Project.
 - .2 Proposed alternates found acceptable by Consultant will be listed in an Addendum.
 - .3 The Consultant is not obliged to accept any materials presented for their review and does not need to provide reasons for rejection of proposed alternates.
- .4 Use clean stock only and comply with NAAWS for quality grades specified.
- .5 Furring, Blocking, Shims, and Hanging Strips: Fire retardant treated softwood, Softwood or hardwood lumber, kiln dried to less than 8% moisture content.

- .6 Panel Materials: Provide panel materials meeting requirements for moisture content and grades in accordance with NAAWS requirements and as specified below. Panel products must be manufactured with no added urea-formaldehyde.
- .7 Douglas fir sheathing, Grade B-B; exposure durability rating shall be 'EXTERIOR', and the glue used shall be a fully waterproof structural adhesive
- .8 European Multi-Ply Plywood: Grade B/BB, urea-formaldehyde free.
- .9 Poplar plywood: to CSA O153, utility interior moisture resistant type.
- .10 Medium Density Fibreboard (MDF): Meeting ASTM D1037 and ANSI A208.2, Premium Grade for interior use, minimum 700 kg/m³ density; formaldehyde emissions shall be 0.30 ppm or less per 0.424m²/m³ of room value.
 - .1 Forestry Stewardship Council (FSC) certified.
 - .2 Urea-formaldehyde free.
 - .3 Acceptable Materials for high moisture areas (e.g., bathrooms):
 - .1 Medex MDF, Roseburg.
 - .2 Flakeboard Premier Plus Moisture Resistant MDF, Flakeboard.
 - .4 Acceptable Materials for standard applications:
 - .1 Medite II MDF, Roseburg.
 - .2 Flakeboard Premier MDF, Flakeboard.
 - .5 Basis-of-Design Materials for thin paper laminates and thermally fused melamine:
 - .1 Flakeboard Premier Plus MDF, Flakeboard.
 - .6 Acceptable Materials for fire resistant core:
 - .1 Medite MDF FR, Roseburg.
 - .2 Flakeboard Premier MDF FR, Flakeboard.
- .11 Particleboard: to ANSI A208.1, Grade M-2 or better, minimum 720 kg/m³ density and Grade M-3, minimum 750 kg/m³ particleboard for countertops and shelves; clearly mark panels with grade mark in visible location; extruded particleboard having loose cores with voids will not be permitted; having no added urea formaldehyde.
 - .1 Acceptable Materials:
 - .1 Vesta Particleboard, Arauco.
 - .2 Purekor Platinum Particleboard, Panel Source International.
 - .3 Encore SDF Sustainable Particleboard, SierraPine Ltd.
- .12 Lumber:
 - .1 Softwood: to CSA O141, kiln dried to maximum moisture content of 12%, dressed 4 sides.
- .13 High Pressure Decorative Laminate (HPDL): to IST 4586-2 and ANSI/NEMA LD3; Grades and application in accordance with applicable NAAWS requirements and as follows:
 - .1 Constructed of multiple layers of phenolic resin-saturated kraft paper in combination with a layer of decorative melamine-saturated paper, all fused together under heat and pressure.

- .2 Horizontal General Purpose Grade (HGS): thickness of 1.2 mm \pm 0.12 mm, used on the following:
 - .1 Horizontal surfaces, unless specified otherwise.
- .3 Vertical General Purpose Grade (VGS): thickness of 0.7 mm \pm 0.10 mm, used on the following:
 - .1 Vertical surfaces, unless specified otherwise.
 - .2 Exposed portions of case bodies, including ends, divisions and bottoms.
 - .3 Exposed shelves.
 - .4 Casework Doors: exposed and semi-exposed surfaces.
 - .5 Drawer Faces: exposed and semi-exposed surfaces.
- .4 Liner Grade (CLS): thickness of 0.5 mm \pm 0.10 mm, used on the following:
 - .1 Semi-exposed shelves.
 - .2 Interior portions of case bodies.
 - .3 All surfaces of drawer boxes.
- .5 Laminate backer grade (BKL): thickness of 0.5 mm \pm 0.10 mm, used on the following:
 - .1 Concealed surface of casework backs.
 - .2 Concealed surfaces, unless specified otherwise.
- .6 Colour Basis-of-Design: As indicated in Section 09 99 99 – Material List
- .7 Acceptable Materials:
 - .1 Arborite.
 - .2 Formica.
 - .3 Lamin-Art.
 - .4 Nevamar.
 - .5 Pionite.
 - .6 Wilsonart.
- .14 Low Pressure Decorative Laminate: to ANSI/NEMA LD3, in accordance with applicable NAAWS requirements, and as follows:
 - .1 Melamine impregnated papers thermally fused under pressure.
 - .2 Thickness: 0.5 mm minimum.
 - .3 Wear Resistance: 400 cycles minimum.
 - .4 Colours: white or as indicated on Drawings.
- .15 Solid-Surfacing Material: Cast, nonporous, filled polymer, with through body colour meeting requirements of ANSI/NEMA LD 3, and having the following nominal properties:
 - .1 Thickness: as indicated on drawings.
 - .2 Surface Burning Characteristics: in accordance with CAN/ULC S102 and as follows:
 - .1 Flame Spread: Maximum 25.
 - .2 Smoke Developed: Maximum 25.

- .3 Food Zone Use: Pass Rating in accordance with NSF 51 Sanitation requirements.
- .4 Colour Basis-of-Design: As indicated in Section 09 99 99 – Material List
- .5 Acceptable Materials:
 - .1 Avonite, Avonite, Inc.
 - .2 Corian, Dupont Polymers.
 - .3 Everform, Formica Corporation.
 - .4 Wilsonart Solid Surface, Wilsonart International.
- .16 Edging:
 - .1 Edge type shall conform to NAAWS requirements.
 - .2 Solid, high impact, purified, colour-thru, acid resistant, PVC edging.
 - .1 3 mm edging at counter tops, drawers, doors, and splashes.
 - .2 1 mm edging at cabinet boxes, exposed shelving, and concealed shelving.
 - .3 All edges of door and drawer panels shall be finished the same as face and back (6 sides finished).
- .17 Adhesive:
 - .1 Decorative laminate: polyvinyl acetate or aliphatic resin in accordance with manufacturer's recommendation for curing under pressure for bonding to wood cores, water resistant type.
 - .2 Edge banding: Thermoplastic hot melt, synthetic resin suitable for applying thin veneer wood edge banding and film overlays.
 - .3 Solid surface adhesive: as recommended by manufacturer.
- .18 Sealant: in accordance with Section 07 92 00 – Sealants.

2.2 CABINET WORK

- .1 Work shall conform to applicable NAAWS requirements.
- .2 Apply edge banding to all four edges.
- .3 Door and Drawer Bumpers: Self-adhesive type approximately 6 mm diameter clear silicone bumpers for all cabinet work doors and drawer faces, two per door and drawer, placed at door top and bottom and drawer top.

2.3 CABINET FABRICATION

- .1 General
 - .1 Flush overlay cabinet doors and drawer fronts as detailed.
 - .2 Fabricate gables and edges meeting walls oversize to allow for scribing to fit on site.
 - .3 Use non-telegraphing grain plywood when laminate is the specified finish.
 - .4 Assemble Work with flush butt hairline corners and joints. Cut-outs for services to be done on site during installation. No hairline cracks will be allowed in the face area of cabinet work modules unless approved in writing by Consultant.

- .5 Carefully fit, cope or mitre and well glue-up Joints. There shall be no end wood visible on finished surfaces.
- .6 Set nail heads in finished surfaces. Countersink screws and bolts, except those detailed to be exposed, and fill holes with edge grain wood plugs to match colour and grain.
- .7 Ensure adjacent part of continuous work match in colour and pattern.
- .2 Construction
 - .1 Minimum core thicknesses as follows:
 - .1 Drawer bottoms, particleboard, 12 mm;
 - .2 Drawer sides and backs, particleboard, 12 mm;
 - .3 Drawer fronts, MDF, 19 mm;
 - .4 Doors, MDF, 19 mm;
 - .5 Lower case backs against walls, particleboard, 10 mm;
 - .6 Upper case backs against walls, particleboard, 10 mm;
 - .7 Shelves, fixed and adjustable, plywood, 19 mm;
 - .8 Counter top cores, Plywood with non-telegraphing grain, 19 mm with 38 mm edge, for wet areas, use plywood with type two adhesive and ensure that all cut-outs are sealed prior to installation of sinks, primer is not considered to be an appropriate sealer;
 - .9 Backsplashes at all locations: Poplar Veneer Plywood, 19 mm; use plywood with type two adhesive at wet areas,
 - .10 All other work Poplar Veneer Plywood, 19 mm.
 - .2 Glue, dowel, mortise, lock joint or dado all cabinet work and cabinet work. Do not use staples. Nailing and screws are acceptable. Do not surface nail or screw through countertops.
 - .3 Blocking, framing, web frames to be solid lumber.
 - .4 Cut and adapt all Work to receive hardware.
 - .1 Drill and prepare end gables for insert type shelf standards on gables.
 - .2 Install all finishing hardware and fittings in shop.
 - .3 Fittings which may be susceptible to damage during shipping and installation may be installed after millwork installed on site.

2.4 CABINET HARDWARE

- .1 Provide the following cabinet hardware, in quantity required, complete with all screws, bolts, washers for complete installation.
- .2 Non-Exposed Fasteners: fabricators choice consistent with quality level specified.
- .3 Exposed Fasteners: Architectural appearance, material, finish and fastener tool type as selected by Consultant; coordinate sample submittals before ordering materials.
- .4 Draw Bolt Fasteners: Mitre butt joint fastener, adjustable and requiring no special tools for installation, galvanized.

- .1 Acceptable Materials:
 - .1 Häfele Canada Inc.
 - .2 K&V 516, Knappe & Vogt Canada.
 - .3 BP5162G, Richelieu
- .5 Spacers: Rigid PVC to size and profile indicated.
- .6 Access Panel Connectors
 - .1 Basis-of-Design Materials:
 - .1 Type JCBA0101C2 complete with Tee-Nut 26112, Richelieu.
- .7 Furniture Levellers and Guides: Richelieu 9 mm Ø screw type glide 34 mm long x 28 mm pad Ø.
- .8 Pulls: Typical drawers and doors.
 - .1 Wire Pulls: chromed 4 mm thick stainless steel wire pulls with nominal 162 mm centres:
 - .1 Acceptable Materials:
 - .1 CBH.
 - .2 Häfele Canada Inc.
 - .3 BP10746140, Richelieu.
 - .4 Stanley.
- .9 Drawer Slides: Following list of drawer slides is provided to indicate general conformance requirements only; notify the Consultant where drawer width, height or intended use differs from that indicated in the general description and the requirements of the manufacturer:
 - .1 Light duty drawer slides: 34 kg capacity, ¾ extension and soft closers:
 - .1 Acceptable Materials:
 - .1 2132, Accuride.
 - .2 3611, Dynaslide.
 - .3 KA3432, Hettich Canada LP.
 - .4 8350, Knappe and Vogt.
 - .2 Medium duty drawer slides and high height drawers (≥150 mm, ≤305 mm): 41 kg capacity, full extension and soft closers:
 - .1 Acceptable Materials:
 - .1 3834, Accuride.
 - .2 Dynapro, Grass.
 - .3 KA5632, Hettich Canada LP.
 - .4 8400, Knappe & Vogt.
- .10 Hinges:
 - .1 Typical Cabinet Doors: Concealed, euro-style hinge with cover caps; fully adjustable for overlay, depth, height and closing force; opening angle of 110°; self-closing feature; nickel plated steel construction; overlay and half overlay mounting, and soft closers, size and profile to suit cabinet construction:

- .1 Acceptable Materials:
 - .1 CLIP top Series, Blum Canada Ltd.
 - .2 Tiomos, GRASS Canada.
 - .3 Salice 700 Series, Häfele Canada Inc.
 - .4 Sensys, Hettich Canada LP.
- .11 Shelf Rests:
 - .1 Stainless steel pin rests: 7 mm Ø socket collar inserts for steel pin shelf supports, drill holes in cabinet work to accept collar, chrome or nickel finish:
 - .1 Acceptable Materials:
 - .1 Series 331/325 grommet, Knappe & Vogt Canada.
 - .2 5829-180/2292-180, Richelieu.
- .12 Miscellaneous Items:
 - .1 Smoker's Pole: fire-safe, weather resistant powder coated aluminum.
 - .1 Basis-of-Design Material:
 - .1 H-2458BL, Rubbermaid, Uline.ca

2.5 FACTORY FINISHING – CABINET WORK

- .1 Cabinet work for High Pressure Decorative Laminate Finish:
 - .1 NAAWS Quality Grade Custom.
 - .2 Construction: Cabinet work shall conform to applicable sections of the NAAWS.
 - .3 Exposed Parts and interior of cabinet doors: High pressure decorative laminate, substrate as indicated.
 - .4 Semi-Exposed Parts: Low pressure decorative laminate, substrate as specified above.
 - .5 Concealed parts: Low pressure decorative laminate backer to balance face materials.
 - .6 Backprime concealed surfaces after installation as follows:
 - .1 Surfaces in contact with concrete, masonry, floors or floor finishes.
 - .2 Underside of window stools.
 - .3 Underside of front edges of countertops and toe-spaces.
 - .4 Other surfaces that may be subjected to moisture during use or cleaning.

Part 3 Execution

3.1 EXAMINATION

- .1 Site Conditions for installation of architectural woodwork shall be in accordance with applicable NAAWS requirements.

- .2 Verify condition and dimensions of previously installed work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 PREPARATION

- .1 Obtain measurements from site.
- .2 Check access to ensure large pieces of work can be safely handled to their place of final installation.
- .3 Verify that solid blocking for support and anchoring of woodwork is installed where required. Confirm exact height and location with Drawings and Consultant.
- .4 Protect finished surfaces and materials of other trades from damage.
- .5 Ensure services and roughing-in which affect or are connected to or through this work are complete and acceptable.
- .6 Back prime cabinet work immediately after delivery to site.

3.3 INSTALLATION

- .1 Install work to applicable NAAWS and Quality Assurance requirements.
- .2 Install cabinet work in its indicated locations, plumb, level, and true.
- .3 Anchor to floor, walls, blocking, or ceiling using fastening devices and hardware consistent with the building materials encountered. Do not use wood plugs. Do not use plastic plugs for ceilings or walls. Provide wall strapping as required.
- .4 Anchor cabinet work and millwork to building structure. Shim level and set square in relation to adjoining surfaces. Scribe to adjacent Work. Provide allowance for finish flooring installation to base.
- .5 Cabinet work:
 - .1 Fasten to framing using zinc-coated bolts, countersunk and plugged with matching wood plugs.
 - .2 Set cabinetwork in place, on base, anchoring securely to building structure and to adjoining cabinetwork. Use approved connector type fasteners between items of cabinetwork to hold adjoining pieces tightly together.
 - .3 Scribe to smooth snug fit with adjoining surfaces and materials to align work. Mitre corners.
 - .4 Perform cutting, fitting, repairing in woodwork as required by other trades where their work is connected to or part of this work.
 - .5 Cut out openings for mechanical, electrical, and communications fittings and fixtures. Coordinate and cooperate in the connection and installation of mechanical, electrical, and communications work.
 - .6 Apply sealant between countertops and adjoining walls and cabinetwork. Seal edges of cut-out core material before fixtures installed.
 - .7 Install finishing hardware shipped loose.

- .6 Supply and install hardware required for the completion of architectural woodwork, including, without limitations, adjustable shelf supports and cabinet hinges, catches, pulls, drawer accessories, bumpers, drawer slides and closet hanger bars, and similar items. Install millwork hardware in the shop wherever possible. Install millwork hardware secure, plumb, level, true to line, and in accordance with the hardware manufacturers' printed instructions. Cut and fit to millwork for proper installation and operation. Provide smoothly operating units free from binding. Clean and adjust hardware for proper operation.

3.4 INSTALLATION, SOLID SURFACING

- .1 Install extra support as required for size and weight of solid surfacing in accordance with AWMAC recommendations.
- .2 Install components plumb and level, in accordance with shop drawings and manufacturers written installation requirements.
- .3 Form joints and seams between solid polymer components using manufacturer's approved seam adhesive. Joints shall be inconspicuous in appearance and without voids to create a monolithic appearance.
- .4 Rout and finish component edges to a smooth, uniform appearance and finish. Edge shapes and treatments, including any inserts, shall be as detailed on the drawings. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.
- .5 Adhere sinks to countertops using manufacturer's recommended adhesive and mounting hardware.
- .6 Install backsplashes and end splashes as indicated on Drawings; adhere to countertops using manufacturer's standard colour matched silicone sealant.
- .7 Coordinate plumbing connections and electrical requirements with affected Sections of work.

3.5 ADJUSTING

- .1 During and after installation adjust all hardware and operating parts as necessary to ensure smooth and proper operation.

3.6 CLEANING

- .1 Clean all cabinet, countertops, shelves and fixtures.
- .2 Repair any marks, scratches or marring.
- .3 Remove and replace damaged, marked, or stained architectural woodwork.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes sanitary fibre reinforced wall panels including trims, adhesive, sealant and fastenings.
- .2 Related Requirements
 - .1 Section 06 10 00 - Rough Carpentry
 - .2 Section 09 21 16 - Gypsum Board Assemblies

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Product Data.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit two copies of **Workplace Hazardous Materials Information System** WHMIS SDS - Safety Data Sheets in accordance with Section 01 33 00 - Submittal Procedures. Indicate VOC's:
 - .1 For caulking materials during application and curing.
 - .2 For adhesives.
- .2 Shop Drawings.
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate, by large scale details, materials, finishes, dimensions, anchorage and assembly.
- .3 Samples.
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit duplicate 300 mm long samples of profiles and colours for corner and door frame.
- .4 Manufacturer's Instructions.
 - .1 Submit manufacturer's installation instructions.
- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.
- .2 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .3 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 MATERIALS

- .1 Wall Panels:
 - .1 Type: fibre reinforced panel to USDA/FSIS and Canadian Food Inspection Agency (CFIA) and Agriculture Canada approved.
 - .2 Dimensions: 1.9 mm thick x 1220 mm x 2440 mm.
 - .3 Texture: smooth.
 - .4 Fire Rating: Class I/A to ASTM E84.
 - .5 Colour: as directed by Consultant from manufacturers standard range.
 - .6 Acceptable Materials:
 - .1 Glasbord, Crane Composites.
 - .2 Graham, Exceliner/glasliner panels.
 - .3 Marlite FRP Wall Panels.
 - .4 Panolam Surface Systems
 - .5 Sequentia, Thermo Design.

2.2 ACCESSORIES

- .1 Adhesive: water resistant type as recommended by manufacturer for substrate.
- .2 Sealant: Manufacturer's recommended silicone sealant; colour matched to panels.
- .3 Fastenings: Nylon drive rivets or stainless steel screws as recommended by manufacturer.

Part 3 Execution

3.1 INSTALLATION

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Install panels in accordance with manufacturer's written instructions; maintain a reference copy of installation instructions on site for review by installers and the Consultant.
- .3 Position panels leaving a minimum 6 mm gap at ceiling and floor junction; minimum 3 mm gap between each panel and division bar moulding to allow for normal expansion and contraction; minimum 3 mm gap around pipes, electrical fittings, other projections; and pre-drill oversize by 3 mm holes ready for fastenings.
- .4 Cut and drill panels using a carbide tipped saw blade or drill bit; or cut with snips as recommended by manufacturer.
- .5 Pre-fit each panel before securing in place; leave leading edge of first panel unfastened; trim division bar to accommodate ceiling cove or base moulding:
 - .1 Apply bead of silicone sealant on one side of division bar and install on leading edge of first panel.
 - .2 Push division bar all the way onto panel and pull back to form a minimum 3 mm gap; confirm plumb; tack division bar using fasteners recommended by manufacturer.
 - .3 Fasten leading edge of first panel.
- .6 Install fasteners at nominal 400 mm o.c. both horizontally and vertically. Maintain edge fasteners 25 mm from panel edge face.
- .7 Stagger fasteners on opposing panel edges and corners next to a division bar to aid in maintaining tight, flat seam.
- .8 Use combination of mechanical fasteners and adhesive to ensure flat surface, using compatible adhesives recommended by panel manufacturer prior:
 - .1 Fasten panel at top and work toward bottom or start at centre and work outward.
 - .2 After installation of first panel is completed remove excess sealant immediately.
 - .3 Apply bead of sealant in remaining channel of division bar.
 - .4 Install second panel into division bar.
 - .5 Pull panel back to leave a minimum 3 mm clearance.
 - .6 Check plumb.
 - .7 Remove excess sealant.
 - .8 Fasten second panel except for leading edge.
 - .9 Repeat previous steps until all panels are installed.
- .9 Remove excess silicone sealant during installation.

- .10 Seal corner seams, ceiling, and base junctions; install accessories as installation progresses, leaving a minimum 3 mm clearance for normal expansion and contraction of panels.
- .11 Cut trims neatly, use only full length except where joins are permitted by Consultant; tightly mitre trims at right angle corners; tightly cut trims at Tee junctions to maintain flush straight fit.

3.2 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Clean surfaces after installation using manufacturer's recommended cleaning procedures.
- .3 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes: Blower Door Test Procedures
 - .1 Provide blower door testing to confirm building envelope meets specified requirements for air infiltration.
 - .2 Tests required: (A) Mid-envelope c/w air barrier in place (B) Final installation.
- .2 Related Requirements:
 - .1 Section 07 42 43 – Insulated Metal Panels
 - .2 Section 07 72 33 – Roof Hatches
 - .3 Section 08 11 13 – Steel Doors and Frames
 - .4 Section 08 11 16 – Aluminum Doors and Frames
 - .5 Section 08 44 13 – Glazed Aluminum Curtain Walls

1.2 REFERENCES

- .1 Acronyms:
 - .1 TEDI: Thermal Energy Demand Intensity (TEDI) (kWh/m²/yr).
 - .2 TEUI: Total Energy Use Intensity (TEUI) (kWh/m²/yr).
 - .3 ERLN: Envelope Air Leakage Rate (EALR_{n75}) (l/s/m²).
 - .4 IPAL: Interior Partitions Air Leakage Rate (IPALR_{n50}) (l/s/m²).
 - .5 PRL: Peak Thermal Load (PTL) (W/m²).
 - .6 MEUI: Mechanical Energy Use Intensity (MEUI) (kWh/m²/yr).
- .2 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM E783-02 (2018), Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
 - .2 ASTM E779-19, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization.
 - .3 ASTM E1186-22, Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
 - .4 ASTM E1258-88(2018), Standard Test Method for Airflow Calibration of Fan Pressurization Devices.
 - .5 ASTM E1827-22, Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with the requirements of 01 33 00 Submittal Procedures.
 - .1 Shop Drawings: Indicate location of blower door set up.

- .2 Equipment: Submit make and model of equipment proposed for test procedures.
- .3 Test Methodology: Submit proposed test methodology, and revise and resubmit where required by Consultant.
- .4 Reports: Submit test reports within two working days of test completion to Owner and Consultant.
- .5 The report shall contain at least the following information:
 - .1 Building description, including, location, address (street, city, province, postal code, country, and elevation above mean sea level in m.
 - .2 Construction, including date built (estimate if unknown), floor areas for conditioned space, attic, basement, and crawl space, and volumes (optional) for conditioned spaces attic, basement, and crawl space:
 - .3 Condition of openings in building envelope including:
 - .4 Doors, closed, locked or unlocked;
 - .5 Windows, closed, latched or unlatched;
 - .6 Ventilation openings, dampers closed or open;
 - .7 Statement whether the test zone is interconnected with at least door-sized openings. If not, the results of pressure measurements between portions of the zone.
 - .8 HVAC system, including the location and sizes of ducts that penetrate the test zone envelope.
 - .9 Procedure, including the test equipment used (manufacturer, model, serial number), and calibration records of all measuring equipment.
 - .10 Measurement data, including:
 - .1 Fan pressurization measurements (inside-outside zero flow building pressure differences);
 - .2 Inside and outside temperature (at start and end of test) and the product of the absolute value of the indoor/outdoor air temperature difference multiplied by the building height;
 - .3 Tabular list of all air leakage measurements and calculations: time, building pressure difference, air density, nominal airflow rate, fan airflow rate, and air leakage rate; and, deviations from standard procedure.
 - .4 Optional data, including wind speed/direction and whether wind speed is estimated to exceed 0 to 2 m/s.
 - .11 Calculations, including:
 - .1 The leakage coefficient and pressure exponent for both pressurization and de- pressurization,
 - .2 The effective leakage area. Report if a reference pressure other than 4 Pa is used; and an estimate of the confidence limits.

1.4 SITE CONDITIONS

- .1 Provide adequate power and lighting to execute testing.
- .2 Provide testing as required by Consultant and York Region requirements and at times as required by York Region requirements. Provide testing in zones and with interior finishes as required.

Part 2 PRODUCTS

2.1 MATERIALS

- .1 Provide materials as required to measure testing including framing, door, sealants and air barrier materials.

2.2 EQUIPMENT

- .1 Air-Moving Equipment: A fan, blower, or blower door assembly that is capable of moving air into and out of the conditioned space at required flow rates under a range of test pressure differences.
- .2 Pressure-Measuring Device: A manometer or pressure indicator to measure pressure difference with an accuracy of 65% of measured pressure.
- .3 Airflow Measuring System: A device to measure airflow with an accuracy of 65 % of the measured flow. The airflow measuring system shall be calibrated in accordance with Test Method ASTM E1258.
- .4 Temperature-Measuring Device: An instrument to measure temperature with accuracy of $\pm 1^{\circ}\text{C}$.

Part 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

- .1 Prepare test area for testing.
- .2 Verify doors and frames are correct size.
- .3 Installation of doors and frames: Refer to Section 08 11 13 - Steel Doors and Frames, Section 08 11 16 - Aluminum Doors and Frames, and Section 08 44 13 - Glazed Aluminum Curtain Walls.

3.2 APPARATUS

- .1 Install blower as recommended by the blower manufacturer.

3.3 SITE QUALITY CONTROL

- .1 Test Methodology: This test is a multi point test. Use more than one location across the building envelope for pressure measurement, for example, one across each façade
- .2 Verify this condition by differential pressure measurements at the highest pressure used in the test. Make these measurements at the highest and lowest level of the building and on the windward and leeward sides

- .3 To perform the test according to ASTM E779 the range of induced pressure difference shall be from 10Pa to 60Pa.
- .4 Avoid locations such as exterior corners and complex architectural features. Select locations close to the middle of the exterior wall.
- .5 Average the pressures from each location using a manifold. Average the pressures over at least a 10 second time period.
- .6 Do not adjust HVAC balancing dampers and registers and close other operable dampers unless they are used to pass air to pressurize, or to de-pressurize the building.
- .7 Make general observations of the condition of the building. Take notes on the windows, doors, opaque walls, roof, and floor.
- .8 Measure and record the indoor and outdoor temperatures at the beginning and the end of the test so that their average values can be estimated.
- .9 Connect the air duct or blower door assembly to the building envelope, using a window, door, or vent opening. Seal or tape openings to avoid leakage at these locations.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Waterproofing Membrane: single-component, polymer-modified, cold-applied, water based liquid waterproofing membrane.
 - .2 Primer.
 - .3 Reinforcing Sheet.
 - .4 Flashing and Transition Membrane.
 - .5 Joint Sealant.
 - .6 Adhesive.
 - .7 Below Grade Insulation.
 - .8 Drainage board.
 - .9 Drainage board accessories.
- .2 Related Requirements:
 - .1 Section 03 30 00 – Cast-in-Place Concrete
 - .2 Section 06 10 00 – Rough Carpentry
 - .3 Section 07 21 13 – Board Insulation
 - .4 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
 - .5 Section 07 92 00 – Sealants

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C836/C836M-18(2022), Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
 - .2 ASTM C1325-22e1 Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units.
 - .3 ASTM D146/D146M-04 (2020), Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.
 - .4 ASTM D412-16(2021), Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - .5 ASTM D4716/D4716M-22, Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
 - .6 ASTM E96/E96M-23, Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4.1 – Building Design and Construction (BD+C), Interior Design + Construction (ID+C).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meeting one week prior to beginning waterproofing Work, with waterproofing contractor's representative, Engineer, Consultant, and Contractor in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.4 ACTION SUBMITTALS /INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.
 - .2 Provide one electronic copy of most recent data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Provide one electronic copy of WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada and indicate VOC content.
- .2 Manufacturer's Installation Instructions: submit manufacturers recommended installation instructions and procedures.
- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Installer qualifications: Use a qualified installer who is authorized, approved, or licensed by waterproofing manufacturer to install manufacturer's products, who has a minimum of five years of experience with installations of similar complexity and scope.
- .2 Obtain primary waterproofing materials from single manufacturer and/or ensure materials ordered and supplied are compatible with one another.
- .3 Compatibility between components of waterproofing system is essential. Provide written declaration to Consultant stating that materials and components, as assembled in system, meet this requirement.
- .4 Mock-ups
 - .1 Provide required Sample Installation in accordance with Section 01 45 00 – Quality Control.
 - .2 Apply waterproofing to 10 m² area of wall to demonstrate surface preparation, crack and joint treatment, corner treatment, thickness, texture, and execution quality.
 - .3 When accepted, mock-up will demonstrate minimum standard of quality required for this Work. Approved mock-up may remain as part of finished Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials to site in manufacturer's original, unopened containers and packaging with labels clearly identifying product name and manufacturer.
- .2 Store materials in a clean, dry area in accordance with manufacturer's instructions.
- .3 Store adhesives, primers and membrane materials at temperatures of 5° C and above to facilitate handling.
- .4 Do not store at temperatures above 32° C for extended periods.
- .5 Protect materials during handling and application to prevent damage or contamination.
- .6 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer.
- .2 Apply waterproofing to dry substrates, when relative humidity is less than 85%, and when surface and ambient temperatures are 3°C above dew point.
- .3 Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.
- .4 Maintain adequate ventilation during application and curing of waterproofing materials.

1.8 WARRANTY

- .1 Submit written warranty, signed by waterproofing manufacturer agreeing to repair or replace waterproofing that does not comply with requirements or that does not remain watertight for a period of two years from Substantial Performance, and as follows:
 - .1 Warranty is inclusive of all failures except for failures resulting from failure of substrate prepared and treated in accordance with requirements or formation of new joints and cracks in substrate exceeding 1.5 mm in width.
 - .2 Warranty is inclusive for procedures to gain access to waterproofing membrane including removal and reinstallation of earthwork, protection board, drainage panels, and insulation.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable manufacturers: Subject to compliance with requirements of this Section, products by the following manufacturers are acceptable. However, it is Contractor's responsibility to provide only products compatible with adjacent materials in assembly.

- .1 Epro Services, Inc.
- .2 Henry Company.
- .3 Tremco Commercial Sealants and Waterproofing.
- .4 W.R. Meadows Inc.

2.2 MATERIALS

- .1 Waterproofing Membrane: single-component, polymer-modified, cold-applied, water based liquid waterproofing membrane able to develop bond to substrate under conditions of service and application indicated and with the following properties:
 - .1 Solids by volume: 60% minimum.
 - .2 Film thickness: 120 mils wet, 60 mils dry.
 - .3 Total cure time: 16 – 24 hours.
 - .4 Elongation: minimum 600 % to ASTM D412.
 - .5 Water vapour transmission: 0.03 perms to ASTM E96, B.
 - .6 Acceptable Materials:
 - .1 Aqua-Bloc 720-38, Henry Company.
 - .2 Mel-Rol LM or Mel-Rol LM All Season, W.R. Meadows
 - .3 Tremproof 260, Tremco Commercial Sealants and Waterproofing.

2.3 ACCESSORIES

- .1 Primer: Manufacturer's standard, factory-formulated polyurethane or epoxy primer.
- .2 Reinforcing Sheet: fibreglass mesh or polyester fabric material designed for and compatible with membrane bitumen as required by waterproofing membrane manufacturer.
- .3 Flashing and Transition Membrane: Nominal 1.5 mm, manufacturer's standard non-staining premanufactured elastomeric membrane and adhesive.
- .4 Joint Sealant: Multi-component polyurethane sealant, compatible with waterproofing; and as recommended by manufacturer for substrate and joint conditions.
- .5 Adhesive for overlay board and insulation: Water-based rubberised liquid coating as recommended by manufacturer.
- .6 Below Grade Insulation: as indicated in Section 07 21 13 - Board Insulation.
- .7 Drainage board: high-strength drainage panel consisting of polypropylene core and fabric for installation over waterproof membranes with the following characteristics:
 - .1 Thickness: 10 mm
 - .2 Compressive strength: minimum 718 kPa to ASTM D1621
 - .3 Flow rate: 196 l/min/m to ASTM D4716.
 - .4 Acceptable Materials:
 - .1 DB 6000, Henry Company
 - .2 TremDrain 6000, Tremco

.3 Mel-Drain 5035, W.R. Meadows

- .8 Provide drainage board accessories as required for complete installation as recommended by drainage board manufacturer. Ensure drainage board is compatible with waterproofing.

Part 3 Execution

3.1 EXAMINATION

- .1 Do not proceed with work until conditions are in accordance with manufacturers instructions.
- .2 Ensure surfaces are smooth, dry, clean and free of ice and debris as per manufacturer's recommendations.
- .3 Verify the compatibility of membrane components with curing compounds, coatings, or other materials which are already installed on the surfaces to be treated.

3.2 PREPARATION OF SURFACES

- .1 Mask off adjoining surfaces not receiving waterproofing to protect other materials from spillage or overspray.
- .2 Ensure concrete is smooth and free from voids and honeycombing prior to application of waterproofing membrane. Where voids, cracks, holes and other damages to surfaces exist, repair prior to application of waterproofing membrane.

3.3 PREPARATION AT TERMINATIONS AND PENETRATIONS

- .1 Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves in accordance with manufacturer's written instructions.
- .2 Prime substrate in accordance with waterproofing manufacturer's written instructions.
- .3 Apply double thickness of waterproofing and embed joint reinforcing strip in preparation coat.
- .4 Provide sealant cants around penetrations and at inside corners of deck-to-wall butt joints.

3.4 PREPARATION AT JOINTS AND CRACKS

- .1 Prepare, treat, rout, and fill joints and cracks in substrate in accordance with manufacturer's written instructions.
- .2 Remove dust and dirt from joints and cracks before coating surfaces.
- .3 Apply bond breaker between sealant and preparation strip.
- .4 Prime substrate and apply a single thickness of preparation strip extending minimum 75 mm along each side of joint.
- .5 Apply double thickness of waterproofing and embed joint reinforcing strip in preparation coat.

- .6 Install sheet flashing and bond to deck and wall substrates where indicated or as required by waterproofing manufacturer's written instructions; extend sheet flashings onto perpendicular surfaces and other work penetrating substrate.

3.5 WATERPROOFING MEMBRANE INSTALLATION

- .1 Apply waterproofing in accordance manufacturer's written instructions after concrete has cured to acceptable moisture levels and vapour emissions, and not less than seven-14 days after concrete forms are removed as recommended by membrane manufacturer.
- .2 Apply primer over prepared substrate in accordance with manufacturer's written instructions.
- .3 Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to spatial orientation of substrate.
- .4 Apply membrane in sufficient coats to obtain seamless installation free from trapped gasses or air pockets to an average dry film thickness of 1.5 mm, with no less than 1.3 mm dry film thickness at any point of the installation.
- .5 Verify wet film thickness of waterproofing every 10 m2.
- .6 Protect waterproofing from damage and wear during remainder of construction period.
- .7 Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

3.6 DRAINAGE BOARD INSTALLATION

- .1 Allow waterproofing to completely cure prior to applying drainage board.
- .2 Install drainage material in accordance with manufacturers written instructions.
- .3 Protect installed drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Foundation Wall Insulation.
- .2 Load Bearing Insulation.
- .3 Semi-Rigid Mineral Wall Insulation.
- .4 Accessories.

.2 Related Requirements:

- .1 Section 03 30 00 – Cast-in-Place Concrete
- .2 Section 04 22 00 – Unit Masonry
- .3 Section 06 10 00 – Rough Carpentry
- .4 Section 07 21 19 – Foam-in-Place Insulation
- .5 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
- .6 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .7 Section 07 52 00 – Modified Bituminous Membrane Roofing
- .8 Section 07 62 00 – Sheet Metal Flashing and Trim
- .9 Section 08 44 13 – Glazed Aluminum Curtain Walls
- .10 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

.1 Reference Standards:

- .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - .3 ASTM C208-22, Specification for Cellulosic Fiber Insulating Board.
 - .4 ASTM C578-23 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - .5 ASTM C591-22, Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 - .6 ASTM C612-14(2019), Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
 - .7 ASTM C726-17, Standard Specification for Mineral Wool Roof Insulation Board.
 - .8 ASTM C728-17a(2022), Standard Specification for Perlite Thermal Insulation Board.
 - .9 ASTM C1126-19, Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
 - .10 ASTM C1289-23a, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

- .11 ASTM D1621-16(2023), Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
- .12 ASTM D2842-19, Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- .13 ASTM D4716/D4716M-22, Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
- .14 ASTM E84-23d Standard Test Method for Surface Burning Characteristics of Building Materials.
- .15 ASTM E96/E96M-23, Standard Test Methods for Gravimetric Determination of Water Transmission Rate of Materials.
- .2 American Society of Heating Refrigeration and Air-Conditioning (ASHRAE):
 - .1 ASHRAE 90.1-2022 (I-P Edition) -- Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings (ANSI Approved; IES Co-sponsored).
- .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian Gas Association (CGA):
 - .1 CSA B149.1:20 – Natural Gas and Propane Installation Code, Includes Errata (2020), Ontario Amendments (2021), and Administrative Update (2021).
 - .2 CSA B149.2:20 –Propane Storage and Handling Code.
 - .3 CSA B149.3:20 –Code for the Field Approval of Fuel-Burning Appliances and Equipment, Includes Ontario Amendments (2021).
- .5 Canadian General Standards Board (CGSB):
 - .1 CGSB 71-GP-24M (Withdrawn), Adhesive, Flexible, for Bonding Cellular Polystyrene Insulation.
- .6 Underwriters Laboratories of Canada (ULC):
 - .1 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies. (ULC S102) (2018).
 - .2 ULC 114, Standard Method of Test for Determination of Non-Combustibility in Building Materials (2018).
 - .3 ULC 604, Standard for Factory-Built Type A Chimneys. (2022).
 - .4 ULC 701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering. (CAN/ULC-S701-11) (Withdrawn).
 - .5 ULC 702.1, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification. (ULC-S702.1) (2021).
 - .6 ULC 702.2, Mineral Fibre Thermal Insulation for Buildings, Part 2: Application Guidelines. (ULC-S702.2-15).
 - .7 ULC 704.1, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced. (2017).
 - .8 ULC 770, Standard Test Method for Determination of Long-term Thermal Resistance of Closed-Cell Thermal Insulating Foams. (CAN/ULC S770-15).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with contractor's representative and Consultant in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.
 - .2 Provide data on product characteristics, performance criteria, and limitations.
 - .3 Published "R" value for thicknesses of insulation for each product indicated.
 - .4 Product test reports and Research/ evaluation reports.
 - .5 Submit manufacturer's literature including installation instructions, independent test data confirming compliance with reference standards, attachment, and specification requirements."
 - .6 Refer to Sections 07 42 13 - Preformed Metal Cladding for thermal performance modeling and engineering requirements.
 - .7 Provide one electronic copy of Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada. Indicate VOC's insulation products and adhesives.
- .2 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
 - .2 Note R-value requirements for exterior assemblies. Provide thermal modeling reports to confirm clear field r-value for proprietary systems.
- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Health and Safety Requirements: in accordance with Section 01 35 29 - Health and Safety Requirements.

- .4 Thermal Conductivity: The thicknesses shown are for the thermal conductivity specified for each material. Provide adjusted thicknesses as directed for the use of material having a different thermal conductivity.
- .5 Fire and Insurance Ratings: Comply with fire-resistance flammability and insurance ratings, where required, and comply with Code interpretations by Authorities Having Jurisdiction.
- .6 Mock-Up:
 - .1 Refer to Section 01 45 00 – Quality Control for mock-up.
 - .2 Mock-up to include through wall flashing detail, window interface, and board insulation attachment.
 - .3 Cooperate with mock-up of exterior wall as described in specification and drawings, including accessories to Consultant's satisfaction.
 - .4 Locate where directed by Consultant.
 - .5 Accepted mock-up may remain as part of the Work

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Storage and Handling Requirements:
 - .1 Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
 - .2 Protect plastic insulation as follows:
 - .1 Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - .2 Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 - .3 Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
- .2 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 INSULATION MATERIALS

- .1 Foundation Wall Insulation: Extruded polystyrene (XPS) to CAN/ULC 701 and as follows:
 - .1 Type: IV.
 - .2 Thermal Resistance: LTTR RSI 0.88/25 mm minimum.
 - .3 Edges: square.
 - .4 Size: 610 mm x 2440 mm x thickness as indicated on Drawings.
 - .5 Compressive Strength: minimum 200 kPa at 10% deformation in accordance with ASTM D1621.

- .6 Water Absorption: maximum 0.7% (% by volume) in conformance with ASTM D2842.
- .7 Acceptable Materials:
 - .1 Styrofoam SM, DuPont Performance Building Solutions.
 - .2 Foamular C-300, Owens-Corning Canada LP.
 - .3 Sopra-XPS 30, Soprema.
- .2 Load Bearing Insulation: Extruded Polystyrene (XPS) or expanded polystyrene (EPS), high density extruded type in accordance with CAN/ULC 701 and CAN/ULC 770 and as follows:
 - .1 Type: IV
 - .2 Thermal Resistance: LTTR RSI 0.87/25 mm minimum.
 - .3 Edges: square.
 - .4 Size: 1220 mm x 2440 mm x thickness as indicated on Drawings.
 - .5 Compressive Strength: minimum 275 kPa at 5% deformation in accordance with ASTM D1621.
 - .6 Water Absorption: maximum 1% (% by volume) in conformance with ASTM D2842.
 - .7 Acceptable Materials:
 - .1 Styrofoam, Hiload 40, DuPont Performance Building Solutions.
 - .2 Foamular NGX 400, Owen-Corning Canada
 - .3 Sopra-XPS 40, Soprema.
- .3 Semi-Rigid Mineral Wall Insulation: Unfaced, preformed semi-rigid fibrous mineral slag board insulation in accordance with CAN/ULC 702 and as follows:
 - .1 Type: 1VB to ASTM C612.
 - .2 Thermal Resistance: RSI 0.74/25 mm minimum.
 - .3 Combustion Characteristics: non-combustible in accordance with CAN/ULC 114.
 - .4 Flame spread and Smoke Development:
 - .1 Flame spread: 0 in accordance with CAN/ULC 102.
 - .2 Smoke Development: 0 in accordance with CAN/ULC 102.
 - .5 Edges: square.
 - .6 Size: 406 mm x 1220 mm x thickness or as indicated on Drawings.
 - .7 Acceptable Materials:
 - .1 Cladstone, Johns Manville.
 - .2 Thermafiber Rain Barrier Mineral Wool Insulation, Owens Corning.
 - .3 CavityRock, Rockwool Inc.
- .4 Mineral Wool Rigid Insulation: Non-combustible, rigid, water repellent, mineral wool insulation board to ASTM C612, Type IVB and CAN/ULC 702 Type 1.
 - .1 Fire Performance:
 - .1 Non-combustibility: To CAN/ULC 114.
 - .2 Surface Burning Characteristics: To CAN/ULC 102.
 - .1 Flame spread: 0.

- .2 Smoke developed: 0.
- .2 Thermal Resistance: RSI 0.72/25 mm minimum and as indicated on Drawings.
- .3 Minimum Compressive Strength: 21 kPa @ 10% Compression.
- .4 Acceptable Materials:
 - .1 Thermafiber RainBarrier ci High Compressive Plus (80), Owens-Corning Canada LP
 - .2 ComfortBoard 80, Rockwool Inc.
- .5 Roof Insulation: Refer to Section – 07 52 00 – Modified Bituminous Membrane Roofing.
- .6 Curtain Wall Spandrel Insulation: Refer to Section 08 44 13 - Glazed Aluminum Curtain Walls, insulation types specific to curtain wall spandrels are specified as a part of curtain wall system requirements.

2.2 ACCESSORIES

- .1 Adhesive (for polystyrene): insulation manufacturers standard with trowel consistency, synthetic rubber based insulation adhesive compatible with polystyrene insulation to CGSB 71-GP-24; suitable for application in temperature down to -12°C.
- .2 Thermally Broken Clip System: Low-conductivity thermal spacers confirm all clips with structural engineer and loads in accordance with Section 01 35 00 – Delegated Design and as follows:
 - .1 Sub-framing Thermal Spacer: 100 % Pultruded glass fibre and thermoset polyester resin insulation clip.
 - .1 Thermal Spacer thickness for top, base and web: 4.8 mm nominal.
 - .2 Thermal Spacer Depth: as required by wind loads for Building location.
 - .3 Depth tolerance: ± 0.127 mm.
 - .4 Spacing: as indicated on Drawings or as required by delegated design.
 - .5 Fasteners: hot dipped galvanized type as recommended by manufacturer in length to suit wall construction.
 - .6 Shims: as required to remove imperfections in sheathing/stud wall.
 - .7 Basis-of-Design Materials:
 - .1 Cascadia Clip, Cascadia Windows Ltd.
 - .3 Girts: Fabricated from minimum 1.27 mm thickness galvanized steel to ASTM A653, Grade 230 with Z275 coating. Material visible after assembly of wall panel shall be finished to match aluminum panels.
 - .4 Sub-girts: Structural quality steel to ASTM A653, with Z275 zinc coating, adjustable double-angle profile as indicated to accept panel with structural attachment to building frame.
 - .5 Screw Fasteners: 316 Stainless steel, of type to suit installation and to support superimposed loads.
 - .6 Insulation Fasteners

- .1 Mechanical Fasteners: High quality, impact resistant plastic fastener system specifically designed for installation of board insulation materials; 38 mm diameter, shaft length to suit insulation thickness and hot dipped galvanized fastener to suit substrate, and as follows:
 - .1 Acceptable Materials:
 - .1 Insulation Fasteners, Ucan Fastening Systems.
 - .2 Ramset Insulfast.
 - .2 Insulation Clips: Impale type, perforated 50 mm x 50 mm cold rolled carbon steel 0.912 mm core metal thickness, adhesive back; 2.657 mm diameter annealed steel wire spindle, length to suit insulation, 25 mm diameter self locking washers, and as follows:
 - .1 Basis-of-Design Materials:
 - .1 Gemco Insulation Fasteners, Insulation Hanger.
- .7 Perimeter Insulation Flashings: Coordinate supply of end closures and flashings for perimeter insulation system with Section 07 62 00 - Sheet Metal Flashing and Trim.
- .8 Sheet steel: liner sheet, structural quality, grade A to ASTM A653, with Z275 zinc coating:
 - .1 Light duty modified silicone finish.
 - .2 Panel thickness: 24 gauge
 - .3 Colour: as directed by Consultant
 - .4 Panel Depth: 31 mm.
 - .5 Panel Width: 800 mm
 - .6 Fasteners: exposed with colour to match panel, spaced at locations as recommended by manufacturer.
 - .7 Basis of Design Materials:
 - .1 L800R Liner, VicWest

Part 3 Execution

3.1 EXAMINATION

- .1 Examine substrates and immediately inform Consultant in writing of defects.

3.2 PREPARATION

- .1 Prior to commencement of work ensure:
 - .1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.

3.3 INSTALLATION: GENERAL

- .1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Install insulation after building substrate materials are dry.

- .3 Install insulation to maintain continuity of thermal protection to building elements and spaces.
- .4 Fit insulation tight (maximum 3 mm air gap) around electrical boxes, wires, plumbing and heating pipes and ducts, around exterior doors and windows and other protrusions.
- .5 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of ULC 604 type A chimneys and CAN/CGA-B149.1 and CAN/CGA-B149.2 type B and L vents.
- .6 Use only insulation boards free from chipped or broken edges that is dry, and unsoiled and that has not been left exposed at any time to ice and snow.
- .7 Use largest possible dimensions to reduce number of joints.
- .8 Offset both vertical and horizontal joints in multiple layer applications.
- .9 Do not enclose insulation until it has been reviewed by Consultant.
- .10 Install rigid insulation to maintain continuous thermal insulation, vapour barrier and air tightness for building spaces and elements.
- .11 Saw-cut and trim insulation neatly to fit spaces. Butt edges and ends tight (maximum 3 mm air gap). Fit insulation tight against mechanical, electrical and other items protruding plane of insulation. Fill voids as recommended by manufacturer; refer to Section 07 21 19 - Foam-in-Place Insulation.
- .12 Follow the instructions for use of materials of insulation and accessory manufacturers.
- .13 Install insulation horizontally. Offset vertical joints minimum 300 mm and interlock corners.
- .14 Leave insulation joints unbonded over line of expansion and control joints; bond a continuous 150 mm wide strip of primary vapour membrane over expansion and control joints using compatible adhesive.

3.4 INSTALLATION: BELOW GRADE INSULATION

- .1 Rigid Fiber Insulation on Architectural Precast or Site Cast Concrete:
 - .1 Secure insulation by use of mechanical fasteners; impaling clips and pins.
 - .1 Locate fasteners from edges and at OC each direction.
 - .2 Lay out fasteners and install in mastic.
 - .3 Install washers and bend prongs of fasteners.
- .2 Install board insulation to vertical surfaces with adhesive applied in accordance with manufacturer's written instructions, and as follows:
 - .1 Interior Application: Extend boards as indicated on Drawings, installed on inside face of perimeter foundation walls.
 - .2 Exterior Application: Extend boards as indicated on Drawings.
 - .3 Apply adhesive to the substrate by the "dab" method not less than 10 mm x 20 mm size at 150 mm centres; bed the insulation in the adhesive before the adhesive loses its tack or skins over.

- .4 Protect below grade insulation on vertical surfaces from damage during backfilling by applying protection board; set in adhesive according to insulation manufacturer's written instructions.

3.5 INSTALLATION: UNDERSLAB INSULATION

- .1 Extend boards as indicated on Drawings, and as follows:
 - .1 Lay boards on level compacted fill.
 - .2 Protect top surface of horizontal insulation from damage during concrete work by applying protection board.
- .2 Load Bearing Insulation: Install in accordance with manufacturer's written instructions, and as follows:
 - .1 Load Bearing Insulation: Install board insulation horizontally having a minimum compressive strength as indicated above on level compacted fill to locations indicated on Drawings.
- .3 Tape joints of underslab insulation and fill with 2 lb spray insulation.

3.6 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.7 PROTECTION

- .1 Protect installed board insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- .2 Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Foam-in-place insulation to exterior hollow steel door frames, aluminum door frames and window frames.
 - .2 Foam-in-place insulation around protrusions through the exterior wall envelope and juncture of different cladding materials.
- .2 Related Requirements:
 - .1 Section 07 21 13 – Board Insulation
 - .2 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
 - .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .4 Section 07 92 00 – Sealants
 - .5 Section 08 11 13 – Steel Doors and Frames
 - .6 Section 08 11 16 – Aluminum Doors and Frames
 - .7 Section 08 44 13 – Glazed Aluminum Curtain Walls
 - .8 Section 08 50 13 – Aluminum Windows

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM E90-23, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission of Loss of Building Partitions and Elements
 - .2 ASTM E283/E283M-19, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
 - .3 ASTM E331-00(2023), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference
 - .4 ASTM D1622-20 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 Canadian Urethane Foam Contractors' Association Inc. (CUFCA).
 - .4 Green Seal Environmental Standards:
 - .1 Standard GS-11, Paints, Coatings, Stains and Sealers, Edition 4.0, 2021.
 - .5 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.
 - .6 Underwriters' Laboratories of Canada (ULC):
 - .1 ULC 101, Standard Methods of Fire Endurance Tests of Building Construction and Materials (CAN/ULC S101-14).

- .2 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies (ULC S102) (2018).
- .3 ULC 705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material - Specification (CAN/ULC S705.1-15).
- .4 ULC 705.2, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Application (2020).
- .5 ULC 770, Standard Test Method for Determination of Long-term Thermal Resistance of Closed-Cell Thermal Insulating Foams. (CAN/ULC S770-15).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide one electronic copy of Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .2 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: submit certified test reports for insulation from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Submit test reports in accordance with CAN/ULC-101 for fire endurance and CAN/ULC-102 for surface burning characteristics.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00 - LEED Product Requirements

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installers: Use companies that are members and licensed with CUFCA having trained and certified installers in accordance with ULC 705.2 and CUFCA requirements.
 - .2 Manufacturer: Obtain air and vapour seal materials from a single manufacturer regularly engaged in manufacturing the products specified in this Section.
- .2 Cooperate and coordinate with the requirements of other units of work specified in other sections.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.6 SITE CONDITIONS

- .1 Apply insulation only when surfaces and ambient temperatures are within manufacturers' prescribed limits.
- .2 Ensure temperature is maintained throughout the curing period.
- .3 Provide sufficient ventilation during and until insulation has cured, to ensure safe working conditions. Introduce fresh air and exhaust air continuously during the 24 hour period after application.

1.7 WARRANTY

- .1 The work under this section shall be warranted by the contractor against defects in workmanship or material for a period of two years from date of Substantial Performance.

Part 2 Products

2.1 MATERIALS

- .1 Insulation: open cell, low expansion, one component, spray polyurethane foam.
 - .1 Water Infiltration: no leakage to ASTM E331.
 - .2 Sound Transmission Classification: 55 to ASTM E90.
 - .3 Tensile Strength: >5 N/cm² to HTC method 2106.
 - .4 RSI Value: minimum 0.88 m² K/W/25 mm to CAN/ULC 770.
 - .5 Acceptable Materials:
 - .1 EnerFoam, DuPont.
 - .2 HandiFoam Window & Door Sealant, Fomo Products Inc.
 - .3 CF 812 WD, Hilti (Canada) Ltd.
- .2 Thermal Barrier: spray applied fire retardant overcoat meeting applicable requirements of the Building Code for thermal barrier of foamed plastic.
 - .1 Gypsum/fibre based:
 - .1 Acceptable Materials:
 - .1 A/D Thermal Barrier, Carbolite (formerly AD Fire Protection Systems)
 - .2 CafcoBlaze-Shield II, Isolatek International.

- .3 Monokote Z-3306, WR Grace & Co.
- .2 Intumescent Coatings:
 - .1 Basis-of-Design Materials:
 - .1 DC315 Intumescent Coating, IFTI

Part 3 Execution

3.1 PREPARATION

- .1 Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of insulation materials.
- .2 Clean spaces that are to receive insulation, of dirt, dust, grease, loose material or other foreign matter that may inhibit adhesion.
- .3 Prior to application, slightly moisten surfaces to which foam-in-place insulation is being applied, to accelerate curing.
- .4 Temporarily brace frames as may be required to prevent possible bowing of frames due to over expansion of the foam-in-place insulation.

3.2 INSTALLATION/AIR SEAL AROUND EXTERIOR WINDOW AND DOOR FRAMES

- .1 Fill exterior hollow steel door frames 75% full with foam-in-place insulation prior to installation of frames. Fill the remainder of the frame after installation, through the gap between the frame and the wall construction.
- .2 Install foam-in-place insulation around all exterior window frames to maintain continuity of the thermal barrier, after air barrier has been installed and sealed to windows as specified.
- .3 Ensure that foam completely fills spaces, without voids, and that foam is continuous at corners.

3.3 INSTALLATION/AROUND PROTRUSIONS THROUGH AIR SEAL

- .1 Install foam-in-place insulation around all protrusions through the exterior building envelope to achieve and maintain continuity of air/vapour seal.
- .2 Insulate access hatches to the same R value as the assembly in which they occur to maintain continuous thermal protection.

3.4 CLEANING

- .1 Cut back excess foam-in-place insulation once cured, flush with surrounding surfaces, or recess back for application of sealant as specified in Section 07 92 00 - Sealants.
- .2 Upon completion of foam-in-place insulation work, clean adjacent surfaces of overspray and dusting to the satisfaction of the Consultant.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section includes requirements for supply and installation of a spray polyurethane foam air and vapour seal system, and other components to bridge and seal the following air leakage pathways and gaps between; but not limited to, the following:
 - .1 Connections of the walls to the roof air seal.
 - .2 Connections of the walls to the foundations.
 - .3 Expansion joints.
 - .4 Openings and penetrations.
 - .5 Piping, conduit, duct and similar penetrations.
 - .6 All other air leakage pathways in the building envelope.
 - .7 A spray applied thermal barrier over the polyurethane.

1.2 RELATED REQUIREMENTS

- .1 Section 05 31 00 – Steel Deck
- .2 Section 06 10 00 – Rough Carpentry
- .3 Section 05 50 00 – Metal Fabrications
- .4 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
- .5 Section 07 62 00 – Sheet Metal Flashing and Trim
- .6 Section 07 92 00 – Sealants
- .7 Section 09 21 16 – Gypsum Board Assemblies

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C411-19 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .2 ASTM C518-19 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .3 ASTM C1338-19(2022) - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .4 ASTM D1621-16 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics.
 - .5 ASTM D1622-20 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - .6 ASTM D1623-17 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
 - .7 ASTM D2126-20 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
 - .8 ASTM D2369-20, Standard Test Method for Volatile Content of Coatings.
 - .9 ASTM D2842-19 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.

- .10 ASTM D6226-21 - Standard Test Method for Open Cell Content of Rigid Cellular Plastics.
- .11 ASTM E96/E96M-22a - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- .2 Green Seal Environmental Standards:
 - .1 Standard GS-11, Paints, Coatings, Stains and Sealers, Edition 4.0, 2021.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 SDS - Safety Data Sheets.
- .4 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.
- .5 Underwriters' Laboratories of Canada (ULC):
 - .1 ULC 101, Standard Methods of Fire Endurance Tests of Building Construction and Materials (CAN/ULC-S101-14).
 - .2 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies (ULC S102). (2018)
 - .3 ULC 127, Standard Corner Wall Method of Test for Flammability Characteristics of Non-Melting Building Materials. (CAN/ULC S127-14)
 - .4 ULC 705.1, Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Material Specification (CAN/ULC S705.1-15).
 - .5 ULC 705.2, Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Application (2020).
 - .6 ULC 711.1, Standard for Thermal Insulation – Bead-Applied Two Component Polyurethane Air Sealant Foam, Part 1: Material Specification. (2019)
 - .7 ULC 711.2, Standard for Thermal Insulation – Bead-Applied Two Component Polyurethane Air Sealant Foam, Part 2: Installation. (CAN/ULC-S711.2-11) (Withdrawn).
 - .8 ULC 718, Standard for Site Quality Assurance Program for Spray Polyurethane Foam (2018).
 - .9 ULC 770, Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams (CAN/ULC-S770-15).
 - .10 ULC 774 - Standard Laboratory Guide for the Determination of Volatile Organic Compound Emissions from Polyurethane Foam. (CAN/ULC S774).

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

- .2 Provide one electronic copy of WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .2 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: submit certified test reports for insulation from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Submit test reports in accordance with ULC-101 for fire endurance and ULC-102 for surface burning characteristics.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
 - .4 Manufacturer's Field Reports: submit to manufacturer's written reports within three days of review, verifying compliance of Work, as described in PART THREE - FIELD QUALITY CONTROL.
- .3 Moisture content of wood: measure moisture content of wood that is to be in direct contact with insulation. Submit results to Consultant for review. Measure ten different locations and report on plans and details.

1.5 QUALITY ASSURANCE

- .1 Applicators to conform to Manufacturer's third party Site Quality Assurance Program.
- .2 Qualifications:
 - .1 Installer: person specializing in sprayed insulation installations with five years documented experience, approved by manufacturer.
 - .2 Manufacturer: company with minimum five years experience in producing of material used for work required for this project, with sufficient production capacity to produce and deliver required units without causing delay in work.
- .3 Health and Safety Requirements: Worker protection:
 - .1 Protect workers as recommended by ULC-705.2 and manufacturer's recommendations:
 - .2 Workers must wear gloves, respirators, dust masks, long sleeved clothing, eye protection, and protective clothing when applying foam insulation.
 - .3 Workers must not eat, drink or smoke while applying foam insulation.
- .4 Independent Testing Agency:
 - .1 Arrange for site reviews by Manufacturer's authorized agent. Schedule the number of site reviews in accordance with the following schedule:

Coverage Area, sq. m. (sq. ft.)	No. of Site Reviews
3,252 – 6,503 (35,000 – 70,000)	1
6,503 –9,755 (70,001 – 105,000)	2

9,755 – 13,006 (105,001 – 140,000)	3
over 13,006 (over 140,000)	4+

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .3 Deliver materials in sealed unopened containers clearly indicating manufacturer, product identification and safety information.
- .4 Store materials above minimum temperature as recommended by manufacturer.
- .5 Store materials in dry and well-ventilated area away from weather and direct sunlight. Maintain temperatures between 18°C and 30°C.
- .6 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Ventilate area to receive insulation by introducing fresh air and exhausting air continuously during and 24 hour after application to maintain non-toxic, unpolluted, safe working conditions.
- .2 Provide temporary enclosures to prevent spray and noxious vapours from contaminating air beyond application area.
- .3 Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of insulation materials.
- .4 Apply insulation only when surfaces and ambient temperatures are within manufacturer's prescribed limits.
- .5 Use of insulation products manufactured with HCFCs or CFCs as blowing agents is prohibited.
- .6 Plan and coordinate the insulation Work to minimize the generation of cut-offs and waste. Sequence Work to maximize use of insulation off-cuts and waste.

1.8 WARRANTY

- .1 The work under this section shall be warranted by the contractor against defects in workmanship or material for a period of two years from date of Substantial Performance.

Part 2 Products

2.1 MATERIALS

- .1 Acceptable Materials: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 WallTite CM01, BASF.
 - .2 Heatlok Soya, Demilec Inc – Cornell Group.
 - .3 Insulthane Extreme, Elastochem
 - .4 JM Corbond III Canadian Formula, Johns Manville.
 - .5 Polarfoam PF-7300, Polyurethane Foam Systems Inc.
 - .6 BOREAL NATURE, Solutions Genyk Inc.
- .2 Insulation: spray polyurethane to CAN/ULC-S705.1, meeting requirements of Montreal Protocol for ozone protection without ozone depleting substances in blowing agents and as follows:
 - .1 Density to ASTM D1622: $\geq 28 \text{ Kg/m}^3$
 - .2 Thermal Resistance 180 days @ 23 deg C to ASTM C518.: 1.96 RSI/50 mm .
 - .3 Open Cell Content to ASTM D6226: $\leq 8\%$
 - .4 Water Vapour Permeance, 50 mm sample to ASTM E96: $\leq 60 \text{ ng/Pa.s.m}^2$
 - .5 Air Barrier Material, 25-30 mm: $0.00004 \text{ L/s/m}^2 \text{ @ } 75 \text{ Pa}$
 - .6 Water Absorption to ASTM D2842: $< 4\%$
 - .7 Tensile Strength to ASTM D1623: $\geq 200 \text{ kPa}$
 - .8 Compressive Strength to ASTM D1621: $\geq 170 \text{ kPa}$
 - .9 Flame Spread Classification: to ULC S102 and CAN/ULC S127 and as follows:
 - .1 Flame Spread: < 300
 - .2 Smoke Developed: < 400
- .3 Primers: in accordance with manufacturer's recommendations for surface conditions.
 - .1 Maximum VOC limit 100 g/l to SCAQMD Rule 1113.
- .4 Thermal Barrier: Spray applied fire retardant overcoat meeting applicable requirements of the Current Building Code for thermal barrier of foamed plastic.
 - .1 Gypsum/fibre based:
 - .1 Acceptable Materials:
 - .1 A/D Thermal Barrier, Carboline (formerly AD Fire Protection Systems)
 - .2 CafcoBlaze-Shield II, Isolatek International.
 - .3 Monokote Z-3306, WR Grace & Co.
 - .2 Intumescent Coatings:
 - .1 Basis-of-Design Materials:
 - .1 DC315 Intumescent Coating, IFTI

2.2 EQUIPMENT

- .1 Comply with CAN/ULC S705.2 and the equipment manufacturer's recommendations for application type.

2.3 ACCESSORIES

- .1 Prime substrate when required by spray polyurethane manufacturer or the membrane manufacturer. Follow requirements of the manufacturer for the type of primer and the installation of the primer for the surface conditions.

Part 3 Execution

3.1 EXAMINATION

- .1 Inspect areas to receive work of this Section and ensure conditions are suitable to begin application.
- .2 Verify that work penetrating through air seal is complete.
- .3 Verify that appropriate back-up material has been installed in all large voids.
- .4 Confirm wood framing moisture content is suitable (not more than 15%) for installation prior to commencement of work.

3.2 PREPARATION

- .1 Protect finish surfaces which may be exposed to view from overspray.
- .2 Clean substrates of dirt, dust, grease, oil, loose material and other matter which may affect bond of spray applied materials.
- .3 Remove oil from galvanized sheet steel substrates and apply prime coating in accordance with manufacturer's instructions.

3.3 APPLICATION

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Apply insulation to clean surfaces in accordance with ULC S705.2, ULC S718, and manufacturer's printed instructions.
- .3 Use primer where recommended by manufacturer.
- .4 Apply sprayed foam insulation in thickness as indicated.
- .5 Remove masking materials and over spray from adjacent areas immediately after foam surface has hardened.
- .6 Repair damaged areas in accordance with manufacturer's application guidelines for insulation.
- .7 Cover spray polyurethane foam with fire retardant overcoat when installed on building interior in accordance with manufacturer's instructions.

3.4 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:

- .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.6 PROTECTION

- .1 Protect spray polyurethane foam installation from ultraviolet exposure in accordance with manufacturer's requirements.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Self-adhesive air and vapour barrier system materials, mastics, adhesives and accessories.
- .2 Related Requirements:
 - .1 Section 03 30 00 – Cast-In-Place Concrete
 - .2 Section 07 21 13 – Board Insulation
 - .3 Section 07 21 19 – Foam-In-Place Insulation
 - .4 Section 07 52 00 – Modified Bituminous Membrane Roofing
 - .5 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .6 Section 07 92 00 – Sealants
 - .7 Section 08 11 13 – Steel Doors and Frames
 - .8 Section 08 11 16 – Aluminum Doors and Frames
 - .9 Section 08 44 13 – Glazed Aluminum Framed Curtain Walls
 - .10 Section 08 50 13 – Aluminum Windows
 - .11 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing of Materials International (ASTM):
 - .1 ASTM D93-20, Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester.
 - .2 ASTM D146/D146M-04(2020), Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.
 - .3 ASTM D412-16(2021), Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
 - .4 ASTM D1970/D1970M-21, Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - .5 ASTM D5147/D5147M-18 Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.
 - .6 ASTM E96/E96M-23, Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
 - .7 ASTM E283/E283M-19, Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Skylights, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
 - .8 ASTM E2178-21a, Standard Test Method for Determining Air Leakage Rate and Circulation of Air Permeance of Building Materials.

- .9 ASTM E2357-24, Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 Canadian Standards Association (CSA Group):
 - .1 CSA A123.23-15 (R2020), Product Specification for Polymer-Modified Bitumen Sheet, Prefabricated and Reinforced.
- .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 37-GP-56M, Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.
 - .2 CAN/CGSB 51.34-M86 (withdrawn), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 ULC 741, Standard for Air Barrier Materials – Specification (CAN/ULC S741-08).
 - .2 ULC 742, Standard for Air Barrier Assemblies – Specification (CAN ULC S742-20).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Select products to be compatible with adjoining membranes previously installed under related Sections.
 - .2 Select products from a single manufacturer, or products which are compatible from different manufacturers.
 - .3 Coordination between all installers of each component of vapour and air retarder system is essential to ensure continuity of system and that junctions between the various components are effectively sealed.
 - .4 Verify with manufacturers and all tradesmen involved with installation procedures of building products incorporated into air barrier elements including, but not limited to, various membranes, coating and sealants as well as continuity with roofing membrane.
- .2 Pre-installation Meeting:
 - .1 Convene one week before commencing Work of this Section.
 - .2 Arrange for manufacturer's factory-trained agent to be on site at beginning of installation to provide training and supervision of personnel who will install membrane. Agent shall provide frequent inspection visits thereafter to assure quality and competence of membrane installations.
- .3 Sequencing:
 - .1 Sequence work in accordance with Construction Progress Schedule.
 - .2 Sequence work to permit installation of materials in conjunction with related materials and seals.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets.
 - .3 Submit statement from manufacturer(s), indicating products supplied under this Section are compatible with one another and with products previously installed under the work of related Sections.
- .2 Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Existing Substrate Condition: report deviations, as described in Part Three -EXAMINATION in writing to Consultant.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.
- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Applicator: company specializing in performing work of this section with minimum three years documented experience with installation of air/vapour barrier systems.
 - .1 Completed installation must be approved by the material manufacturer.
- .2 Single-Source Responsibility: obtain primary air and vapour materials from a single manufacturer regularly engaged in the manufacturing and supply of the specified products and meeting or exceeding the material properties and performance characteristics of the materials and manufacturers named in this Section.
- .3 Mock-ups:
 - .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct typical exterior wall panel, 3 m long by 4 m wide, incorporating window and frame and sill, insulation, building corner condition, and junction with roof system; illustrating materials interface and seals.
 - .3 Locate where directed.
 - .4 Mock-up may remain as part of finished work.
 - .5 Allow review of mock-up by Consultant before proceeding with air/vapour barrier Work. Accepted mock-up will demonstrate minimum standard of quality required for this project.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 01 - LEED Product Requirements.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .3 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Install solvent curing sealants and vapour release adhesive materials in open spaces with ventilation.
- .2 Ventilate enclosed spaces in accordance with Section 01 51 00 - Temporary Utilities.
- .3 Maintain temperature and humidity recommended by materials manufacturer before, during and after installation.
- .4 Ensure wood has a moisture content less than 19% prior to encapsulating with impermeable membrane.
- .5 Apply air/vapour barrier membrane to gypsum board surfaces which are dry, when temperature is 4 degrees C or higher or as per manufacturer's recommendations.
- .6 Apply air/vapour barrier membrane to cast-in-place concrete, precast concrete, masonry (strike masonry joints flush) which are smooth, clean, dry, and in good condition. Moisture, grease, machine oil or other foreign material must be removed. Concrete must be cured, minimum seven days, and dry before application, and when temperature is 5 degrees C or higher or as per manufacturer's recommendations.
- .7 All membrane shall be installed at surface and ambient temperature of 5°C or above, in dry weather conditions.
- .8 For applications below 5°C consult membrane manufacturer's technical representative for instructions and, obtain Consultant's approval before proceeding with Work.
- .9 Self adhered membrane shall not be applied below application temperature of minus 10 °C despite primers being able to be applied at colder temperatures.

1.8 WARRANTY

- .1 Manufacturer's Warranty: issue and written and signed warranty in the name of the Owner, certifying the product will meet the physical characteristics published by the manufacturer for a period of five years starting from the completion date of installation of membranes.
- .2 Installer's Warranty: Submit installers warranty stating that air and vapour membranes and accessories are installed in accordance with manufacturer's recommendation and that membrane, transitions and through-wall flashing

membranes, primers, mastics, adhesives and sealants are sourced from one manufacturer.

Part 2 Products

2.1 SELF-ADHESIVE AIR AND VAPOUR BARRIER SYSTEM MATERIALS

- .1 Primer: SBS synthetic rubbers, adhesive resins and solvents used to prime porous substrates to enhance adhesion of self-adhesive membranes at temperatures above -10°C.
 - .1 Specific gravity at 20°C (kg/l): 0.79 to 1.0 kg/l.
 - .2 Solids by weight: 24% to 53%.
 - .3 Flash point: -30°C to ASTM D93.
 - .4 Acceptable Materials: manufacturers recommended product.
- .2 Air/Vapour Barrier Membrane (winter application): to CAN/CGSB 37.56 or ASTM D1970; SBS modified bitumen, self-adhering sheet membrane with polyethylene facer, for application temperatures between -10°C and 10°C and as follows:
 - .1 Thickness: 1 mm to 1.5 mm.
 - .2 Tensile strength: 11.3 kN/m to 15.4 kN/m to ASTM D5147.
 - .3 Ultimate elongation: 25% to 40%.
 - .4 Flexibility at cold temperature: minimum -30°C.
 - .5 Air permeability: <0.0003 L/sec. m²
 - .6 Water vapour permeability: <0.05 perm.
 - .7 Static puncture: minimum 178 N.
 - .8 Lap adhesion: 800 N/m.
 - .9 Acceptable Materials:
 - .1 Perm-A-Barrier Wall Membrane LT, GCP Applied Technologies.
 - .2 Blueskin SA LT, Henry Company.
 - .3 AVB LT, IKO.
 - .4 Sopraseal Stick 1100 T, Winter Grade, Soprema.
 - .5 Exoair 110 LT, Tremco Inc.
 - .6 Air Shield LT, W.R. Meadows.
- .3 Air/Vapour Barrier Membrane (summer application): to CAN/CGSB 37.56 or ASTM D1970; SBS modified bitumen, self-adhering sheet membrane with polyethylene facer, for application temperature above 5°C, and as follows:
 - .1 Thickness: 1 mm to 1.5 mm.
 - .2 Tensile strength: minimum 6 kN/m.
 - .3 Ultimate elongation: 25% to 40%.
 - .4 Flexibility at cold temperature: minimum -17°C.
 - .5 Air permeability: <0.0003 L/sec. m²
 - .6 Water vapour permeability: <0.05 perm.
 - .7 Static puncture: 400 N.

- .8 Lap adhesion: minimum 1750 N/m.
- .9 Acceptable Materials:
 - .1 Perm-A-Barrier Wall Membrane, GCP Applied Technologies.
 - .2 Blueskin SA, Henry Company.
 - .3 AquaBarrier AVB, IKO.
 - .4 AVB LT, IKO.
 - .5 Sopraseal Stick 1100, Summer Grade, Soprema.
 - .6 Exoair 110, Tremco Inc.
 - .7 Air Shield, W.R. Meadows.
- .4 Waterproofing Underlayment: self adhering membrane for high temperature applications; rubberized asphalt will not flow up to temperatures as high as 116°C.
 - .1 Primer: as recommended by manufacturer.
 - .2 Acceptable Materials:
 - .1 Ice and Water Shield HT, Grace Construction Products.
 - .2 PE200 HT, Henry
 - .3 Lastobond Shield HT, Soprema.
 - .4 Roofblock HT, Vaproshield
 - .5 Mel-Prime, W.R. Meadows.

2.2 MASTICS AND ADHESIVES

- .1 Waterproofing Mastic: solvent-based mastic containing SBS modified bitumen, fibres and mineral fillers, used to seal around penetrations and extrusions.
 - .1 Compatibility: With air/vapour barrier membrane, substrate and insulation.
 - .2 Specific gravity at 20°C: 1.0 kg/l to 1.12 kg/l.
 - .3 Application Temperature: -10°C to +35°C.
 - .4 Solids by Weight: 70% to 83 %.
 - .5 Acceptable Materials: manufacturers recommended product.

2.3 ACCESSORIES

- .1 Thinner and cleaner for Butyl or Neoprene Sheet: as recommended by sheet material manufacturer.
- .2 Attachments: galvanized steel bars and anchors.
- .3 Roof-to-Wall Transition Membranes: Manufacturer's recommended reinforced self adhesive, compatible with roofing air and vapour membranes and wall materials specified in this Section.
 - .1 Basis-of-Design Materials:
 - .1 Henry Blueskin Butyl Flash for transition with EPDM, PVC and TPO Membranes.
- .4 Through Wall Membranes: Manufacturer's recommended reinforced self adhesive, compatible with air and vapour membrane and that will not become

plastic and extrude onto finished surfaces when exposed to high wall temperatures.

- .1 Acceptable Materials:
 - .1 3015TWF, 3M.
 - .2 Blueskin TWF, Henry Company.
 - .3 TWF, IKO.
 - .4 Sopraseal Stick 1100T, Soprema.
 - .5 Air-Shield TWF, W.R. Meadows
- .5 Sealant: Non-hardening sealant compatible with vapour barrier materials, recommended by membrane manufacturer and In accordance with Section 07 92 00 - Sealants.
- .6 Substrate Primer: adhesive compatible with substrate and vapour barrier materials and as recommended by vapour barrier membrane manufacturer.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that surfaces and conditions are ready to accept work of this section.
- .2 Verification of Conditions: Verify that conditions of substrate or work previously installed under other Sections are acceptable for air barrier installation in accordance with manufacturer's written recommendations.

3.2 PREPARATION

- .1 Ensure surfaces are clean, dry, sound, smooth, continuous and comply with air barrier manufacturer's requirements.
- .2 Remove loose or foreign matter, which might impair adhesion of materials.
- .3 Ensure substrates are clean of oil or excess dust; masonry joints struck flush, and open joints filled; and concrete surfaces free of large voids, spalled areas or sharp protrusions
- .4 Do not install materials during rain or snowfall.
- .5 Report unsatisfactory conditions to Consultant in writing.
- .6 Do not start work until deficiencies have been corrected.
 - .1 Beginning of Work implies acceptance of conditions.

3.3 INSTALLATION: SELF ADHERING SYSTEM

- .1 Prime surfaces of difficult to stick to substrates using adhesive in accordance with air barrier manufacturer's written recommendations before applying membrane.
- .2 Apply primer to substrates in accordance with manufacturer's written instructions. Apply primer that will be covered with membrane the same day. Re-prime areas that are not covered the same day.

- .3 Align and position self-adhering transition membrane, remove protective film and press firmly into place. Ensure minimum 150 mm overlap at all end and side laps.
- .4 Corner details: Double cover outside and inside corners, use 300 mm wide initial strip of membrane centred on axis of corner. Follow with full width of sheet membrane to cover initial strip completely.
- .5 Construction and control joints: Install membrane in double thickness over properly sealed joints, use 300 mm wide initial strip of membrane centred over joint. Follow with full width of sheet membrane. Assure that joints are properly sealed; joint filler and a compatible sealant are installed.
- .6 Tie-in to window frames, aluminium screens, hollow metal doorframes, spandrel panels, roofing system and at the interface of dissimilar materials as indicated in drawings in order to facilitate a continuous air, vapour & moisture membrane.
- .7 Roll laps and membrane with a counter top roller to effect seal.
- .8 Small protrusions (pipes, etc.) through the waterproofing membrane, should be pre-stripped with a membrane and sealed with mastic.
- .9 Inspect membrane installation meticulously and immediately. Holes and tears in the membrane must be repaired with air / vapour barrier membrane material. The repair must exceed the affected surface area by a minimum of 150 mm. The membrane piece applied for the repair must be sealed around its edges with mastic.
- .10 Laps in membrane to be positively shingle lapped. In any case where construction does not allow for proper sequencing and a negative lap occurs, leading edge to be terminated with compatible mastic.

3.4 INSTALLATION: THROUGH WALL FLASHINGS

- .1 Apply through-wall flashing membrane where detailed on the drawings. Apply through-wall flashing membrane where detailed on the drawings. At openings, extend flashing 200 mm beyond jambs.
- .2 Coordinate installation of through wall flashing with air/vapour barrier of this Section, to ensure a water tight installation and to maintain continuity of the air/vapour barrier. Sequence membrane flashing installation with air/vapour barrier installation, so that air/vapour barrier membrane overlaps top edge of membrane flashing, minimum 50 mm and is completely and continuously sealed in place to maintain air/vapour barrier and to shed water in cavity to the exterior.
- .3 Apply continuous membrane flashing over all ledger angles or supporting sills, extending flashing up behind air/vapour barrier, and up vertical surface minimum 200 mm. Coordinate installation of flashing with installation of air/vapour barrier, so that air/vapour barrier weather laps over membrane flashing to provide a weather tight installation and to maintain continuity of the air/vapour barrier. Extend flashing horizontally over ledger angle or supporting sill, stopping maximum 10 mm from horizontal leg of ledger angle or supporting sill.
- .4 For the application of SBS modified self-adhered through-wall flashings and other applications of SBS modified self-adhered transition membranes, condition the substrate with applicable primer.

- .1 Apply primer at rate recommended by manufacturer to all areas to receive SBS modified self-adhering sheet membrane as indicated on drawings by roller or spray and allow to dry.
- .2 Primed surfaces not covered by self-adhering membrane or self-adhering through-wall flashing membrane during the same working day must be re-primed.
- .5 Prime surfaces and allow to dry, press membrane firmly into place, overlap minimum 50 mm at all side and end laps. Promptly roll all laps and membrane to ensure the seal.
- .6 Ensure applications form a continuous flashing membrane and extend up a minimum of 203 mm up the back-up wall.
- .7 Seal the top edge of the membrane where it meets the substrate using termination sealant. Trowel-apply a feathered edge to seal termination to shed water.
- .8 Ensure through-wall flashing membrane extends fully to the exterior face of the exterior masonry veneer. At locations where flashing terminates or intersects wall openings including door frames, "end dam" flashing to protect openings and redirect water out. Trim off excess as directed by the Consultant.

3.5 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART ONE - ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART ONE - QUALITY ASSURANCE.
- .2 The Consultant shall inspect installed membrane for continuity of air barrier prior to placement of insulation.
- .3 Provide pull adhesion test in accordance with ASTM D4541 for metal and ASTM D7234 for concrete. Provide results to Consultant.
- .4 Non-confirming work and damages: Make repairs to manufacturers written instructions.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.7 PROTECTION

- .1 Protect finished work from penetrations.

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- .2 Do not permit adjacent work to damage work of this section.
- .3 Ensure finished work is protected from climatic conditions.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Self adhered air barrier sheet materials, vapour barrier sheet materials and accessories as indicated on Drawings.
- .2 Related Requirements:
 - .1 Section 03 30 00 – Cast-In-Place Concrete
 - .2 Section 04 22 00 – Unit Masonry
 - .3 Section 06 10 00 – Rough Carpentry
 - .4 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .5 Section 07 46 23 – Wood Siding and Soffit
 - .6 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .7 Section 07 92 00 – Sealants
 - .8 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Architectural Manufacturers Association (AAMA) / Fenestration and Glazing Industry Alliance (FGIA):
 - .1 711-22, Specification for Self Adhering Flashing used for Installation of Exterior Wall Fenestration Products
 - .2 American Concrete Institute (ACI):
 - .1 ACI PRC-302.2-22, Concrete Slabs that Receive Moisture-Sensitive Flooring Materials Guide.
 - .3 American Association of Textile Chemists and Colorists (AATCC):
 - .1 AATCC 127-2017, Water Resistance: Hydrostatic Pressure Test
 - .4 American Society for Testing and Materials International (ASTM):
 - .1 ASTM D882-18, Standard Test Method for Tensile Properties of Thin Plastic Sheeting
 - .2 ASTM D1117-01, Standard Guide for Evaluating Nonwoven Fabrics (Withdrawn 2009).
 - .3 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials
 - .4 ASTM E96/E96M-23, Standard Test Methods for Gravimetric Determination Water Vapor Transmission Rate of Materials.
 - .5 ASTM E154/E154M-08a(2019), Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
 - .6 ASTM E1643-18a, Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

- .7 ASTM E1677-23, Standard Specification for Air Barrier (AB) Material or Assemblies for Low-Rise Framed Building Walls.
- .8 ASTM E1745-17(2023), Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
- .9 ASTM E1993/E1993M-98(2020), Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
- .10 ASTM E2178-21a, Standard Test Method for Determining Air Leakage Rate and Circulation of Air Permeance of Building Materials.
- .11 ASTM E2357-24, Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies.
- .12 ASTM F1249-20, Standard Test Method for Water Vapour Transmission Rate through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
- .5 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .6 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 51.32-M77, Sheathing, Membrane, Breather Type. (Withdrawn)
 - .2 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction. (Withdrawn)
- .7 Canadian Standards Association (CSA Group):
 - .1 CSA A23.1:19/A23.2:19, Concrete materials and methods of concrete construction test methods and standard practices for concrete
- .8 European Standard (DIN):
 - .1 DIN EN 13859-1, Flexible sheets for waterproofing – Definitions and characteristics of underlays- Part 1: Underlays for discontinuous roofing; German version EN 13589-1:2014.
- .9 Technical Association of the Pulp and Paper Industry (TAPPI):
 - .1 TAPPI T 410 om-19, Grammage of Paper and Paperboard (Weight per Unit Area).
 - .2 TAPPI T 460 om-21, Air Resistance of Paper (Gurley Method).
- .10 Underwriters Laboratories of Canada (ULC):
 - .1 ULC 741, Standard for Air Barrier Materials- Specification (CAN/ULC S741-08).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordination between all installers of each component of vapour and air retarder system is essential to ensure continuity of system and that junctions between the various components are effectively sealed.

- .2 Verify with manufacturers and all tradesmen involved with installation procedures of building products incorporated into vapour and air retarder elements including, but not limited to, various membranes, coatings and sealants as well as continuity with roofing membrane.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for each product specified.
 - .2 Submit manufacturer's installation instructions including joint treatment recommendations.
 - .3 Product Data: Provide data on material performance criteria and limitations.
 - .4 Shop Drawings: Provide Drawings of special joint conditions.
 - .5 Installation Data: Manufacturer's special installation requirements, including preparation, installation requirements and techniques, product storage and handling criteria.
- .2 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Mock-ups:
 - .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct typical exterior wall panel, 3 m long by 4 m wide, incorporating window openings with frame and sill installed, insulation, building corner condition, junction with roof system; illustrating materials interface and seals.
 - .3 Construct typical underslab installation, minimum 10 sq.m. incorporating insulation, corner condition, junction with foundation; lapping, penetration, illustrating materials interface and seals.
 - .4 Locate where directed by Consultant.
 - .5 Mock-up may remain as part of Work.
 - .6 Allow 24 hours for inspection of mock-up by Consultant before proceeding with air/vapour barrier work.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 01 - LEED Product Requirements.
- .2 Store materials in clean, dry area in accordance with manufacturer's instructions.
- .3 Protect materials during handling and application to prevent damage.
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Apply air and vapour barrier membrane within the range of ambient and substrate temperatures recommended by air and vapour barrier membrane manufacturer.

Part 2 Products

2.1 SELF ADHERED AIR BARRIER SHEET MATERIALS

- .1 Self-Adhered Air Barrier Membrane: water resistive, vapour permeable, air barrier sheet membrane consisting of laminated modified polyolefin with two layers of non-woven polyethylene and adhesive backing to be protected with three piece release film. Tested to ULC 741 and as follows:
 - .1 Air Permeance: $< 0.02 \text{ L/s/m}^2$ @ 75 Pa in accordance with ASTM E2178 and ULC 741.
 - .2 Air Leakage: pass in accordance with ASTM E2357.
 - .3 Vapour Permeance: >12 perms to ASTM E96, Dessicant method A.
 - .4 Water Vapour Transmission Rate: 202 g/m^2 24 hours maximum.
 - .5 Primer: rubber based adhesive primer for self adhered air barrier as required by membrane manufacturer.
 - .6 Acceptable Materials:
 - .1 Delta Vent SA, Dorken Systems Inc.
 - .2 Blueskin VP160, Henry Company.
 - .3 Majvest 500SA, SIGA SWISS.
 - .4 Air Outshield SA 280, SRP.
 - .5 Wrapsheild SA, Vaproshield, LLC.
 - .6 Air-Shield SMP, W.R. Meadows of Canada.
 - .7 Other materials may be acceptable subject to compliance with requirements, provided information is provided to Consultant for review and acceptance prior to Bid Closing. Only membranes with a minimum of 29 PERMS to ASTM E96 desiccant method A will be considered.
- .2 Termination sealants as recommended by air barrier membrane manufacturer.

2.2 VAPOUR BARRIER SHEET MATERIALS

- .1 Plastic Sheet Vapour Retarder (Exterior Stud Walls): 6 mil polyethylene sheet meeting requirements of CAN/CGSB-51.34.
- .2 Plastic Sheet Vapour Retarder (Underslab): High density, puncture resistant polyolefin resin sheet in accordance with ASTM E1745 and CAN/CGSB-51.34, and as follows:
 - .1 Thickness: 15 mil.
 - .2 Vapour Permeance: Nominal ≤ 0.02 Perms maximum.
 - .3 Tensile Strength and Puncture Resistance: ASTM E1745 Class A minimum.

- .4 Acceptable Materials:
 - .1 VaporFlex, Layfield Construction Materials 15.
 - .2 VaporBlock VB, Raven Industries 15.
 - .3 Stego Wrap, Stego Industries LLC 15 mil.
 - .4 Perminator HP, W.R. Meadows 15 mil.

2.3 ACCESSORIES

- .1 Accessory Materials: Provide manufacturer's required seam tape, pipe boots and vapour proofing mastic forming a complete system in accordance with ASTM E1643.
- .2 Seam Tape: High density, air resistant polyethylene tape with pressure sensitive adhesive. Type as recommended by vapour retarder manufacturer. Minimum 100 mm for lap joints and perimeter seals, 50 mm wide elsewhere.
- .3 Sealant: as recommended by vapour retarder manufacturer in accordance with Section 07 92 00 - Sealants.
- .4 Substrate Crack Filler: Closed cell foam backer rod.
- .5 Through Wall Membranes: Manufacturer's recommended reinforced self adhesive, compatible with air and vapour membrane and that will not become plastic and extrude onto finished surfaces when exposed to high wall temperatures.
 - .1 Acceptable Materials:
 - .1 3015TWF, 3M.
 - .2 Blueskin TWF, Henry Company.
 - .3 TWF, IKO.
 - .4 Sopraseal Stick 1100T, Soprema.
 - .5 Air-Shield SMP, W.R. Meadows
- .6 Flashing Tape: Self-adhering waterproof tape 100 mm wide to AAMA 711 and as recommended by vapour retarder membrane manufacturer.
- .7 Fasteners: Provide non-corrosive metal screws, nails, plastic clips and other fasteners as recommended by air/vapour retarder manufacturer required for complete installation of Work.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine surfaces to receive membrane. Notify consultant if surfaces are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

3.2 INSTALLATION: SELF ADHERED AIR BARRIER SHEET MATERIALS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

- .2 Apply self adhering air barrier membrane to substrate in overlapping shingle fashion. Stagger all vertical joints.
- .3 Prime surfaces as per manufacturer's instructions and allow to dry.
- .4 Prime surfaces of difficult to stick to substrates using adhesive in accordance with air barrier manufacturer's written recommendations before applying membrane.
- .5 Align self-adhering membrane to substrate, remove top panel of protective release film and press firmly into place.
- .6 Hold membrane in place to avoid tenting, bubbles, and wrinkles and remove remaining panels of protective film and press firmly into place.
- .7 Ensure minimum 64 mm overlap at all end and side laps of membrane applications or as required by Manufacturer.
- .8 Pressure roll all membrane surfaces, laps and flashings with a counter top roller or J-roller to ensure surface adhesion.
- .9 Seal top edge of the membrane at the end of each day with termination sealant. Trowel apply a feathered edge to seal termination and shed water.
- .10 Application of termination sealant:
 - .1 Seal membrane terminations, heads of mechanical fasteners, masonry tie fasteners, around penetrations, duct work, electrical and other apparatus extending through the primary air barrier membrane and around perimeter edge of membrane terminations at window and door frames with termination sealant.

3.3 **INSTALLATION: SHEET VAPOUR BARRIER**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Verify that services are installed and have been accepted by the Consultant and Authorities Having Jurisdiction prior to installation of vapour retarder.
- .3 Pre-strip framing at floors and other changes in plane that cannot be accessed after framing is installed.
- .4 Install sheet vapour retarder on warm side of exterior wall, ceiling, and floor assemblies prior to installation of gypsum board to form continuous retarder in accordance with manufacturers written instructions.
- .5 Use sheets of largest practical size to minimize joints.
- .6 Install materials in a manner that maintains continuity; repair punctures and tears with sealing tape before work is concealed.
- .7 Openings:
 - .1 Cut sheet vapour retarder to form openings and lap and seal to window and door frames in accordance with good building envelope practice.
- .8 Seal perimeter of sheet vapour retarder as follows:
 - .1 Apply continuous bead of sealant to substrate at perimeter of sheets.

- .2 Lap sheet over sealant and press into sealant bead.
- .3 Adhere sheets using sealant bead at each steel framing member and at top and bottom tracks.
- .4 Install sealant bead with no gaps; smooth out folds and ripples occurring in sheet over sealant.
- .9 Seal lap joints of sheet vapour retarder as follows:
 - .1 Attach first sheet to substrate.
 - .2 Apply continuous bead of sealant over solid backing at joint.
 - .3 Lap adjoining sheet minimum 100 mm and press into sealant bead.
 - .4 Adhere sheets using sealant bead at each steel framing member and at top and bottom tracks.
 - .5 Install sealant bead with no gaps; smooth out folds and ripples occurring in sheet over sealant.

3.4 INSTALLATION: UNDERSLAB SHEET VAPOUR BARRIER

- .1 Install vapour barrier in accordance with manufacturer's written instructions and ASTM E1643, and generally as follows:
 - .1 Unroll vapour barrier with the longest dimension parallel to direction of concrete placement.
 - .2 Lap vapour barrier onto face of grade beams.
 - .3 Overlap joints 200 mm and seal with manufacturer's required tape.
 - .4 Seal penetrations including pipe and conduit risers in accordance with manufacturer's written instructions.
 - .5 Make no additional penetrations except as required for placing of reinforcing steel and permanent utilities.
- .2 Repair damaged areas by cutting patches of vapour barrier membrane; sized to overlap damaged area a minimum of 150 mm to each side of puncture; and tape all sides using manufacturer's required tape.

3.5 INSTALLATION: THROUGH WALL FLASHINGS

- .1 Apply through-wall flashing membrane where detailed on the drawings. Apply through-wall flashing membrane where detailed on the drawings. At openings, extend flashing 200 mm beyond jambs.
- .2 Coordinate installation of through wall flashing with air/vapour barrier of this Section, to ensure a water tight installation and to maintain continuity of the air/vapour barrier. Sequence membrane flashing installation with air/vapour barrier installation, so that air/vapour barrier membrane overlaps top edge of membrane flashing, minimum 50 mm and is completely and continuously sealed in place to maintain air/vapour barrier and to shed water in cavity to the exterior.
- .3 Apply continuous membrane flashing over all ledger angles or supporting sills, extending flashing up behind air/vapour barrier, and up vertical surface minimum 200 mm. Extend flashing horizontally over ledger angle or supporting sill, stopping maximum 10 mm from horizontal leg of ledger angle or supporting sill. At openings, extend flashing 200 mm beyond jambs.

- .4 Apply continuous membrane flashing over all ledger angles or supporting sills, extending flashing up behind air/vapour barrier, and up vertical surface minimum 200 mm. Coordinate installation of flashing with installation of air/vapour barrier, so that air/vapour barrier weather laps over membrane flashing to provide a weather tight installation and to maintain continuity of the air/vapour barrier. Extend flashing horizontally over ledger angle or supporting sill, stopping maximum 10 mm from horizontal leg of ledger angle or supporting sill.
- .5 For the application of SBS modified self-adhered through-wall flashings and other applications of SBS modified self-adhered transition membranes, condition the substrate with applicable primer.
 - .1 Apply primer at rate recommended by manufacturer to all areas to receive SBS modified self-adhering sheet membrane as indicated on drawings by roller or spray and allow to dry.
 - .2 Primed surfaces not covered by self-adhering membrane or self-adhering through-wall flashing membrane during the same working day must be re-primed.
- .6 Prime surfaces and allow to dry, press membrane firmly into place, overlap minimum 50 mm at all side and end laps. Promptly roll all laps and membrane to ensure the seal.
- .7 Ensure applications form a continuous flashing membrane and extend up a minimum of 203 mm up the back-up wall.
- .8 Seal the top edge of the membrane where it meets the substrate using termination sealant. Trowel-apply a feathered edge to seal termination to shed water.
- .9 Ensure through-wall flashing membrane extends fully to the exterior face of the exterior masonry veneer. At locations where flashing terminates or intersects wall openings including door frames, "end dam" flashing to protect openings and redirect water out. Trim off excess as directed by the Consultant.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Composite metal panels, face sheets and accessories including; thermally broken clip System, sub-framing thermal spacers, insulation fasteners, isolation tape, blocking and bracing as required for panel system.
- .2 Related Requirements:
 - .1 Section 01 35 00 – Delegated Design
 - .2 Section 06 10 00 – Rough Carpentry
 - .3 Section 07 21 13 – Board Insulation
 - .4 Section 07 42 43 – Insulated Wall Panels
 - .5 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .6 Section 07 92 00 – Sealants
 - .7 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Aluminum Association (AA):
 - .1 AA DAF-45-2003 (R2009), Designation System for Aluminum Finishes.
 - .2 American Aluminum Manufacturers Association (AAMA)/Fenestration & Glazing Industry Alliance (FGIA):
 - .1 AAMA 2605-22, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels. (With Coil Coating Appendix)
 - .2 AAMA 509-14, Voluntary Test and Classification Method for Drained and Back Ventilated Rain Screen Wall Cladding System.
 - .3 AAMA 621-02 Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
 - .3 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A240/A240M-23a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM A480/A480M-23b, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - .3 ASTM A653/A653M-23, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

- .4 ASTM A755/A755M-18, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
- .5 ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .6 ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .7 ASTM C297/C297M-16, Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions.
- .8 ASTM D523-14(2018), Standard Test Method for Specular Gloss.
- .9 ASTM D1781-98(2021), Standard Test Method for Climbing Drum Peel for Adhesives.
- .10 ASTM D1929-23, Standard Test Method for Determining Ignition Temperature of Plastics.
- .4 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .5 Canadian Sheet Steel Building Institute (CSSBI):
 - .1 CSSBI 20M-17, Standard for Sheet Steel Cladding for Industrial, Commercial and Institutional Building Applications.
 - .2 CSSBI S8-18, Quality and Performance Specification for Prefinished Sheet Steel Used for Building Products.
- .6 Canadian Standards Association (CSA Group)
 - .1 CSA S157-17/S157.1-17(R2022), Strength Design in Aluminum/Commentary on CSA S157-17, Strength Design in Aluminum.
 - .2 CSA S136-16, North American Specification for the Design of Cold Formed Steel Structural Members
 - .3 CSA W47.2-11(R2020), Certification of Companies for Fusion Welding of Aluminum, Includes Update No. 1 (2011), Update No. 2 (2012).
- .7 Underwriters Laboratories of Canada (ULC):
 - .1 ULC 134, Standard Method of Fire Test of Exterior Wall Assemblies. (CAN/ULC-S134-13).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with Contractor, Consultant, installer, manufacturer's representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

- .2 Manufacturer's representative shall also provide frequent inspection visits during the course of work of this Section to assure quality and competence of panel installation.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet.
 - .2 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets acceptable to Labour Canada, and Health and Welfare Canada.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures and Section 01 35 00 – Delegated Design:
 - .1 Indicate layout, profiles and product components including anchorage, accessories, finish colours and textures.
 - .2 Include details showing thickness and dimensions of the various system parts, fastening and anchoring methods, locations of joints and gaskets and location and configuration of movement joints.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit duplicate 300 x 300 mm samples of composite panel in thickness specified from representative materials, finishes and colours. Include clips, anchors, supports, fasteners, closures, and other panel accessories for assembly approval.
- .4 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.
- .5 Submit quality control submittals in accordance with Section 01 45 00 - Quality Control.
 - .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
 - .2 Certificates: submit certificates signed by manufacturer certifying that composite wall panels comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Field Reports: submit to manufacturer's written reports within three days of review, verifying compliance of Work, as described in FIELD QUALITY CONTROL.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Installer Qualifications: Engage experienced installer with a minimum of five years experience who has completed systems similar in material, design, and extent to that indicated for Project and with record of successful performance and is approved by manufacturer.

- .2 Retain a professional engineer, registered in the province of the Work, to design fabrication and erection of the Work of this Section in accordance with applicable Building Code and Contract Document requirements including, but not limited to, the following:
 - .1 Seal and signature to shop drawings and design submittals requiring structural engineering.
 - .2 Site review and certification of installed components.
 - .3 Completion of Letters or Commitment and Supervision specified in Section 01 35 00 – Delegated Design.
 - .4 Manufacturer's Engineering Recommendations: Perform composite wall panel work in accordance with written recommendations from panel manufacturer.
 - .5 Verify panel thickness based on maximum deflections provided in this Section and to suit building location and configuration.
- .3 Mock-ups:
 - .1 Mock-ups: construct mock-ups in accordance with Section 01 45 00 - Quality Control and to requirements supplemented as follows:
 - .1 Provide mock-up for evaluation of surface finishes and workmanship.
 - .2 Construct mock-up indicating relationship between wall panels, air spaces, air/vapour retarder membrane, windows, and doors.
 - .3 Co-ordinate type and location of mock-ups with project requirements.
 - .4 Accepted units will be used as standard for acceptance of production units.
 - .5 Remove and replace units which are not accepted.
 - .6 Do not proceed with remaining work until workmanship, colour, and finish are reviewed by Consultant.
 - .7 Refinish mock-up area as required to produce acceptable work.
 - .8 When accepted, mock-up will demonstrate minimum standard of quality required for this work.
 - .1 Approved mock-up may remain as part of finished work.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 01 - LEED Product Requirements.
- .2 Deliver, store and protect material in accordance with panel manufacturer's recommendations.
- .3 Do not expose panels with strippable film to direct sunlight or extreme heat.
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 WARRANTY

- .1 Special warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.
- .2 Special Finish Warranty: Submit a written warranty, signed by manufacturer, covering failure of the factory-applied exterior finish on metal wall panels within the specified warranty period and agreeing to repair finish or replace wall panels that show evidence of finish deterioration. Deterioration of finish includes, but is not limited to, colour fade, chalking, cracking, peeling, and loss of film integrity for a period of 20 years from date of Substantial Performance.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 Alucobond Plus, Alcan Composites Inc.
 - .2 Alcotex, Alcotex Inc.
 - .3 Accumet 2000, Flynn.
 - .4 Alpolic, Mitsubishi Chemical.
 - .5 Reynobond, Reynolds American Manufacturing.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Maximum deflection not to exceed L/180 under system's own weight plus wind load (positive and negative) loads acting normal to the plane in accordance with the Building Code Climatic Data, wind load 1:30 years.
- .2 Calculate live load deflections in accordance with CSSBI 20M, as modified by the requirements of this Section.
- .3 Provide for movement of components without causing buckling, failure of joint seals, undue stress on fasteners when subject to seasonal temperature range from -40°C (-40°F) to +50°C (120°F), and seismic and wind loads noted.
- .4 Include expansion joints to accommodate movement in wall system and between wall system and building structure, where these movements are caused by deflection of building structure, and accommodate these movements, without permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.
- .5 Provide for positive drainage to the exterior of all water entering or condensation occurring within the system.
- .6 Final review and acceptance of work completed by this Section shall be carried out by the manufacturer's representative, the Consultant, Contractor and the Subcontractor.

2.3 COMPOSITE METAL PANEL MATERIALS

- .1 Composite aluminum panel: Aluminum sheets thermally bonded in continuous process, under tension, to thermoplastic core with no glues or adhesives between dissimilar materials, and as follows:
 - .1 Total Composite Thickness: 4 mm
 - .2 Aluminum Face Sheets:
 - .1 Thickness: 0.51 mm.
 - .2 Factory Finish: coil coated with fluoropolymer paint to AAMA 2605
 - .3 Colour: as indicated on Drawings.
 - .3 Core: non-combustible, in accordance with ULC 134.
 - .4 Bond Integrity: tested for resistance to delamination as follows:
 - .1 Bond Strength: 10.3 MPa minimum to ASTM C297.
 - .2 Peel Strength: 100 N mm/mm minimum to ASTM D1781.
 - .3 No degradation in bond performance after 8 hours of submersion in boiling water and after 21 days of immersion in water at 21 degrees C.
- .2 Aluminum extrusions:
 - .1 Alloy: AA-6063-T5.
 - .2 Colour: Mill finish where non-exposed.
- .3 Stiffeners:
 - .1 Alloy: AA-6063-T5.
 - .2 Colour: Mill finish.

2.4 SYSTEM BACK-UP MATERIALS

- .1 Girts: Fabricated from minimum 1.27 mm thickness galvanized steel to ASTM A653, Grade 230 with Z275 coating. Material visible after assembly of wall panel shall be finished to match aluminum panels.
- .2 Sub-girts: Structural quality steel to ASTM A653, with Z275 zinc coating, adjustable double-angle profile as indicated to accept panel with structural attachment to building frame.
- .3 Provide blocking and bracing required for panel system.
- .4 Isolation Tape: Manufacturers standard material for separating dissimilar metals from direct contact.
- .5 Stiffeners, as required: Minimum 25 mm x 25 mm aluminum, bonded to the full length of face sheet using double sided high bond isolating tape to prevent weather staining and frost lines to the face of the panel. Bonding tape to be protected with continuous bead of caulking on both sides of stiffeners, type as recommended by manufacturer.
- .6 Insulation Fastenings: Corrosion resistant, galvanized bugle head screws with 38 mm diameter washer, 25 mm minimum penetration into framing.

2.5 FABRICATION

- .1 Aluminum wall panels and components shall comply with details as indicated on drawings and as indicated in shop drawings.
- .2 All components shall be factory fabricated ready for field installation. All components shall match quality and installation of accepted mock-up specified above.
- .3 Tolerances:
 - .1 Panel bow shall not exceed 0.8% of panel overall dimension in width or length.
 - .2 Panel dimensions shall allow for field adjustment and thermal movement.
 - .3 Panel lines, breaks and curves shall be sharp, smooth and free of warps or buckles.
 - .4 Panel shall be visually flat.
 - .5 Panel surfaces shall be free of scratches or marks caused during fabrication.

2.6 ACCESSORIES

- .1 Panel Stiffeners: structurally fastened or restrained at ends, secured to rear face of composite panel with silicone or double sided high bond isolating tape to prevent weather staining and frost lines to the face of the panel as recommended by panel manufacturer, size stiffeners to maintain panel flatness to specified tolerances, material as recommended by manufacturer.
- .2 System Sealants: Sealants within the panel system, as recommended by manufacturer, colour as selected by Consultant.
- .3 Gaskets: Santoprene or EPDM as recommended by manufacturer.
- .4 Flashings: Fabricate flashing from 1.57 mm minimum thickness aluminum sheet. Where exposed to view, finish to match adjacent panels. Provide lap strip under flashing at abutted conditions; with lapped surfaces sealed with a full-bed of non-hardening sealant.
- .5 Fasteners:
 - .1 Attachment of the panel system to the primary panel structural supports shall be made using manufacturer's recommended fasteners.
 - .2 Typical joinery shall be attached with concealed, non-corrosive fasteners. When exposed fasteners are required in isolated conditions, the fastener shall be obscured in the panel joinery, exposed fasteners shall be stainless steel.

Part 3 Execution

3.1 PREPARATION

- .1 Obtain all dimensions from job site.
- .2 Ensure all structural support is aligned and condition is acceptable.

- .3 Building surfaces shall be smooth, clean and dry, and free from defects detrimental to the installation of the system. Notify Contractor of conditions not acceptable for installation of system.
- .4 Inspect wall system and components before installation and verify that there is no shipping damage.
- .5 Do not install damaged panels; repair or replace as required for smooth and consistent finished appearance.

3.2 INSTALLATION

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Install composite panels in accordance with manufacturer's written instructions and shop drawings.
 - .1 Allow for thermal movement.
- .3 Install air/vapour retarder membrane in accordance with Section 07 27 13 - Modified Bituminous Air and Vapour Barrier and the manufacturer's instructions.
- .4 Install both layers of girts as indicated on drawings and to ensure no air gap between girts and insulation boards.
- .5 Install girts attached to structural support or wall framing, using recommended fasteners.
- .6 Install insulation between girts forming tight to following applied girt to maintain continuous thermal barrier.
- .7 Erect panels plumb, level and true.
- .8 Do not install component parts that are observed to be defective, including warped, bowed, dented, scraped and broken members.
- .9 Install exterior metal cladding to structural support by hidden mechanical fasteners.
- .10 Ensure fasteners penetrate wall framing. Where fastener does not penetrate framing, DO NOT remove fastener. Removal of fastener will damage integrity of air/vapour membrane. Realign fastener location and install new fastener in close proximity to original fastener.
- .11 Install pre-formed corners and end enclosures, sealed to arrest direct weather penetration.
- .12 Ensure panels aligned vertically and horizontally.
- .13 Assemble and secure wall system so stresses on sealants are within manufacturers' recommended limits.
- .14 Separate dissimilar metals; use appropriate gasket and fasteners to minimize corrosive or electrolytic action between metals.
- .15 Install flashings to divert all moisture and condensation to exterior. Trim and flash around doors, louvers, and windows. Use only membrane flashing supported by insulation per architectural details.

3.3 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Submit reports to Consultant within three days of review.

3.4 CLEANING

- .1 Remove strippable film coating (if used) as soon as possible after surrounding material has been installed.
- .2 Remove all excess materials, debris and equipment at completion.
- .3 Clean all panels clean and free of all grime and dirt.
- .4 Touch-up damaged finishes with manufacturer's recommended touch-up paint.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Metal sheet and cladding system including accessories, closure strips, sub-framing thermal spacers, girts and sub-girts, clips and connectors, expansion joints, stiffeners, insect and rodent screens, sealants and fasteners. Provide blocking and bracing required for panel system.

.2 Related Requirements:

- .1 Section 01 35 00 – Delegated Design
- .2 Section 05 50 00 – Metal Fabrications
- .3 Section 07 42 43 – Insulated Wall Panels
- .4 Section 07 62 00 – Sheet Metal Flashing and Trim
- .5 Section 07 92 00 – Sealants

1.2 REFERENCES

.1 Reference Standards:

- .1 American Association (AA):
 - .1 AA DAF-45-2003 (R2009), Designation System for Aluminum Finishes.
- .2 American Architectural Manufacturers Association (AAMA)/ Fenestration & Glazing Industry Alliance (FGIA):
 - .1 2603-22, Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
 - .2 2604-22, Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
 - .3 2605-22 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- .3 American National Standards Institute (ANSI):
 - .1 ASME B18.6.3-2013, Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series).
 - .2 ANSI H35.1/H35.1M-2017, American National Standard Alloy and Temper Designation Systems for Aluminum, 2017.
- .4 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - .3 ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

- .4 ASTM C518-21, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- .5 ASTM D523-14 (2018), Standard Test Method for Specular Gloss.
- .6 ASTM D638-22, Standard Test Method for Tensile Properties of Plastics.
- .7 ASTM D659-86e1, Method of Evaluating Degree of Chalking of Exterior Paints.
- .8 ASTM D695-23, Standard Test Method for Compressive Properties of Rigid Plastics.
- .9 ASTM D732-17, Standard Test Method for Shear Strength of Plastics by Punch Tool.
- .10 ASTM D822-23, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .11 ASTM D2244-23, Standard Practice for Calculation of Colour Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
- .12 ASTM D2369-20, Standard Test Method for Volatile Content of Coatings.
- .13 ASTM D2832-92(2016), Standard Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.
- .14 ASTM D4138-07a (2022), Standard Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means
- .15 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .16 ASTM E283/E283M-19; Standard Test Method for determining Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors under Specified Pressure Differences across the Specimen.
- .17 ASTM E331-00(2023); Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- .18 ASTM E831-19, Standard Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis.
- .19 ASTM E1592-05(2017), Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
- .20 ASTM F1667/F1667M-21a, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- .5 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .6 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type (Withdrawn).
 - .2 CAN/CGSB 93.5-92, Installation of Metal Residential Siding, Soffits and Fascia (Withdrawn).

- .7 Canadian Standards Association (CSA Group):
 - .1 CSA S136-16, North American Specification for the Design of Cold-Formed Steel Structural Members.
- .8 South Coast Air Quality Management District (SCAQMD):
 - .1 Rule 1113-16, Architectural Coatings.
 - .2 Rule 1168-22, Adhesive and Sealant Applications.
- .9 Underwriters Laboratories ECOLOGO Certification Program (UL):
 - .1 UL 2761, (formerly CCD-045) Sealants and Caulking Compounds.
 - .2 UL 2762, (formerly CCD-046) Adhesives.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with Contractor, Consultant, installer, manufacturer's representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Manufacturer's representative shall also provide frequent inspection visits during the course of work of this Section to assure quality and competence of membrane installation and panel alignment.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet.
 - .2 Submit WHMIS SDS - Safety Data Sheets acceptable to Labour Canada, and Health and Welfare Canada. Indicate VOC's:
 - .1 Caulking and sealant materials during application and curing.
 - .2 Finishing materials.
 - .3 Insulation adhesives.
 - .4 Paints.
 - .5 Isolation coatings.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures and Section 01 35 00 – Delegated Design:
 - .1 Indicate arrangement of cladding system including dimensions, wall openings, location of joints, profiles of inner and outer skin, types and locations of supports, fasteners, flashing, closures, compliance with design criteria and requirements of related work.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit duplicate 300 x 300 mm samples of wall system, representative of materials, finishes and colours.

- .2 Prior to ordering materials, provide to consultant the following for verification purposes: three samples of colour of finish specified.
- .4 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
- .5 Manufacturers' Field Reports: Submit copies of manufacturers field reports.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Installer Qualifications: Engage experienced installer, with a minimum of five years experience, who has completed systems similar in material, design, and extent to that indicated for Project and with record of successful performance.
- .4 Retain a professional engineer, registered in the province of the Work, to design fabrication and erection of the Work of this Section in accordance with applicable Building Code and Contract Document requirements including, but not limited to, the following:
 - .1 Seal and signature to shop drawings and design submittals requiring structural engineering.
 - .2 Site review and certification of installed components.
 - .3 Completion of Letters or Commitment and Supervision specified in Section 01 35 00 – Delegated Design.
 - .4 Manufacturer's Engineering Recommendations: Perform composite wall panel work in accordance with written recommendations from panel manufacturer.
 - .5 Verify panel thickness based on maximum deflections provided in this Section and to suit building location and configuration.
- .5 Mock-ups:
 - .1 Construct mock-up in accordance with Section 01 45 00 – Quality Control.
 - .2 Construct a portion of one exterior wall in location agreed upon by Consultant to establish a standard of construction, workmanship, and appearance.
 - .3 Construct mock-up indicating relationship between wall panels, air spaces, air/vapour retarder membrane, windows, and doors.
 - .4 Do not continue with work of this Section until Consultant has approved mock-up.
 - .5 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver and store materials in accordance with manufacturer's instructions.
- .2 Protect panels during transportation, unloading, storing, and erecting to prevent bending, warping, twisting, and surface damage.
- .3 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 WARRANTY

- .1 Provide the manufacturers standard warranty with the minimum coverage of 20 years for the paint finish against chalking, fading, peeling, checking, cracking, or colour change.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 VicWest Steel.
 - .2 Westform Metals.
 - .3 Westman Steel.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Design metal panel wall system in accordance with CSA S136.
- .2 Design metal panel wall to provide for thermal movement of component materials caused by ambient temperature range of 60 degrees C without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.
- .3 Include expansion joints to accommodate movement in wall system and between wall system and building structure, caused by structural movements, without permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.
- .4 Design members to withstand dead load and wind loads calculated in accordance with Ontario Building Code and applicable local regulations, to maximum allowable deflection of 1/180th of span.
- .5 Provide for positive drainage of condensation occurring within wall construction and water entering at joints, to exterior face of wall in accordance with NRC "Rain Screen Principles".
- .6 Permeance through wall system not to exceed 1 ng/(Pa.s.m²).
- .7 Design wall system to accommodate specified erection tolerances of structure.
- .8 Design wall system to allow for movement of air between exterior and interior side of metal cladding.

- .9 Provide an effective air barrier, to prevent infiltration and/or exfiltration of air through wall assembly.

2.3 METAL CLADDING MATERIALS

- .1 Aluminum-zinc galvanized sheet steel cladding: AZM180 galvalume sheet steel applied to both sides, commercial steel (CS), type A, grade 275 to ASTM A792/A792M and as follows:
 - .1 Nominal Core Thickness: 0.76 mm or thicker to meet design loads.
 - .2 Profile: to match VicWest corrugated profile having nominal 880 mm panel c/c with 40 mm deep profile at 68 mm c/c.
 - .3 Galvanizing Coating: Dofasco Inc., Galvalume Plus.
 - .4 Finish: prefinished as specified below.
 - .5 Basis of Design Materials:
 - .1 1 9/16" CL7040 Corrugated, VicWest Steel.
 - .2 1 9/16" Corrugated, Westform Metals.

2.4 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory applied silicone modified polyester (SMP).
 - .1 Class: F1S.
 - .2 Colour: indicated on Drawings.
 - .3 Specular gloss: 25-35 units +/-5 to ASTM D523 for matte finish.
 - .4 Coating thickness: dry film thickness not less than 0.9 mil to ASTM D4138.
 - .5 Resistance to accelerated weathering for chalk rating of eight, colour fade five units or less and erosion rate less than 20% to ASTM D2244 and ASTM D659.

2.5 ACCESSORIES

- .1 Closure strips:
 - .1 Closed Cell Closure Strips: Provide minimum 25.4 mm thick matching metal wall panel profile.
 - .2 Metal Profile Closure Strips: Shall be fabricated from same gauge, material and finish as metal panel.
- .2 Provide blocking and bracing required for panel system.
- .3 Girts: Fabricated from minimum 1.27 mm thickness galvanized steel to ASTM A653/A653M, Grade 230 with Z275 coating. Material visible after assembly of wall panel shall be finished to match aluminum panels.
- .4 Sub-girts: Structural quality steel to ASTM A653/A653M, with Z275 zinc coating, adjustable double-angle profile as indicated to accept panel with structural attachment to building frame.
- .5 Fasteners: Manufacturer's standard to suit design loads and applications.
 - .1 Screws to ANSI B18.6.3. Purpose made stainless steel; exposed parts to match finish of exterior sheet.

- .6 Sealant: as indicated in Section 07 92 00 - Sealants and as recommended by manufacturer. Colour of exposed sealant to match adjacent panel.
- .7 Isolation coating: bituminous paint.
- .8 Clips and Connectors: As recommended by manufacturer for complete installation of cladding.
- .9 Exterior corners: of same profile, material and finish as adjacent cladding material, shop cut and brake formed to required angle, concealed corner brace, mechanically fasten connections with painted head to match cladding.
- .10 Exposed joint (perpendicular to profile): ends of cladding sheet shop cut clean and square, backed with tight fitting filler lapping back of joint, exposed components colour matched to cladding.
- .11 Accessories: cap flashings, drip flashings, internal corner flashings, copings and closures for head, jamb, sill and corners, of same material, thickness and finish as exterior cladding, brake formed to shape.
- .12 Expansion joints: as recommended by Manufacturers Instructions.
- .13 Stiffeners: metal stiffeners as shown in drawings.
- .14 Insect and rodent screen: linear perforated aluminum screen sized to suit application.

Part 3 Execution

3.1 PREPARATION

- .1 Protect metal surfaces in contact with concrete, masonry mortar, plaster or other cementitious surface with isolation coating.
- .2 Touch up building framing members with primer as required.

3.2 INSTALLATION

- .1 Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Install continuous starter strips, inside and outside corners, edgings, soffit, drip, cap, sill and window/door opening flashings as indicated.
- .3 Install outside corners, fillers and closure strips with carefully formed and profiled work.
- .4 Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.
- .5 Attach components in manner not restricting thermal movement.
- .6 Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- .7 Caulk junctions with adjoining work with sealant. Do work in accordance with Section 07 92 00 - Sealants.
- .8 Control/ Expansion Joints
 - .1 Construct control and expansion joints as indicated.

- .2 Use cover sheets, of brake formed profile, of same material and finish as adjacent material.
- .3 Use mechanical fasteners to secure sheet materials.
- .4 Assemble and secure wall system to structural frame so stresses on sealants are within manufacturers' recommended limits.
- .9 Construction
 - .1 Installation Tolerances: Shim and align panels and cladding system within installed tolerance of 6 mm in 6100 mm on level, plumb, and location lines as indicated, and within 3 mm offset of adjoining faces and of alignment of matching profiles.

3.3 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Submit reports to Consultant within three days of review.

3.4 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Wash down exposed interior and exterior surfaces using solution of mild domestic detergent in warm water, applied with soft clean wiping cloths. Wipe interior surfaces clean as part of final clean-up.
- .3 Remove excess sealant with recommended solvent.
- .4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Zinc galvanized sheet steel and stainless steel insulated metal panels and accessories including flashings, enclosures, trims, fasteners, washers, liquid sealants, preformed sealants and sealing tape.
- .2 Related Requirements:
 - .1 Section 01 35 00 – Delegated Design
 - .2 Section 05 50 00 – Metal Fabrications
 - .3 Section 07 21 13 – Board Insulation
 - .4 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .5 Section 07 92 00 – Sealants

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A755/A755M-18, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil Coating Process for Exterior Exposed Building Products.
 - .3 ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - .4 ASTM A924/A924M-22a, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - .5 ASTM C273/C273M-20, Standard Test Method for Shear Properties of Sandwich Core Materials.
 - .6 ASTM C518-21, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .7 ASTM C612-14(2019), Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C1363-19, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
 - .9 ASTM D1621-16(2023), Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - .10 ASTM D1622-20, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - .11 ASTM D6226-21, Standard Test Method for Open Cell Content of Rigid Cellular Plastics.

- .12 ASTM E72-22, Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
- .13 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .14 ASTM E119-22, Standard Test Methods for Fire Tests of Building Construction and Materials.
- .15 ASTM E283/E283M-19, Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Skylights, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
- .16 ASTM E331-00(2023), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- .17 ASTM E814-23a, Standard Test Method for Fire Tests of Penetration Firestops Systems.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 Canadian Sheet Steel Building Institute (CSSBI):
 - .1 CSSBI 20M-2017, Standard for Sheet Steel Cladding for Architectural, Industrial and Commercial Building Applications.
 - .2 CSSBI S8-2018, Quality and Performance Specification for Prefinished Sheet Steel Used for Building Products.
- .4 Underwriters Laboratories Canada (ULC):
 - .1 ULC 101, Standard Methods of Fire Endurance Tests of Building Construction and Materials. (CAN/ULC-S101-14).
 - .2 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies. (ULC S102).
 - .3 ULC 127, Standard Corner Wall Method of Test for Flammability Characteristics of Non-Melting Foam Plastic Building Materials. (CAN/ULC S127-14).
 - .4 ULC 134, Standard Method of Fire Test of Exterior Wall Assemblies. (CAN/ULC-S134-13).
 - .5 ULC 138, Standard Method of Test for Fire Growth of Insulated Building Panels in Full-Scale Room Configuration. (CAN/ULC S138-06).
 - .6 ULC 705.1, Standard for Thermal Insulation-Spray Applied Rigid Polyurethane Foam, Medium Density-Material-Specification. (CAN/ULC S705.1-15).
 - .7 ULC 705.2, Standard for Thermal Insulation-Spray Applied Rigid Polyurethane Foam, Medium Density-Application (2020).
 - .8 ULC 770, Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams (CAN/ULC S770-15).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate work of this Section with work of other sections that may have items supported by or built into fabricated wall panel assemblies

including; but not limited to, supports and connectors to structure, doors and windows, mechanical and electrical components, metal flashing and trim and erection tolerances.

- .2 Convene pre-installation meeting in accordance with Section 01 31 19 – Project Meetings one week prior to beginning work of this Section with Contractor, Consultant, installer, and manufacturer's representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's product specifications, standard details, certified product test results, and general recommendations as applicable to materials and finishes for each component and for total panel assemblies.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Provide plans, elevations and section showing panel details, attachment to structural support and indicate the following:
 - .1 Profile of panels.
 - .2 Gauge of exterior and interior sheet.
 - .3 Location, layout and dimensions of panels.
 - .4 Corner conditions.
 - .5 Location and type of fasteners.
 - .6 Shape and method of attachment of trim.
 - .7 Other details as required for a complete and weathertight installation.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit two (2) 300 mm x 300 mm samples representing specified profile, colour and texture, and other exposed panel accessories for verification and acceptance by the Consultant.
- .4 Submit quality assurance submittals in accordance with Section 01 45 00 - Quality Control.
 - .1 Source Quality Control Submittals: Submit design notes and calculations signed and sealed by professional engineer indicating compliance with design criteria for work of this Section.
 - .2 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 35 21 – LEED Requirements.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: Provide panels that are listed and labelled in accordance with CAN/ULC S101, ULC S102 and CAN/ULC S134 for fire endurance and flame spread testing
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Manufacturer: Use a manufacturer that has completed wall panel assemblies having similar extent and complexity as required for the Work of this Contract.
 - .2 Installers: Use experienced installers having experience with specified insulated wall panel projects similar in material, design and extent as required for Work of this Contract with a record of five successful years in-service performance.
- .3 Retain a professional engineer, registered in the province of the Work, to design fabrication and erection of the Work of this Section in accordance with applicable Building Code and Contract Document requirements including, but not limited to, the following:
 - .1 Seal and signature to shop drawings and design submittals.
 - .2 Field review of installed components.
 - .3 Completion of Letters or Commitment and Supervision specified in Section 01 35 00 – Delegated Design.
- .4 Mock-ups:
 - .1 Construct mock-up in accordance with Section 01 45 00 – Quality Control.
 - .2 Construct a portion of one exterior wall in location agreed upon by Consultant to establish a standard of construction, workmanship, and appearance.
 - .3 Do not continue with work of this Section until Consultant has reviewed mock-up.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 01 - LEED Product Requirements and as recommended by manufacturer's instructions.
- .2 Deliver panel materials and components in manufacturer's original, unopened, undamaged packaging with identification labels intact.
- .3 Store wall panels on dry, level, firm, and clean surface. Stack materials on platforms or pallets no more than two bundles high.
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 WARRANTY

- .1 Manufacturer's Warranty: Submit manufacturer's standard two year warranty that panels are free from defects in materials and workmanship beginning from the

date of substantial completion. Manufacturer's warranty is in addition to other rights contained within the Contract Documents.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section, meeting energy model requirements, and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:

- .1 [Centria Architectural Systems.](#)
- .2 [Falk Panels Canada Ltd.](#)
- .3 Kingspan Insulated Panels Ltd.
- .4 Metl-Span LLC, A BlueScope Steel Company.
- .5 Vicwest, Insulated Metal Panels.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Design fabricated wall panel assemblies to meet or exceed the following minimum requirements:
- .1 Structural Performance: Design panel composition and fastening requirements in accordance with ASTM E72 based on the following deflection criteria:
 - .1 Live Loads: Determine live load deflections in accordance with CSSBI 20M, as modified by the requirements of this Section.
 - .2 Wind Load: Determine wind loads using normal importance factors listed in the Building Code for deflection and strength, modified by the appropriate exposure, gust and pressure (internal and external) factors in accordance with Building Code structural commentaries.
 - .3 Deflection Limitation: L/180 based on maximum allowable deflection under one in 50 year sustained wind loading.
 - .4 Fatigue: Withstand two million alternate cycles of specified deflection limitation with no delamination of face skins from core, foam core cracking or permanent deformation.
 - .5 Movement: Allow for movement of components without causing buckling, failure of joint seals, undue stress on fasteners when subjected to seasonal surface temperatures ranging from -35°C to +50°C, and to accommodate movement between wall system and building structure by deflection of building structure and seismic loads as indicated in the building code.
 - .2 Fire Performance
 - .1 Flame Spread Tests: Provide materials with the following surface-burning characteristics in accordance with ASTM E84 and CAN/ULC S101 and as follows:
 - .1 Flame Spread Index: 25 or less.

- .2 Smoke Developed Index: 450 or less.
- .2 Fire Endurance Test: Panels to remain in place for not less than 15 minutes in accordance with CAN/ULC S101.
- .3 Fire Growth Test: Provide panels tested in accordance with CAN/ULC S138.
- .4 Flammability Test: Panels tested in accordance with CAN/ULC S127.
- .5 The finished panel in a 152 mm thickness shall meet the requirements for Assembly Rating – two Hour fire endurance rating; Non-Load Bearing Wall Assembly in accordance with ZOL/WA 120-02 design, ASTM E119, CAN/ULC-S101.
- .3 Air and Moisture Performance: Design panel joints to resist and control air and rainwater penetration using pressure equalization and rain screen technique to the following maximum limits:
 - .1 Air Infiltration: Maximum 0.3 L/m² of wall area at 0.95 kPa pressure differential in accordance with ASTM E283/E283M.
 - .2 Water Penetration: Zero uncontrolled water penetration at 0.95 kPa pressure differential in accordance with ASTM E331.
 - .3 Provide for positive drainage to the exterior of all water entering or condensation occurring within the system.
- .4 Thermal Performance: Design wall thickness of fabricated wall panels using nominal long term thermal resistance of RSI 1.15 per 25 mm of polyurethane thickness in accordance with ASTM C1363.

2.3 MATERIALS

- .1 Zinc Galvanized Sheet Steel: Tension levelled, Commercial Steel (CS) designation, Type A, Grade 230 in accordance with ASTM A653/A653M or ASTM A792/A792M to manufacturer's standard and as follows:
 - .1 Thickness: Provide sheet steel in the following base metal thickness, or thicker as required to meet design loads:
 - .1 Liner Sheet: Minimum 0.46 mm.
 - .2 Exterior Sheet: Minimum 0.46 mm.
 - .2 Galvanizing Designation: Z275 or AZM 150 applied evenly to both sides.
- .2 Core Material (non-rated): Foamed in place multi-component polyisocyanurate or polyurethane insulation; blown using Montreal Protocol compliant agents having zero ozone depletion potential and having the following physical properties based on CAN/ULC S705.1 and ULC S705.2:
 - .1 Closed Cell Composition: Nominal 95% to ASTM D6226.
 - .2 Density: Nominal 35 to 45 kg/m³ to ASTM D1622.
 - .3 Compressive Strength: Nominal 210 kPa to ASTM D1621.

2.4 PANELS

- .1 Insulated metal panels consisting of roll formed steel face and liner sheets chemically fused to a foamed in place rigid polyisocyanurate expanded foam core and as follows:

- .1 Panel Width: 610 mm.
 - .2 Panel Thickness: 150 mm.
 - .3 Exterior Sheet: Shadowline profile.
 - .4 Interior Sheet: Shadowline profile.
 - .5 Joint Reveal: 3 mm
 - .6 Finish: Prefinished materials coated to film thickness as recommended by coating manufacturer, and designed specifically for vertical surfaces to 30° from vertical, and horizontal surfaces 5° up to 60° from horizontal and in accordance with ASTM A755/A755M and as follows:
 - .1 Interior Finish: Imperial White
 - .2 Exterior Finish: Imperial White
 - .7 Basis-of-Design Materials:
 - .1 Kingspan QuadCore KS Series
- .2 Insulated Metal Panels (Wash Bay Area): Roll formed steel face and stainless steel coated liner sheet chemically fused to a foamed in place rigid polyisocyanurate expanded foam core and as follows:
- .1 Panel Width: 1067 mm.
 - .2 Panel Thickness: 150 mm.
 - .3 Exterior Sheet: Shadowline profile
 - .4 Interior Sheet: Type 304 stainless steel.
 - .5 Exterior Finish: Prefinished materials coated to film thickness as recommended by coating manufacturer, and designed specifically for vertical surfaces to 30° from vertical, and horizontal surfaces 5° up to 60° from horizontal and in accordance with ASTM A755/A755M, Imperial White colour.
 - .6 Basis-of-Design Materials:
 - .1 Kingspan QuadCore KS Series with CLEANsafe 304 coating.
- .3 Wall Panels (behind exterior cladding): Insulated metal panels consisting of roll formed steel face and liner sheets chemically fused to a foamed in place rigid polyisocyanurate expanded foam core and as follows:
- .1 Panel Width: 610 mm.
 - .2 Panel Thickness: as indicated on drawings.
 - .3 Exterior Sheet: Shadowline profile
 - .4 Interior Sheet: Shadowline profile
 - .5 Joint Reveal: 3 mm.
 - .6 Finish: Prefinished materials coated to film thickness as recommended by coating manufacturer, and designed specifically for vertical surfaces to 30° from vertical, and horizontal surfaces 5° up to 60° from horizontal and in accordance with ASTM A755 and as follows:
 - .1 Finish: Selected from manufacturer's standard range.
 - .7 Basis-of-Design Materials:
 - .1 KarrierPanel, Kingspan Insulated Panels Ltd.

2.5 FABRICATION

- .1 Fabricate panels to thickness required by insulation value indicated on Drawings.
- .2 Fabricate panels from roll formed steel face and liner sheets chemically fused to a foamed in place rigid polyurethane expanded foam core as a single piece construction full height or stacked in multiple courses to suit design requirements for Work of the Contract.
- .3 Fabricate longitudinal edges of panel with roll formed male and female interlocking geometry fully supported by foamed in place insulation core with insulation core moulded into tongue and groove joint to allow positive insulation-to-insulation contact between panels to provide continuous thermal enclosure.

2.6 ACCESSORIES

- .1 Accessories: Manufacturer's standard materials as required for a complete and functional installation including, but not limited to, the following:
 - .1 Flashings, Enclosures and Trims: Matching colour and thickness of exterior sheet, coordinate requirements with Section 07 62 00 - Sheet Metal Flashing and Trim.
 - .2 Closure Channels: provide fibreglass closure channels as indicated on Drawings.
 - .3 Fasteners: Concealed type; in joint hex or pan headed fasteners.
 - .4 Washers: Concealed type; weather tight.
 - .5 Liquid Sealants: Non-curing, pressure resistant type; for use within internal panel joints, coordinate requirements with Section 07 92 00 - Sealants.
 - .6 Preformed Sealants: Preformed silicone sheets; for use in transition joints between wall panels and adjacent construction, coordinate requirements with Section 07 92 00 - Sealants.
 - .7 Intumescent Sealant: provide sealant in accordance with building code requirements to manufacturers recommendations for fire rated panels.
 - .8 Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: Verify that support structures are aligned and tolerances are within requirements provided during preconstruction meeting; starting work of this Section denotes acceptance of conditions.

3.2 INSTALLATION

- .1 Prior to installation, inspect structure to ensure all walls and openings are within ± 3 mm of location shown on drawings. Structure to be plumb within 1:1000 of

overall height. Installation is not to proceed until the building is within these tolerances.

- .2 Support system shall be attached to the structural as required to transmit design loads.
- .3 Framing and other components shall be straight to match plane of panel as required to meet the installed panel tolerances with straight, sharply formed edges.
- .4 After their correct position has been determined and allowances for expansion, building movement, uniform joint width and alignment of all parts has been determined, the components shall be permanently fastened.
- .5 Place panel fasteners through pre-punched holes in attachments clips, concealed within the joint of the panel. Secure units to the structural supports. Space clips as recommended by Manufacturer or as indicated on reviewed shop drawings.
- .6 Installed panels shall not deviate from overall plane or alignment by more than five percent greater than their dimensioned width at any location along their full length and shall not be wavy, out of line or of different width from panel to panel.
- .7 Install flashings to divert all moisture and condensation to exterior. Trim and flash around doors, louvers, and windows.
- .8 Install pre-formed corners and end enclosures, sealed to avoid direct weather penetration.
- .9 Insulate voids and provide continuous air seal at joints and openings.
- .10 Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- .11 Confirm panels are aligned vertically and horizontally.
- .12 Apply continuous butyl sealant at intersections between wall panels and dissimilar materials.
- .13 Control Joints
 - .1 Construct control joints as indicated, using cover sheets or brake formed profiles of same material and finish as adjacent material, mechanically fastened.
 - .2 Assemble and secure wall system to metal frame so stresses on sealants are within manufacturers' recommended limits.

3.3 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:

- .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
- .2 Twice during progress of Work at 25% and 60% complete.
- .3 Upon completion of Work, after cleaning is carried out.
- .4 Submit reports to Consultant within three days of review.

3.4 CLEANING

- .1 Cleaning: Strip protective films, clean surfaces and remove any substances such as metal fillings caused by drilling that could cause discolouration of staining; remove excess materials, debris and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Cedar siding and soffits, accessories including trims, closures, cap pieces, fasteners, sealants and insect screens.
- .2 Related Requirements:
 - .1 Section 06 10 00 – Rough Carpentry
 - .2 Section 07 21 13 – Board Insulation
 - .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .4 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .5 Section 07 92 00 – Sealants
 - .6 Section 09 21 16 – Gypsum Board Assemblies
 - .7 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 Reference Standards:
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - .3 ASTM D5116-17, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
 - .4 ASTM F1667/F1667M-21a, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
 - .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 79.1-M91, Insect Screens (Withdrawn).
 - .5 National Lumber Grades Authority (NLGA):
 - .1 NLGA Standard Grading Rules for Canadian Lumber 2017.
 - .6 Underwriters Laboratories ECOLOGO Certification Program (UL):
 - .1 UL 2761, Sealants and Caulking Compounds (formerly CCD-045) 2011.
 - .7 Western Red Cedar Lumber Association (WRCLA)

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings:

- .1 Convene pre-installation meeting one week prior to beginning work of this Section, with Contractor, Owner, installer, manufacturer's representative in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review structural load limitations.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.
- .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit duplicate siding and soffit in specified width, 600 mm long, in dry condition.
- .3 Manufacturer's Instructions: Provide to indicate special handling criteria and installation sequence.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit closeout data in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Provide manufacturer's printed recommendations for general maintenance, including cleaning instructions.

1.6 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct typical exterior wall panel, 3 m long by 4 m wide, incorporating window openings with frame and sill installed, cladding, insulation, building corner condition, junction with roof system; illustrating materials interface and seals.
 - .3 Locate where directed.
 - .4 Mock-up may remain as part of Work.
 - .5 Allow 48 hours for review of mock-up by Consultant before proceeding with work.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle, store and protect materials in accordance with manufacturer's instructions.
- .2 Store materials in safe area, away from construction traffic; store under cover and off ground, protected from moisture.
- .3 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 CEDAR SIDING AND SOFFIT

- .1 Western Red Cedar: Graded to meet NLGA Grading Standards Rules, paragraph 200 and WRCLA.
 - .1 Grade: "A" clear or better.
 - .2 Surface: surfaced to sides (S4S).
 - .3 Texture: smooth.
 - .4 Edge: square
 - .5 Moisture Content: kiln dried to less than 15% moisture content, confirm moisture content and provide testing results to Consultant prior to application.
 - .6 Size (Nominal): 38 mm x 64 mm x longest practical length at 73.5 mm o.c..
 - .7 Fasteners: concealed stainless steel
 - .8 Finish: Exterior to be factory finished and an additional finish coat applied on site to provide a uniform finish. Interior to be factory primed and finished on site. Finish in accordance with Section 09 91 00 - Painting.

2.2 ACCESSORIES

- .1 Manufacturer's standard exposed trim, closures, cap pieces and other accessories required for complete installation.
- .2 Wood Strapping: as indicated in Section 06 10 00 – Rough Carpentry.
- .3 Breathable Weather Barrier Membrane: as indicated in Section 07 27 19 - Sheet Membrane Air and Vapour Barrier.
- .4 Girts: Fabricated from minimum 1.27 mm thickness galvanized steel to ASTM A653/A653M, Grade 230 with Z275 coating. Material visible after assembly of wall panel shall be finished to match aluminum panels.
- .5 Sub-girts: Structural quality steel to ASTM A653/A653M, with Z275 zinc coating, adjustable double-angle profile as indicated to accept panel with structural attachment to building frame.
- .6 Fasteners: nails to ASTM F1667/F1667M, No. 316 stainless steel, sized as required, splitless siding nail type with flat head, length sufficient to penetrate solid wood minimum 32 mm.

- .7 Sealants: as indicated in Section 07 92 00 - Sealants.
- .8 Insect Screen:
 - .1 In accordance with CAN/CGSB 79.1.
 - .2 Stainless Steel Wire: Type 304, 18 x 16 mesh (1.13 mm x 1.3 mm) using nominal 0.28 mm wire diameter; having minimum 66.08% apparent opening size, using non-magnetic stainless steel wire.
 - .3 Clips: low conductivity fibreglass attachments clips for assemblies with concrete structure.

Part 3 Execution

3.1 INSTALLATION

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Select siding boards of longest possible lengths. Discard boards that are warped, twisted, bowed, crooked or otherwise defective.
- .3 Install sill flashings, wood starter strips, inside corner flashings, edgings and flashings over openings.
- .4 Fasten wood siding in straight, aligned lengths to furring.
- .5 Seal cut surfaces. Apply touch up coats as required.
- .6 Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- .7 Space cedar slats equally in any given span.
- .8 Visually inspect siding, caulking, flashing annually for overall condition. Re-apply caulking and coating as necessary. Adjust flashing as required.

3.2 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Submit reports to Consultant within three days of review.

3.3 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .2 The use of pressure washers is not recommended.

3.4 MAINTENANCE

- .1 Explain proper maintenance procedures to Owner at project closeout.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 21 13 – Board Insulation
- .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .4 Section 07 62 00 – Sheet Metal Flashing and Trim
- .5 Section 07 92 00 – Sealants

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A653/A653M-19, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C920-18 - Standard Specification for Elastomeric Joint Sealants.
 - .3 ASTM E84-19b, Standard Test Methods for Surface Burning Characteristics of Building Materials.
 - .4 ASTM E96/E96M-16, Standard Test Methods for Water Vapor Transmission of Materials.
 - .5 ASTM E136-19, Standard Test Method for Behaviour of Materials in a Vertical Tube Furnace at 750°C.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters Laboratories' of Canada (ULC)
 - .1 CAN/ULC S102-18, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC S114-05, Standard Method of Test for Determination of Non-Combustibility in Building Materials

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Sequencing: Coordinate installation with flashings and other adjoining construction to ensure proper sequencing.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include:
 - .1 Preparation instructions and recommendations.
 - .2 Installation instructions.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures:

- .1 Provide shop drawings indicating attachment methods, joinery, sealing methods and compliance with design criteria and requirements of related work.
- .3 Submit samples in accordance with Section 01 33 00 - Submittal Procedures:
 - .1 Submit duplicate 150 mm long samples of wall system in each type, colour, texture and pattern required. Include clips, caps, battens, fasteners, closures and other exposed accessories.

1.5 QUALITY ASSURANCE

- .1 Installer Qualifications: Engage experienced installer with a minimum of three (3) years experience who has completed systems similar in material, design, and extent to that indicated for Project and with record of successful performance.
- .2 Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship of the following details:
 - .1 Sill and head connections at windows and penetrations
 - .2 Joint between panels
 - .3 Detailing of corner caps and flashings.
 - .4 Do not proceed with remaining Work until mock-up has been reviewed by Consultant
 - .5 Refinish mock-up area as required to produce acceptable Work; at no additional cost to the Owner

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Store products in manufacturer's unopened packaging until ready for installation.
- .2 Store siding flat on a smooth level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with authority having jurisdiction.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- .2 Proceed with siding installation when substrate is completely dry.

1.9 WARRANTY

- .1 Manufacturer's Warranty: Submit manufacturer's standard warranty that panels are free from defects in materials and workmanship beginning from the date of substantial completion and as follows:
 - .1 Product Warranty: manufacturers standard limited, non prorated product warranty for a period of 25 years.
 - .2 Finish Warranty: 15 years: Deterioration of finish includes, but is not limited to, chipping, cracking, and peeling.

Part 2 Products

2.1 PERFORMANCE / DESIGN CRITERIA

- .1 Design composite building panel wall to provide for thermal movement of component materials caused by ambient temperature range of 80 degrees C without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.
- .2 Include expansion joints to accommodate movement in wall system and between wall system and building structure, caused by structural movements, without permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.
- .3 Design members to withstand dead load and wind loads calculated in accordance with current Building Code and applicable local regulations, to maximum allowable deflection of 1/180th of span.
- .4 Provide for positive drainage of condensation occurring within wall construction and water entering at joints, to exterior face of wall in accordance with NRC "Rain Screen Principles".
- .5 Design wall system to accommodate specified erection tolerances of structure.
- .6 Maintain following installation tolerances:
 - .1 Maximum variation from plane or location shown on drawings: 3 mm/m of length and up to 20 mm/100 m maximum.
 - .2 Maximum offset from true alignment between two adjacent members abutting end to end, in line: 0.75 mm.

2.2 MATERIALS

- .1 Wood Plastic Composite (WPC) stain, scratch, fade and mould resistant shell composed of 95% recycled materials including reclaimed wood and fibre, PE polymer and additives, 360 degrees capped.

2.3 SIDING MATERIALS

- .1 Composite Wood Cladding:
 - .1 Profile: UH61
 - .2 Thickness: 25 mm.
 - .3 Width: 196 mm
 - .4 Colour: Australian Red Cedar.
 - .5 Factory Finish: Manufacturers standard factory applied finish.
 - .6 Acceptable Materials:
 - .1 Norwegian Fluted Siding, NewtechWood

2.4 ACCESSORIES

- .1 Subgirts: Rolled, Z-shaped, Z-275 galvanized steel girts to suit design loads and application.
- .2 Rigid Insulation: refer to Section 07 21 13 – Board Insulation

- .3 Wood strapping: pressure treated wood strapping in accordance with Section 06 10 00 – Rough Carpentry and as detailed on Drawings; to accept exterior sheet with structural attachment to building frame. Exposed materials of wall assembly to match panels.
- .4 Hat Sections and Other Sub framing: Rolled shapes, Z-275 galvanized steel to suit design loads and application.
- .5 Siding Accessories: Provide starter strips, edge trim, corner cap, and other items as recommended by siding manufacturer for building configuration, and as follows:
 - .1 Provide accessories made from same material as adjacent siding, unless otherwise indicated.
 - .2 Provide accessories matching colour and texture of adjacent siding, unless otherwise indicated.
- .6 Flashing: Provide pre-finished, galvanized sheet steel flashing and trims in accordance with Section 07 62 00, at window and door heads and where indicated.
- .7 Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant; colour as directed.
- .8 Elastomeric Joint Sealant: single component polyurethane sealant joint sealant in accordance with Section 07 92 00.
- .9 Fasteners: Corrosion resistant fasteners as recommended by siding manufacturer for materials being fastened to and as follows:
 - .1 Fastening to Wood: Ribbed, bugle head screws of sufficient length to penetrate a minimum of 25 mm into substrate.
- .10 Touch Up Kit: Provide manufacturers standard touch-up kit for each colour provided.
- .11 Insect Screen:
 - .1 In accordance with CAN/CGSB 79.1.
 - .2 Stainless Steel Wire: Type 304, 18 x 16 mesh (1.13 mm x 1.3 mm) using nominal 0.28 mm wire diameter; having minimum 66.08% apparent opening size, using non-magnetic stainless steel wire.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 PREPARATION

- .1 Building surfaces shall be smooth, clean and dry, and free from defects detrimental to the installation of the system. Notify Contractor of conditions not acceptable for installation of system.

- .2 Proceed with installation only after unsatisfactory conditions have been corrected.
- .3 Ensure air/vapour barrier installation is complete and has been reviewed by the Consultant.

3.3 INSTALLATION: VERTICAL SIDING

- .1 Install materials in strict accordance with manufacturer's installation instructions.
- .2 Starting: Install a starter strip at the side course of the wall. Apply planks vertically locking clip at the top of each board and leaving min 19 mm space at the floor.
- .3 Allow minimum clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- .4 Maintain clearance between siding and adjacent finished grade.
- .5 Use one single length of lap siding board to span an entire section of wall/between windows and doors, when possible. Minimize the number of butt joints.
 - .1 Locate splices at least one stud cavity away from window and door openings.
 - .2 Locate splices at least 305 mm away from window and door openings.
- .6 Specific framing and fastener requirements: refer to the applicable Building Code compliance reports.

3.4 INSTALLATION: TRIM AND MOULDING

- .1 Install materials in strict accordance with manufacturer's installation instructions. Install flashing around all wall openings.
- .2 Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum 25 mm plus full thickness of sheathing. Additional fasteners may be required to ensure adequate security.
- .3 Place fasteners no closer than 19 mm and no further than 51 mm from side edge of trim board and no closer than 25 mm from end. Fasten maximum 406 mm on center.
- .4 Maintain clearance between trim and adjacent finished grade.
- .5 Trim inside corner with single board.
- .6 Outside Corner Board: Attach trim on both sides of corner with 16 gauge corrosion resistant finish nail 13 mm from edge spaced 406 mm apart, weather cut each end spaced minimum 305 mm apart.
- .7 Allow 3 mm gap between trim and siding.
- .8 Shim frieze board as required to align with corner trim.
- .9 Site paint exposed cut edges to match colour of board, trim, or plank.

3.5 CLEANING

- .1 Remove damaged, improperly installed, or otherwise defective siding materials and replace with new materials complying with specified requirements.

- .2 Clean finished surfaces according to siding manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for insulated modified bituminous roofing system over steel deck as follows:
 - .1 Deck sheathing
 - .2 Vapour retarder
 - .3 Insulation and insulation overlay
 - .4 Adhesive applied base sheet
 - .5 Adhesive applied cap sheet
 - .2 Products supplied for Work of this section must be from a single manufacturer and compatible with adjacent products.
- .2 Related Requirements:
 - .1 Section 03 30 00 – Cast-in-Place Concrete
 - .2 Section 05 31 00 – Steel Decking
 - .3 Section 06 10 00 – Rough Carpentry
 - .4 Section 07 21 13 – Board Insulation
 - .5 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .6 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .7 Section 07 92 00 – Sealants
 - .8 Division 22 – Plumbing: Coordination of pipes and pipe fittings and other materials penetrating roof membranes.
 - .9 Division 23 – Heating, Ventilation and Air Conditioning: Coordination of ductwork and other materials penetrating roof membranes.
 - .10 Division 26 – Electrical: Coordination conduit, wiring, communications cabling, cable trays and other materials penetrating roof membranes.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C518-21, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .2 ASTM C578-23, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - .3 ASTM C726-17, Standard Specification for Mineral Wool Roof Insulation Board.
 - .4 ASTM C728-17a(2022), Standard Specification for Perlite Thermal Insulation Board.
 - .5 ASTM C1002-22, Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

- .6 ASTM C1177/C1177M-17, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- .7 ASTM C1289-23a, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- .8 ASTM D41/D41M-11(2023), Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
- .9 ASTM D312/D312M-16a(2023), Standard Specification for Asphalt Used in Roofing.
- .10 ASTM D448-12(2022) Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
- .11 ASTM D2178/D2178M-15a(2021), Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
- .12 ASTM D2842-19, Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- .13 ASTM D3273-21, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
- .14 ASTM D6162/D6162M-21, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fibre Reinforcements.
- .15 ASTM D6163/D6163M-21, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fibre Reinforcements.
- .16 ASTM D6164/D6164M-21, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.
- .17 ASTM D6222/D622M-16(2023), Standard Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using Polyester Reinforcement.
- .18 ASTM D6223/D6223M-21, Standard Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcement.
- .19 ASTM D6509/D6509M-16(2023), Standard Specification for Atactic Polypropylene (APP) Modified Bituminous Base Sheet Materials Using Glass Fiber Reinforcement.
- .20 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .21 ASTM E96/E96M-23, Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 Canadian General Standards Board (CGSB):
 - .1 CGSB 37-GP-9Ma, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing. (Withdrawn)

- .2 CAN/CGSB-51.33-M89, Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction. (Withdrawn)
- .4 Canadian Roofing Contractors Association (CRCA):
 - .1 CRCA Roofing Specifications Manual.
- .5 Canadian Standards Association (CSA Group):
 - .1 CSA-A123.3-05 (R2015), Asphalt Saturated Organic Roofing Felt (Reaffirmed 2010).
 - .2 CAN/CSA-A123.4-04 (R2023), Asphalt for Constructing Built-Up Roof Coverings and Waterproofing Systems, Includes Update No. 1 (2006).
 - .3 CSA A123.21:20, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane Roofing Systems.
 - .4 CSA-A123.23-15 (2020), Product Specification for polymer-modified bitumen sheet, prefabricated and reinforced.
 - .5 CSA A231.1:19/A231.2:19, Precast Concrete Paving Slabs/Precast Concrete Pavers, Includes Update No. 1 (2020).
 - .6 CSA O121-17 (R2022), Douglas Fir Plywood.
 - .7 CSA O151-17 (R2022), Canadian Softwood Plywood.
- .6 Department of Justice Canada (Jus):
 - .1 Canadian Environmental Protection Act, 1999 (CEPA).
- .7 Ontario Industrial Roofing Contractors' Association (OIRCA):
 - .1 OIRCA Guide Specification.
- .8 Underwriters Laboratories' of Canada (ULC):
 - .1 ULC 102.2, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies (ULC S102.2). 2018
 - .2 ULC 107, Methods of Fire Tests of Roof Coverings (CAN/ULC S107.10).
 - .3 ULC-701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering (CAN/ULC-S701-11). (Withdrawn).
 - .4 ULC-704.1, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced. 2017
 - .5 ULC-706, Standard for Wood Fibre Insulating Boards for Buildings (CAN/ULC S706-09).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meeting one week prior to beginning work of this Section, with Contractor, Consultant, OIRCA representative, installer, manufacturer's representative in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

- .5 Notify the Consultant prior to bid closing if anything in the specification or the drawings does not meet OIRCA or manufacturer's warranty requirements.
- .6 Review OIRCA warranty certificate requirements.

1.4 ACTION SUBMITTALS / INFORMATION SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Provide copies of most recent technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide copies of Workplace Hazardous Materials Information System WHMIS SDS and indicate VOC content for:
 - .1 Primers.
 - .2 Vapour retarder membrane.
 - .3 Sealers.
 - .4 Insulation.
 - .5 Base and cap sheet.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate flashing, control joints, tapered insulation details, slope, minimum and maximum thicknesses, board size, layout, and numbering and elevation datums at low and high points.
 - .2 Provide installation details for parapets, curbs, and roof penetrations.
 - .3 Provide layout for tapered insulation.
- .3 Manufacturer's Certificate: certify that products meet or exceed specified requirements.
- .4 Test and Evaluation Reports: submit laboratory test reports certifying compliance of bitumens, roofing felts, and membrane with specification requirements.
- .5 Manufacturer's field report: in accordance with Section 01 45 00 – Quality Control.
- .6 Reports: indicate procedures followed, ambient temperatures and wind velocity during application.
- .7 Manufacturer's Installation Instructions: indicate special precautions required for seaming the membrane.
- .8 Declaration of Materials Compatibility: submit written declaration stating that materials are compatible with the membrane and substrates and adjacent air/vapour barrier membrane, and are acceptable to the membrane manufacturer. Include a list of materials, suppliers, and manufacturers.
- .9 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Single-Source Responsibility: obtain roofing membrane materials from a single manufacturer regularly engaged in the manufacturing and supply of the specified products and meeting or exceeding the material properties and performance characteristics of the materials and manufacturers named in this Section and to meet the warranty requirements.
- .2 Installer Qualifications: company or person specializing in application of modified bituminous roofing systems with five years documented experience approved by manufacturer.
- .3 Roofing and sheet metal work shall be performed in conformance with roofing manufacturer's written recommendations using materials in accordance with CAN/ULC S107.
- .4 Perform Work to OIRCA practice Manual and manufacturers written instructions.
- .5 Work shall be executed by an applicator approved by the OIRCA as a member in good standing at time of application.
- .6 Inspection: Roofing system to be inspected throughout the installation by an OIRCA accepted independent Inspector.
- .7 Provide only materials listed by OIRCA.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Section 01 61 01 – LEED Product Requirements.
- .2 Storage and Handling Requirements:
 - .1 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.
 - .2 Provide and maintain dry, off-ground weatherproof storage.
 - .3 Store rolls of felt and membrane in upright position. Store membrane rolls with selvage edge up.
 - .4 Remove only in quantities required for same day use.
 - .5 Place plywood runways over completed Work to enable movement of material and other traffic.
 - .6 Store sealants at +5 degrees C minimum.
 - .7 Store insulation protected from weather, daylight and deleterious materials.
 - .8 Do not store materials on roof in concentrations that exceed design live load.
- .3 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Ambient Conditions:

- .1 Do not perform roofing work when air temperature, including wind chill, falls below the membrane manufacturer's recommended limit.
- .2 Do not apply roofing materials to a damp, frozen or unsuitable surface.
- .3 Do not expose roofing materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during the same day.
- .4 Ensure wood has a moisture content less than 19% prior to encapsulating with impermeable membrane.
- .2 Fire Protection:
 - .1 Comply with safety measures described in manufacturer's written installation requirements, requirements of insurance companies and other requirements of the Authorities Having Jurisdiction.
 - .2 Fire Extinguishers, located within six meters of each roofing torch, ULC labelled for ABC protection.
 - .3 At the end of each workday, use a heat detector gun to spot any smouldering or concealed hot spots. Job planning must be organized to ensure workers are still on location at least one hour after torch application.
 - .4 Do not apply torch directly to dry or unprotected wood surfaces.

1.8 WARRANTY

- .1 The Contractor shall provide a Roofing Warranty certificate with a five year Roofing Warranty Period, signed by both the Contractor and the Warrantor stating:
 - .1 The Roofing System has been constructed in accordance with the Contract Documents;
 - .2 The Roofing Warranty Period;
 - .3 Moisture leaks to be corrected within a time-frame determined by the Owner.
 - .4 The Owner as the warrantee, and stating that roofing work will remain in place and be free of any defects in materials and workmanship for the stated Roofing Warranty Period; and either:
 - .1 If a five (5) year Roofing Warranty Period is required: Warrantor shall, at no additional expense to the Owner, repair any roofing failures (of the Roofing System including: moisture penetration, installation errors, manufacturers defects) which includes the replacement of all affected components of the Roofing System, occurring between the date of Substantial Performance of the Work and the end of the Roofing Warranty Period.
- .2 Roofing Membrane Manufacturer: Provide manufacturer's warranty stating that they will repair or replace defective roofing (including labour) and base flashing materials that do not remain watertight, that splits, tears, or separates at the seams or from the substrate within the specified warranty period and as follows:
 - .1 Warranty Period: 10 years Warranty, starting from Substantial Performance for the Project.

- .2 Name of Warrantee: Warrantor shall issue a written and signed warranty identifying the owner's name as the warrantee, and stating that executed work will remain in place and be free of any defects in materials and workmanship for the stated warranty period.

1.9 THIRD PARTY ROOFING INSPECTION

- .1 The Contractor will engage third party roofing inspection. The Inspector will provide numerous inspections and reports to the Owner during the progress of the roofing work, in accordance with the OIRCA Roofing Applications Standards, to help ensure the roofing work is provided as set out in this Contract. Upon notice from the Owner, the Contractor shall expediently perform all steps and make changes as identified by the roofing inspector, at no cost to the Owner. The involvement of the roofing inspector does not relieve the Contractor of the responsibility to supervise, inspect and provide the roofing work as set out in this Contract.
- .2 The Construction schedule shall include roofing inspections. The Owner will provide the number of roofing inspections and the frequency. The Owner, Consultant, roofing inspector(s), and Roofing System manufacturer, at reasonable times, shall have proper and safe access to the Work, including parts of the Work in preparation at locations other than the Place of the Work, for the purposes of observation, inspection and testing.
- .3 Provide copies of the manufacturer's site reports to the Owner, Consultant, and roofing inspector, prior to Substantial Performance of the Work.

Part 2 Products

2.1 MANUFACTURERS

- .1 Basis-of-Design: Materials and colours listed below form the Basis-of-Design materials for this project.
- .2 Acceptable Membrane Manufacturers: Subject to compliance with requirements specified in this section and as established by the Basis-of-Design materials, manufacturers offering similar products that may be incorporated into the Work include the following:
 - .1 Henry Company.
 - .2 IKO Industries Ltd.
 - .3 Siplast.
 - .4 Soprema.
- .3 Use only materials from one manufacturer.

2.2 PERFORMANCE / DESIGN CRITERIA

- .1 Provide system with products to achieve ten year manufacturers warranty certificate as indicated above.
- .2 Compatibility between components of roofing system is essential. Provide written declaration to Consultant stating that materials and components, as assembled in system, meet this requirement.

- .3 Roofing System: to CSA A123.21 for wind uplift resistance.
 - .1 Net factored wind uplift pressure 0.53kPa to 2.15kPa. Wind uplift diagram as indicated on Structural Drawings.
 - .2 Coordinate with roof system manufacturer; confirm results with Consultant prior to commencing Work.

2.3 DECK COVERING

- .1 Glass Mat Faced Roof Boards: to ASTM C1177 for manufacturing and ASTM D3273 for mould resistance, standard, mould resistant, thickness as indicated.
 - .1 Surface Burning Characteristics: In accordance with CAN/ULC S102.
 - .1 Flame Spread: 0.
 - .2 Smoke Developed: 0.
 - .2 Long Edges: Square.
 - .3 Location: Where indicated on Drawings.
 - .4 Acceptable Materials:
 - .1 GlasRoc Sheathing, CertainTeed.
 - .2 Securock Gypsum Fiber Roof Board, CGC.
 - .3 DensDeck, Georgia Pacific.
 - .4 Dexcell Glass Mat Roof Board, National Gypsum.
- .2 Sheathing board attachment to steel deck: Corrosion-resistant, self-tapping screws and plates, capable of meeting Performance Criteria specified.
 - .1 Minimum Fastener Properties:
 - .2 Nominal 8 mm diameter fastener with oversized head.
 - .3 Buttress Threads: 12 threads per inch.
 - .4 Pull-out value in 22 gauge Grade E steel deck: 4.2 kN.
 - .5 Typical Static Back-Out: 5.1 N-m.
 - .6 Length to be sufficient to penetrate steel deck by minimum recommended length.

2.4 ROUGH CARPENTRY

- .1 Blocking, nailers, and other carpentry: as indicated in Section 06 10 00 - Rough Carpentry.
- .2 Do not use pressure treated materials where membrane materials are to be adhered directly to wood Products.

2.5 PRIMER

- .1 Primer comprised of elastomeric bitumen, volatile solvents and adhesive enhancing additives as recommended by membrane roofing manufacturer to suit substrate and installation conditions.
 - .1 Acceptable Materials:
 - .1 Blueskin Adhesive – Henry Company.
 - .2 IKO SAM Adhesive.

- .3 TA-325, Siplast.
- .4 Elastocol Stick, Soprema.

2.6 AIR AND VAPOUR RETARDER

- .1 Premanufactured Self Adhesive Air/Vapour Barrier: Self-adhesive air/vapour barrier membrane composed of SBS modified bitumen with thermoplastic polymers and high density polyethylene film and as follows:
 - .1 Thickness: Minimum 0.8 mm.
 - .2 Cold Bending: -35°C.
 - .3 Static Puncture: 400 N.
 - .4 Membrane Breaking Strength (MPa): MD=75, XD=98.
 - .5 Water Vapour Permeance: 0.92 ng/Pa•s•m² to ASTM E96.
 - .6 Acceptable Materials:
 - .1 Vapor Bloc SA – Henry Company.
 - .2 MVP, IKO.
 - .3 Sopravap'R, Soprema.
 - .4 V-Force Vapor Barrier for Siplast System, Elevate (Formerly Firestone).
- .2 Vapour retarder continuity strip: SBS membrane with reinforcement, and elastomeric bitumen. Sanded upper surface; underside self-adhesive, compatible with wall and roof air/vapour retarder membranes as recommended by accepted membrane manufacturers below.
 - .1 Acceptable Materials:
 - .1 ModifiedPlus G100 Tack Sheet, Henry Company.
 - .2 Armourbond Flash Sand, IKO.
 - .3 Paradiene 20 SA, Siplast.
 - .4 Sopraflash Stick Duo, Soprema.

2.7 INSULATION

- .1 Primary Insulation: Closed-cell polyisocyanurate foam core laminated to heavy non-asphaltic glass fibre reinforced facers; 25 mm thickness of largest panels practical, having square edges, minimum LTTR RSI 0.92/25 mm; conforming to ASTM C1289 Type II, Class 1, Grade 3, ULC 704.1, Type III, Class 3, (20 psi) to a tolerance not exceeding 3 mm from nominal size in any dimension, and as follows:
 - .1 Third-party test reports from an accredited laboratory must be provided to verify the declared performance in cold temperatures.
 - .2 Acceptable Materials:
 - .1 Secureshield GC, Carlisle.
 - .2 ACFoam III, Atlas Roofing Corporation.
 - .3 H-Shield GC, Hunter.
 - .4 Therm III, IKO.
 - .5 E'NRGY 3, Johns Manville.

- .6 Paratherm, Siplast.
- .7 Sopra-ISO Plus, Soprema.
- .2 Insulation Mineral Wool Roof Insulation: mineral wool fiber insulation made from ballast rock and slag and with rigid impregnated with a bitumen upper layer and as follows:
 - .1 Acceptable Materials:
 - .1 Toprock® DD, Rockwool Inc.
 - .2 Soprarock DD Plus, Soprema.
 - .3 Sloped Insulation: Extruded-Polystyrene (XPS) Board Insulation: ASTM C578, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
 - .1 Rigid closed cell extruded polystyrene foam insulation.
 - .2 Comply with ASTM C 578-95, Type IV, density 1.6 lb/cu. ft. min. compressive resistance 210 kPa to ASTM D1621
 - .3 Thermal resistance: RSI-values of 0.88. at 40 °F and 75 °F respectively to ASTM C518.
 - .4 Water absorption: 0.7 to ASTM D2842)
 - .5 Surface Burning Characteristics ASTM C 578
 - .1 Flame spread 0.
 - .2 Smoke Developed 155.
 - .6 Basis-of-Design Materials:
 - .1 Sopra XPS 30, Soprema

2.8 MEMBRANE

- .1 Composite Cover Board and Base Sheet: Asphaltic-support board and factory applied base sheet:
 - .1 Description: SBS modified base sheet membrane and polyester reinforcement, factory applied to a semi-rigid asphaltic board. The top surface is covered with sand. The membrane side lap is 60% self-adhesive and 40% covered with a poly film that is heat sealed.
 - .1 Board size: 910 mm x 2440 mm x thickness as indicated on Drawings (minimum 5 mm).
 - .2 In conformance with: CGSB 37.56-M
 - .3 Properties:

	MD	XD
.1 Strain Energy (kJ/m)	9	7
.2 Breaking Strength (N/50 mm)	17	12.5
.3 Ultimate Elongation (%)	60	65
.4 Tear Resistance (N)	60	
.5 Static Puncture Resistance (N)	400	
.6 Dimensional Stability (%)	-0.4	0.3
.7 Plastic Flow (°C)	≥ 115	
.8 Cold Bending (at -30°C)	No Cracking	

- .9 Lap Joint Strength (kN/m) Pass > 4kN/m
- .2 Acceptable Materials:
 - .1 Protectoboard Base 180, IKO.
 - .2 Protectoboard with Paratech 180 TG, Siplast
 - .3 2-1 Soprasmart Board, Soprema.
- .2 Roof Cap Sheet: Roof waterproofing system comprised of reinforced, elastomeric bitumen cap sheet applied using manufacturer's recommended cold adhesive; base sheet having two surfaces sanded; cap sheet having bottom surface sanded and top surface is protected by coloured granules, and as follows:
 - .1 Prefabricated membrane to CSA A123.23.
 - .2 Reinforcement: Composite polyester and glass grid.
 - .3 Elastomeric Bitumen: Mix of bitumen and SBS polymer.
 - .4 Protection: Coloured granules – white.
 - .5 Acceptable Materials:
 - .1 MP-HD-Cap, IKO.
 - .2 Parafor 30, Siplast
 - .3 ColPly Traffic Cap 460, Soprema.
- .3 Membrane base sheet flashing (stripping):
 - .1 Primer: Manufacturer's recommended elastomeric bitumen or synthetic rubber blend, volatile solvents, adhesive enhancing additives and resins used to prime substrate to enhance the adhesion of self-adhesive membranes suitable for application temperatures.
 - .2 Roofing membrane with non-woven polyester reinforcement and glass grid and elastomeric bitumen. Top face covered with thermofusible plastic film, underside self-adhesive and protected by silicone release paper in accordance with CSA A123.23 type two, class C, grade one.
 - .3 Components:
 - .1 Reinforcement: Non-woven polyester and glass grid.
 - .2 Elastomeric bitumen: Mix of selected bitumen and SBS polymer.
 - .3 Mark top face with lines to ensure proper roll alignment.
 - .4 Characteristics:
 - .1 Cold bending at minimum -25°C: No cracking.
 - .2 Reinforcing weight: minimum 160 g/m².
 - .3 Membrane Thickness: minimum 2.5 mm.
 - .5 Acceptable Materials:
 - .1 G100 Tack Sheet, Henry.
 - .2 Armourbond Flash, IKO.
 - .3 Sopralply Flam Stick, Soprema,

2.9 ADHESIVE

- .1 Insulation Adhesive: Manufacturers standard adhesives specifically formulated for installation of plastic insulation to roofing materials:

- .1 Acceptable Materials:
 - .1 Insta-Foam Products Inc. Insta-Stik, Dow.
 - .2 880-333 – Henry Company.
 - .3 IKO Millennium.
 - .4 Parafast Insulation Adhesive by Siplast.
 - .5 Duotack Adhesive, Soprema.
- .2 Roofing Base Sheet Adhesive: manufacturers standard OIRCA approved products.
- .3 Sheathing Board Adhesive: Manufacturers standard adhesives specifically formulated for installation of sheathing to metal deck.
 - .1 Basis-of-Design Materials:
 - .1 830-05, Henry Company.
 - .2 IKO Millennium.
 - .3 Parafast Insulation Adhesive, Siplast.
 - .4 Duotack Adhesive, Soprema.

2.10 ACCESSORIES

- .1 Fasteners:
 - .1 Fasteners to Steel Decking: Cadmium-plated flat-headed, self-tapping screws, No. 14, of Type A or AB, in conformance with CSA B35.3.
- .2 Perimeter Fire Seal: SBS modified bitumen, minimum 60 gm/m² glass fleece reinforced, self adhering membrane having sanded top face, cut into strips minimum 150 mm wide x nominal 1.5 mm thick.
 - .1 Acceptable Materials:
 - .1 Modiflex Tapes, IKO.
 - .2 Sopraguard Tape, Soprema.
- .3 Walkways:
 - .1 Consisting of one additional ply of cap sheet membrane. Grey colour to be different from field membrane as selected by Consultant.
- .4 Flashing and sheet metal in accordance with section 07 62 00 – Sheet Metal Flashing and Trim.
- .5 Waterproofing Mastic: solvent-based mastic containing SBS modified bitumen, fibres and mineral fillers, used to seal around penetrations and extrusions.
 - .1 Compatibility: With air/vapour barrier membrane, substrate and insulation.
 - .2 Specific gravity at 20°C: 1.0 kg/l to 1.12 kg/l.
 - .3 Application Temperature: -10°C to +35°C.
 - .4 Solids by Weight: 70% to 83 %.
 - .5 Acceptable Materials:
 - .1 AquaBarrier Mastic, IKO
 - .2 Sopramastic, Soprema.

- .6 Expansion Joint Waterproofing Membrane: EPDM-based synthetic rubber flexible membrane as recommended by waterproofing system materials manufacturer.
 - .1 Acceptable Materials:
 - .1 Soprajoint Plus, Soprema.
 - .2 Situra Redline
 - .3 Or as recommended by membrane manufacturer.
- .7 Low Rise Foam Adhesive:
 - .1 Acceptable Materials:
 - .1 Millennium, IKO
 - .2 Duotack, Soprema.
- .8 Torches: Use only torches designed for torching roofing material and acceptable to manufacturer.
- .9 Waterproofing liquid flashing: two component PMMA liquid membrane with fleece fabric.
 - .1 Acceptable Materials:
 - .1 Pumadeq 31MV, Henry Company.
 - .2 Metateck, IKO
 - .3 Parapro Field/ Parapro Flashing, Siplast.
 - .4 RS 230 Field, Soprema Alsan with Alsan RS 230 Flash, Soprema.

2.11 PIPE SUPPORTS

- .1 Roof drain pans, vent stack covers and other roof penetration flashings: pre-manufactured, stainless steel construction, purpose-made to suit application and location, designed to tie-in to SBS modified membrane roofing systems.
 - .1 Basis-of-Design Materials:
 - .1 Materials as required (coordinate with electrical and mechanical Drawings), Thaler Metal Industries Ltd., include submittal of manufacturer's 20-year Warranty.
- .2 Premanufactured Pipe Supports: fabricated from 100% recycled content, with 2.7 mm thickness galvanized steel frame, 150 mm wide x 100 mm tall x length to suit installation; including fasteners, bridge components, and angled supports as required for a complete installation and having the following accessories:
 - .1 Pipe and Conduit Support: Galvanized pipe clamp sized to suit gas pipe in accordance with manufacturers instruction's.
 - .2 Multi-Pipe and Conduit Support: Galvanized pipe support system size and number to suit pipes being supported in accordance with manufacturer's instructions.
 - .3 Extendable Height Support: Galvanized steel pipe extensions to suit installation in accordance with manufacturer's instructions.
 - .4 Provide loose piece of cap sheet membrane under each support.
 - .5 Acceptable Materials:
 - .1 C-Port, Clearline Technologies.

- .2 Dura-Blok, Eaton
- .3 Quick Block Sleeper, Pipe-Ease Inc.

Part 3 Execution

3.1 EXAMINATION

- .1 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual and OIRCA Roofing Practices Manual.
- .2 Verification of Conditions:
 - .1 Inspect with Consultant deck conditions including parapets, construction joints, roof drains, plumbing vents and ventilation outlets to determine readiness to proceed. The start of roofing work will mean roofing conditions are acceptable for work completion.
- .3 Evaluation and Assessment:
 - .1 Prior to beginning of work ensure:
 - .1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.
 - .2 Curbs have been built.
 - .3 Roof drains have been installed at proper elevations relative to finished roof surface.
 - .4 Plywood and lumber nailer plates have been installed to deck, walls and parapets as indicated.

3.2 PREPARATION

- .1 The interface of the walls and roof assemblies to be fitted with durable rigid material sheet metal and plywood providing connection point for continuity of air barrier.
- .2 Assembly, component and material connections to be made in consideration of appropriate design loads.
- .3 Cover walls, walks, sloped roofs and adjacent work where materials hoisted or used. Roofing Contractor shall assume full responsibility for damage.
- .4 Use warning signs and barriers. Maintain in good order until completion of Work.
- .5 Clean off drips and smears of bituminous material immediately.
- .6 Dispose of rain water off roof and away from face of building until roof drains or hoppers installed and connected.
- .7 Repair or replace defaced or disfigured finishes caused by work of this section.
- .8 Fire Protection: Provide fire protection during installation.
 - .1 Comply with safety measures described in manufacturer's written installation requirements, requirements of insurance companies and other requirements of the Authorities Having Jurisdiction.

- .2 Fire Extinguishers, located within six meters of each roofing torch, ULC labelled for ABC protection.
- .3 At the end of each workday, use a heat detector gun to spot any smouldering or concealed hot spots. Job planning must be organized to ensure workers are still on location at least one hour after torch application.
- .4 Do not apply torch directly to dry or unprotected wood surfaces.

3.3 SHEATHING

- .1 Mechanically fasten sheathing where indicated on Drawings with manufacturer's written instructions.
- .2 Place with long axis of each sheet transverse to trusses, with end joints staggered and fully supported.

3.4 PRIMING DECK

- .1 Do priming in accordance with manufacturers written recommendations.
- .2 Apply deck primer to deck substrate at the rate recommended by manufacturer.
- .3 Surfaces to be primed must be free of rust, dust or any residue that may hinder adherence.
- .4 Cover primed surfaces with roofing membrane within time limits recommended by roofing membrane system manufacturer.

3.5 AIR AND VAPOUR RETARDER INSTALLATION

- .1 Install self adhering air/vapour barrier membrane by unrolling air/vapour barrier membrane onto substrate aligned with substrate materials starting at bottom of slope without removing silicone release sheet, and as follows:
 - .1 Peel back one end of silicone release sheet and adhere membrane to substrate; peel remaining release sheet at a 45° angle to avoid wrinkles in membrane.
 - .2 Cut roll and start again where membrane is not properly aligned to deck; re-align membrane and overlap end of misaligned piece by 150 mm.
 - .3 Overlap adjacent membranes by 75 mm; overlap end laps by 150 mm; stagger end laps by 300 mm; place thin sheet of metal under end lap of membrane to provide structural support to lapped membranes.
- .2 Overlap roof air/vapour barrier to wall air/vapour barrier using compatible continuity strip to provide continuity of building envelope.

3.6 GENERAL MEMBRANE INSTALLATION

- .1 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed Work and materials out of storage.
- .2 Clean off drips and smears of bituminous material immediately.
- .3 Dispose of rain water off roof and away from face of building until roof drains or hoppers installed and connected.
- .4 Do not install roofing materials during rain or snowfall.

- .5 Provide fire protection during installation.
- .6 Metal connectors and decking shall be treated with rust proofing or galvanization.

3.7 INSULATION APPLICATION

- .1 Insulation: fully adhered, adhesive application:
 - .1 Adhere insulation to vapour barrier using manufacturer's recommended adhesive applied at a rate recommended by the manufacturer
 - .2 Place boards in parallel rows with ends staggered and minimum two layers with staggered joints, and in firm contact with one another.
 - .3 Cut end pieces to suit.
 - .4 Apply adhesive in continuous ribbons at 300 mm on centre.
- .2 Tapered insulation application:
 - .1 Adhere insulation using manufacturer's recommended adhesive applied at rate recommended by manufacturer; adhere insulation at locations where roof deck will be visible in final installation.
 - .2 Install tapered insulation in accordance with shop drawings. Stagger joints between layers 150 mm minimum.
- .3 Overlay Board: adhesive application (roof slopes more than 6% slope):
 - .1 Adhere overlay board to insulation with adhesive at the rate recommended by manufacturers written instruction.
 - .2 Place boards with long joints continuous, and short joints staggered. Ensure boards are evenly and tightly butted together, with joints offset from primary insulation joints.
 - .3 Cut ends to suit and apply adhesive in continuous ribbons at 300 mm on centre.
 - .4 Apply only as many boards as can be covered with roofing membrane the same day.

3.8 (EXPOSED) CONVENTIONAL MEMBRANE ROOFING (CMR) APPLICATION

- .1 Base sheet application - adhered:
 - .1 Install membrane base sheet in full bed of adhesive applied at rate recommended by roofing membrane manufacturer using a notched 5 mm neoprene squeegee starting at drain and perpendicular to slope.
 - .2 Apply base sheet in parallel strips, lapping side joints 100 mm and end joints 150 mm; stagger end joints a minimum of 300 mm.
 - .3 Roll surface installed membrane using a 30 kg steel roller to smooth membrane and to provide continuous and uniform adhesion to insulation.
 - .4 Seal lap joints of base sheet at end each workday; perform work without interruption to avoid tears and formation of fish mouths, air pockets or wrinkles.
 - .5 Cut off corners at end laps being covered by next roll.
 - .6 Terminate base sheet at top of cant or at perimeter.
- .2 Perimeter Fire Seal Application

- .1 Apply perimeter fire seal to roof perimeter and curb substrates prior to applying base sheet materials. Apply fire seal to vertical joints in parapet or curb sheathing, and at vertical corners.
- .2 Extend fire seal minimum 50 mm up parapet faces and extend fire seal minimum 75 mm onto adjacent substrates. Ensure air bubbles and fish mouths are removed.
- .3 Install perimeter fire seal to act as temporary moisture seal until installation of flashing materials.
- .3 Reinforced gusset installation:
 - .1 Install gussets at every angle, and on inside and outside corners.
 - .2 Install self adhesive gussets before installing self adhesive base sheet flashing membranes.
- .4 Base sheet flashing installation:
 - .1 Apply base sheet flashing when primer coat is dry and in accordance with manufacturer's written instructions.
 - .2 Position pre-cut membrane pieces; peel back 100 mm to 150 mm of silicone release paper to hold the membrane in place at the top of the parapet, then gradually peel back remaining silicone release paper, pressing down on the membrane with aluminium applicator to provide good adhesion and to provide smooth transition between up-stand and field surface; smooth entire membrane surface with a roller for full adhesion.
 - .3 Cut off corners at end laps being covered by next roll.
 - .4 Install a reinforcing gusset in all inside and outside corners.
 - .5 Seal overlaps at the end of each workday.
- .5 Cap sheet application – adhered:
 - .1 Install cap sheet in a full bed of adhesive applied at a rate recommended by membrane manufacturer using notched 5 mm neoprene squeegee starting at drains and perpendicular to the slope; use brush grade or trowel grade adhesive as required for different membrane installation requirements as recommended by manufacturer's written installation requirements.
 - .2 Lap side joints 100 mm and end joints 150 mm; stagger end joints and joints between membranes plies a minimum of 300 mm; stagger base and cap sheet membranes by 300mm.
 - .3 Brush surface to provide complete and uniform adhesion immediately after placement of membrane into adhesive.
 - .4 Cut off corners at end laps being covered by next roll.
 - .5 Provide a smooth application, free of wrinkles, fish mouths, air pockets or tears.
 - .6 Terminate cap sheet at top of cant or at perimeter.
- .6 Cap Sheet Flashings Application:

- .1 Install cap sheet flashing in 1 m widths. Overlap side by 100 mm. Stagger base and cap sheet overlaps by minimum 100 mm. Make overlaps 150 mm wide.
- .2 Draw parallel chalk line 150 mm from parapet or upstand bases. Sink surface granules into bed of hot bitumen with torch from chalk line to parapet or upstand.
- .3 Adhere cap sheet to base sheet membrane starting from bottom and working to top using trowel grade adhesive applied with 5 mm notched steel trowel at a rate recommended by membrane manufacturer; use roller to apply even pressure over entire surface to provide uniform adhesion across entire surface.
- .7 Roof penetrations:
 - .1 Install roof drain pans, vent stack covers and other roof penetration flashings and seal to membrane in accordance with manufacturer's recommendations and details.

3.9 WALKWAYS

- .1 Install walkway membrane in accordance with the manufacturer's printed installation instructions to provide walkway access from roof access points to rooftop units and other mechanical elements requiring maintenance service.

3.10 DRAINS

- .1 Ensure all leaders are properly secured before proceeding with work.
- .2 Install drains and seals in accordance with the manufacturer's printed instructions.
- .3 Make openings water and vapour tight at membrane.
- .4 Install strainer and drain cover as per details.

3.11 ELECTRICAL CONDUIT FLASHING

- .1 At all electric conduit locations, install conduit flashing per manufacturer's approved details.
- .2 Flash-in base with roof membrane per manufacturer's approved detail.
- .3 Coordinate with electrical sub-contractor for disconnection and reconnection of wiring within a two hour limited timeframe.

3.12 GAS LINES AND CONDUIT

- .1 Install preformed plastic gas line supports.
- .2 Install supports at 2440 mm o.c. maximum, and at all directional changes in accordance with reviewed shop drawings. In addition if the gas lines are 19 mm or less the maximum space for supports are 1220 mm.
- .3 Install support at maximum of 305 mm from all connections in the gas lines.
- .4 Where preformed plastic supports are not suitable install specified precast concrete pavers, complete with pedestals on top of membrane.

- .5 On top of concrete pavers re-install existing wood blocking. Replace damaged missing with specified wood blocking to required height.
- .6 Secure gas line and conduit with clamping ring.
- .7 Ensure that piping is not damaged during roofing work and cleanup. Make good any damages caused.

3.13 FIELD QUALITY CONTROL

- .1 Inspection and testing of roofing application to be carried out by OIRCA accepted testing laboratory designated by Owner in cooperation with Consultant.
- .2 Inspection fees to be paid by Owner, in accordance with Section 01 45 00 – Quality Control.
- .3 Flood Testing:
 - .1 Do not conceal waterproofing until inspection and testing are completed to satisfaction of Consultant.
 - .2 Temporarily plug drains and dam horizontal surface areas to be tested and flood with water to minimum depth of 80 mm.
 - .3 Maintain flooded depth for 24 hours.
 - .4 If leaks occur repair and retest.
 - .5 Remove water at end of test.
- .4 Manufacturers' Field Services:
 - .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
 - .2 Manufacturer's field services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
 - .4 Obtain reports within three days of review and submit.

3.14 CLEANING

- .1 Clean off drips and smears of bituminous material immediately.
- .2 Remove bituminous markings from finished surfaces.

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- .3 In areas where finished surfaces are soiled caused by work of this section, consult manufacturer of surfaces for cleaning advice and complying with their documented instructions.

3.15 PROTECTION

- .1 Protect roof from traffic and damage. Comply with precautions deemed necessary by Consultant.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Sheet metal materials.
 - .2 Prefinished steel sheet.
 - .3 Ice and water shield membrane.
 - .4 Insulation.
 - .5 Vapour retarder.
 - .6 Accessories: Underlay, ventilation and drainage mat, slip sheet, snap cap, sealant, cleats, fasteners, washers, flashing, roof curbs, and trim.
- .2 Related Sections:
 - .1 Section 01 35 00 – Delegated Design
 - .2 Section 06 10 00 – Rough Carpentry
 - .3 Section 07 21 13 – Board Insulation
 - .4 Section 07 42 13 – Preformed Metal Cladding
 - .5 Section 07 42 43 – Insulated Wall Panels
 - .6 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .7 Section 07 92 00 - Sealants

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A755/A755M-18, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
 - .3 ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot Dip Process.
 - .4 ASTM C303-21, Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
 - .5 ASTM D523-14(2018), Standard Test Method for Specular Gloss.
 - .6 ASTM D822-23, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
 - .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 37.29M89, Rubber-Asphalt Sealing Compound (Withdrawn).
 - .2 CAN/CGSB 37.5-M89, Cutback Asphalt Plastic Cement (Withdrawn).
 - .3 CAN/CGSB 51.32-M77, Sheathing, Membrane, Breather Type (Withdrawn).
 - .3 Canada Green Building Council (CaGBC):

- .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian Roofing Contractors Association (CRCA):
 - .1 CRCA Roofing Specifications Manual.
- .5 Canadian Standards Association (CSA Group):
 - .1 CSA A123.3-05(R2015), Asphalt Saturated Organic Roofing Felt (Reaffirmed 2010).
 - .2 CSA A123.5-16 (R2020), Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules.
 - .3 CSA-A123.23-15 (2020), Product Specification for polymer-modified bitumen sheet, prefabricated and reinforced.
 - .4 CSA S136-16, North American Specification for the Design of Cold Formed Steel Structural Members.
- .6 National Research Council Canada (NRC)/Institute for Research in Construction (IRC) - Canadian Construction Materials Centre (CCMC):
 - .1 CCMC-2011, Registry of Product Assessments.
- .7 Ontario Industrial Roofing Contractors Association (OIRCA):
 - .1 OIRCA Guide Specification.
- .8 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 Architectural Sheet Metal Manual, 7th Edition, 2012.
- .9 Underwriters Laboratories' of Canada (ULC):
 - .1 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies (ULC S102).
 - .2 ULC 114, Standard Method of Test for Determination of Non-Combustibility in Building Materials. (2018)
 - .3 ULC 702.2, Mineral Fibre Thermal Insulation for Buildings, Part 2: Application Guidelines. (ULC-S702.2-15)
 - .4 ULC 704.1, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
 - .2 Submit product data sheets for roofing felts and insulation. Include:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Limitations.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:

- .1 Indicate arrangements of sheets and joints, types and locations of fasteners and special shapes and relationship of panels to structural frame.
- .2 Shop drawings to detail continuity of air, vapour and thermal barriers at changes in plane, at transitions between assemblies, and at penetrations.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit duplicate 300 x 300 mm samples of each sheet metal material.
- .4 Submit proof of manufacturer's CCMC Listing and listing number to Consultant.
- .5 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence and cleaning procedures.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.4 QUALITY ASSURANCE

- .1 Installer Qualifications: Engage experienced installer with a minimum of five years experience who has completed systems similar in material, design, and extent to that indicated for Project and with record of successful performance. Installer to be a member of the Ontario Industrial Roofing Contractors Association (OIRCA).
- .2 Retain a professional engineer, registered in the province of the Work, to design fabrication and erection of the Work of this Section in accordance with applicable Building Code and Contract Documents requirements including, but not limited to, the following:
 - .1 Seal and signature to shop drawings and design submittals.
 - .2 Field review of installed components.
 - .3 Completion of Letters or Commitment and Compliance specified in Section 01 35 00 – Delegated Design.
- .3 Obtain each type of metal roofing system through one source from a single manufacturer.
- .4 Mock-Ups
 - .1 Submit mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Mock-up will be used:
 - .1 To judge workmanship, substrate preparation, operation of equipment and material application.
 - .3 Locate where directed.
 - .4 Allow 24 hours for inspection of mock-up by Consultant before proceeding with sheet metal flashing work.
 - .5 When accepted, mock-up will demonstrate minimum standard of quality required for this Work. Approved mock-up may remain as part of finished Work.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver and store materials in accordance with manufacturer's instructions.

- .2 Protect panels during transportation, unloading, storing, and erecting to prevent bending, warping, twisting, and surface damage.
- .3 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.6 WARRANTY

- .1 Manufacturer's Warranty for Finishes: 20 years from date of Substantial Performance.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include the following:
 - .1 Agway Metals Inc.
 - .2 Behlen Industries.
 - .3 Berridge Manufacturing Company.
 - .4 Garland Canada Inc.
 - .5 Vicwest Steel Inc.
 - .6 Westform Metals.

2.2 PERFORMANCE / DESIGN CRITERIA

- .1 General: The complete roof cladding system shall meet the following performance/design criteria and maintain its intended appearance, remain wind and watertight, allow for expansion and contraction of metal components and transmit loads to the supporting structural back-up.
- .2 The design, and erection of a complete metal roof system is the responsibility of this subcontractor and are based on the performance criteria specified. The method assembly, reinforcing and anchorage is schematic and shows general intent only. Location and methods of providing same shall be this subcontractor's responsibility who shall design the assembly, reinforcing and anchorage to suit specific conditions in an acceptable manner complying with the requirements specified herein.
- .3 Provide flashing as shown and required to make the system wind and watertight, and still allow for thermal movement.
- .4 All fastenings shall be concealed where possible. Where exposed in finished surfaces, screw heads shall be neat and symmetrical, made completely watertight and capable of allowing expansion and contraction of metal roof cladding. Exposed fasteners shall be color-matched to finished metal cladding or stainless steel and as scheduled.
- .5 Thermal Movements and Wind Loads: The metal wall and associated flashing systems shall be so designed and constructed as to provide for such expansion and contraction of component materials as will be caused by an ambient

temperature range of -40°C to +60°C without causing harmful buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.

- .6 Provide and/or make allowances for free noiseless vertical and horizontal thermal and wind loading movement, due to the contraction and expansion of any and all component parts.
- .7 Assembly and erection procedures shall take into account the ambient temperature range and wind pressure at the time of installation.
- .8 The system shall provide clear internal paths of drainage in order to drain any trapped moisture to the exterior, discharging moisture in a manner avoiding staining of architectural finishes, collecting in puddles, formation of unsafe icicles and dripping onto pedestrians.
- .9 Fasten panel assembly to building structure in a manner, which transmits all loads to the main structure without exceeding the capacity of any fastener.

2.3 SHEET METAL MATERIALS

- .1 Zinc coated steel sheet: to ASTM A653/A653M, commercial quality (CS), with Z275 galvanized coating and as follows:
 - .1 Base Metal Thickness: 0.76 mm.
 - .2 Finish: prefinished as specified below.
 - .3 Profile: to match AR38, Agway Metals.
 - .1 Ribbed, shallow vee in direction of standing seam.
 - .2 Seam Profile: Standing Seam.

2.4 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory applied silicone modified polyester.
 - .1 Class: F1S.
 - .2 Colour: to match adjacent metal
 - .3 Specular gloss: 25-35 units +/-5 to ASTM D523 for matte finish.
 - .4 Coating thickness: dry film thickness not less than 0.9 mil to ASTM D4138.
 - .5 Resistance to accelerated weathering for chalk rating of eight, colour fade five units or less and erosion rate less than 20% to ASTM D2244 and ASTM D659.
- .2 Prefinished steel with factory applied polyvinylidene fluoride.
 - .1 Class: F1S.
 - .2 Colour: to match adjacent metal
 - .3 Specular gloss: 30 units +/-5 to ASTM D523.
 - .4 Coating thickness: not less than 22 micrometres.
 - .5 Resistance to accelerated weathering for chalk rating of eight, colour fade five units or less and erosion rate less than 20% to ASTM D822/D822M as follows:
 - .1 Outdoor exposure period 2500 hours.
 - .2 Humidity resistance exposure period 5000 hours.

- .3 Prefinished steel with factory applied polyvinyl chloride.
 - .1 Class: F1S.
 - .2 Colour: to match adjacent metal
 - .3 Specular gloss: 30 units +/-5 to ASTM D523.
 - .4 Coating thickness: not less than 200 micrometres.
 - .5 Resistance to accelerated weathering for chalk rating of eight, colour fade five units or less and erosion rate less than 20% to ASTM D822/D822M as follows:
 - .1 Outdoor exposure period 5000 hours.
 - .2 Humidity resistance exposure period 5000 hours.

2.5 ICE AND WATER SHIELD MEMBRANE

- .1 Waterproofing Underlayment: self adhering membrane for high temperature applications; rubberized asphalt will not flow up to temperatures as high as 116°C.
 - .1 Primer: as recommended by manufacturer.
 - .2 Acceptable Materials:
 - .1 Ice and Water Shield HT, Grace Construction Products.
 - .2 Stormshield, IKO.
 - .3 Jiffy Seal Ice & Water Guard HT, Protecto Wrap.
 - .4 LapLock PSU (HT), Roofnado
 - .5 Lastobond Shield HT, Soprema.

2.6 VAPOUR RETARDER

- .1 Self adhered vapour retarder: SBS rubberized asphalt membrane, self adhering vapour retarder, having a non-slip surface and UV resistant opaque surface.
 - .1 Acceptable Materials:
 - .1 Modified Vapour Protector, IKO.
 - .2 Sopravap'R, Soprema.
 - .3 Vapor-Bloc SA, Henry Company.

2.7 FABRICATION

- .1 Fabricate all components of the system in the factory, ready for field installation.
- .2 Provide roof sheet and all accessories in longest practicable length to minimize field lapping of joints.

2.8 ACCESSORIES

- .1 Provide components required for complete metal roofing system assembly including trim, copings, fasciae, corner units, ridge cap, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items; match material and finish of metal roofing system.
- .2 Isolation coating: alkali resistant bituminous paint.
- .3 Plastic cement: to CAN/CGSB-37.5.

- .4 Underlay: No.15 perforated asphalt felt to CSA A123.3.
- .5 Ventilation: sandwich structure, open core with nonwoven filter or membrane.
- .6 Slip sheet: reinforced sisal paper or a heavy felt kraft paper.
- .7 Snap Cap:
 - .1 Provide 25 mm high snap caps for full length of the roof panel and retained by panel clips, fabricated from Z275 galvanized (zinc coated) sheet steel conforming to ASTM A653/A653M structural quality Grade 230 having a nominal core thickness 0.76 mm. Finish and colour to match roof sheet.
- .8 Sealant: Asbestos-free sealant, compatible with systems materials, recommended by system manufacturer and as indicated in Section 07 92 00 - Sealants.
- .9 Rubber-asphalt sealing compound: to CAN/CGSB-37.29.
- .10 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.
- .11 Fasteners: concealed.
- .12 Washers: of same material as sheet metal, 1 mm thick with rubber packings.
- .13 Flashing, Roof Curbs, and Trim: Prefinished flashing materials to match roofing materials in accordance with Section 07 62 00 - Sheet Metal Flashing and Trim.
- .14 Touch-up paint: as recommended by sheet metal roofing manufacturer.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine substrates to ensure proper attachment to framing.
- .2 Examine roof deck to verify deck is clean and smooth, free of depressions, waves or projections and within flatness tolerances required by metal roofing system manufacturer.
- .3 Verify roof opening, curbs, pipes, sleeves, ducts or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.
- .4 Verify deck is dry and free of snow or ice.

3.2 INSTALLATION

- .1 Install metal roofing system in accordance with manufacturer's written instruction.
- .2 Use concealed fastenings except where approved by Consultant before installation.
- .3 Provide underlay under sheet metal roofing. Secure in place and lap joints 100 mm minimum.
- .4 Apply slip sheet over asphalt felt underlay to prevent bonding between sheet metal and felt. Secure with minimum anchorage and lap joints 50 mm minimum in direction of waterflow.

- .5 Install sheet metal roof panels using cleats spaced at 300 mm on centre.
- .6 Secure cleats with two fasteners each and cover with cleat tabs.
- .7 Stagger transverse seams in adjacent panels.
- .8 Flash roof penetrations with material matching roof panels, and make watertight.
- .9 Form seams in direction of water-flow and make watertight.

3.3 STANDING SEAM ROOFING

- .1 Fold lower end of each pan under 20 mm.
 - .1 Slit fold 25 mm away from corner to form tab where pan turns up to make standing seam.
 - .2 Fold upper end of each pan over 50 mm.
 - .3 Hook 20 mm fold on lower end of upper pan into 50 mm fold on upper end of underlying pan.
- .2 Apply sheet metal roofing beginning at eaves. Loose lock pans to valley flashing and edge strips at eaves and gable rakes.
- .3 Finish standing seams 25 mm high on flat surfaces. Bend up one side edge 40 mm and other 45 mm.
 - .1 Make first fold 6 mm wide single fold and second fold 12 mm wide, providing locked portion of standing seam with 5 plies in thickness.
 - .2 Fold lower ends of seams at eaves over at 45 degrees angle.
 - .3 Terminate standing seams at ridge and hips by turning down in tapered fold.
- .4 Form valleys of sheets not exceeding 3 m in length. Lap joints 150 mm in direction of flow.
 - .1 Extend valley sheet minimum 150 mm under roofing sheets.
 - .2 At valley line, double fold valley and roofing sheets and secure with cleats spaced 450 mm on centre.

3.4 ACCESSORY INSTALLATION

- .1 Install accessories with positive anchorage to building and weather tight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
- .2 Install components required for a complete metal roofing system assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- .3 Install flashing and trim in accordance with performance requirements, manufacturer's written installation instructions, and SMACNA recommendations; provide concealed fasteners where possible, and set units true to line and level; install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- .4 Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges

folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

3.5 CLEANING

- .1 Remove temporary protective coverings and strippable films, if any, as metal roofing system are installed, unless otherwise indicated in manufacturer's written installation instructions.
- .2 Clean finished surfaces as recommended by metal roofing system manufacturer upon completion of metal roofing system installation; maintain in a clean condition during remainder of construction.
- .3 Replace metal roofing system components that become damaged or have deteriorated beyond successful repair by finish touch-up or similar minor repair procedures.
- .4 Remove all excess materials, debris and equipment at completion.
- .5 Clean all panels clean and free of all grime and dirt.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Metal flashings.
 - .2 Scuppers.
 - .3 Accessories: Isolation coating, roofing cement, underlay for metal flashing, metal accessories, sealants, fasteners, counter flashing wind restraint clips, washers, adhesives and insect screen.
- .2 Related Requirements:
 - .1 Section 06 10 00 – Rough Carpentry
 - .2 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
 - .3 Section 07 42 43 – Insulated Wall Panels
 - .4 Section 07 52 00 – Modified Bituminous Membrane Roofing
 - .5 Section 07 61 00 – Sheet Metal Roofing
 - .6 Section 07 92 00 – Sealants
 - .7 Section 08 11 13 – Steel Doors and Frames
 - .8 Section 08 11 16 – Aluminum Doors and Frames
 - .9 Section 08 44 13 – Glazed Aluminum Curtain Walls
 - .10 Section 08 50 13 – Aluminum Windows

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Aluminum Association (AA):
 - .1 AA ADM Aluminum Design Manual, 2020 Edition.
 - .2 AA DAF45-2003(R2009), Designation System for Aluminum Finishes.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A240/A240M-23a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM A606/A606M-23, Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.
 - .3 ASTM A653/A653M-23 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .4 ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - .5 ASTM B32-20, Standard Specification for Solder Metal.
 - .6 ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .7 ASTM B370-22 Standard Specification for Copper Sheet and Strip for Building Construction.

- .8 ASTM D523-14(2018), Standard Test Method for Specular Gloss.
- .9 ASTM D822-23, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .10 ASTM D4586/D4586M-07(2018), Standard Specification for Asphalt Roof Cement, Asbestos-Free.
- .3 American National Standards Institute (ANSI)
 - .1 ANSI H35.1/H35.1M-2017, American National Standard Alloy and Temper Designation Systems for Aluminum.
- .4 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .5 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 37.29M89, Rubber-Asphalt Sealing Compound (Withdrawn).
 - .2 CAN/CGSB 51.32-M77, Sheathing, Membrane, Breather Type (Withdrawn).
 - .3 CAN/CGSB 79.1-M91, Insect Screens (Withdrawn).
- .6 Canadian Roofing Contractors Association (CRCA):
 - .1 Roofing Specifications Manual.
- .7 Canadian Standards Association (CSA Group):
 - .1 CSA A123.3-05 (R2015), Asphalt Saturated Organic Roofing Felt.
 - .2 CSA AAMA/WDMA/CSA 101/I.S.2/A440:22, North American Fenestration Standard/Specification for windows, doors, and skylights, Includes Errata (2018).
 - .3 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
- .8 Green Seal Environmental Standards:
 - .1 GS-11, Paints, Coatings, Stains and Sealers, 2015.
 - .2 GS-36, Adhesives for Commercial Use, 2013.
- .9 Ontario Industrial Roofing Contractors' Association (OIRCA):
 - .1 OIRCA Guide Specification.
- .10 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 Architectural Sheet Metal Manual, 7th Edition, 2012.
- .11 South Coast Air Quality Management District (SCAQMD):
 - .1 Rule 1113-16, Architectural Coatings.
 - .2 Rule 1168-22, Adhesive and Sealant Applications.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordinate work of this Section with interfacing and adjoining Work for proper sequencing of each installation and to provide positive weather resistance, durability of the work, and protection of materials and finishes.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
- .2 Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- .3 Submit one sample, 300 x 300 mm in size, illustrating metal finish colour.
- .4 Submit manufacturer's printed product literature for sheet metal flashing systems materials, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Installer qualifications: Engage an experienced installer having a minimum of three years experience who has completed projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- .2 Construct and install roof metal flashings in accordance with OIRCA Manual details and in accordance with the OIRCA Manual. If requirements conflict, this specification takes precedence over the manual.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Stack pre-formed and pre-finished material in manner to prevent twisting bending and rubbing.
- .2 Provide protection for galvanized surfaces.
- .3 Prevent contact of dissimilar metals during storage and protect from acids, flux, and other corrosive materials and elements
- .4 Protect prefinished surfaces from scratches and from rust staining.
- .5 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 WARRANTY

- .1 The same warranty provisions apply to flashings associated with roofing as to the roofing.
- .2 Provide the manufacturers standard warranty with the minimum coverage of 20 years for the paint finish against chalking, fading, peeling, checking, cracking, or colour change.
- .3 Provide Warranty for sheet metal flashing and trim to include in maintenance manuals as specified in Section 01 78 00 – Closeout Submittals

Part 2 Products

2.1 METAL FLASHINGS

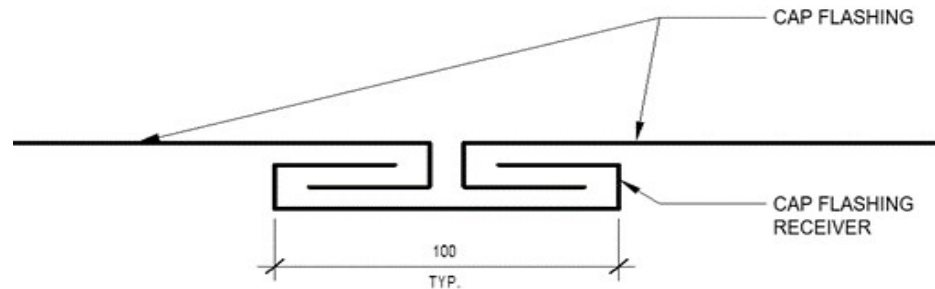
- .1 Zinc coated galvanized steel sheet (pre-finished): Type A commercial quality to ASTM A653/A653M, with Z275 designation zinc coating.
 - .1 Class: F1S-Finished one side
 - .2 Thickness: minimum 0.61 mm base metal thickness.
 - .3 Factory Finish: silicone modified polyester
 - .1 Basis-of-Design Materials:
 - .1 WeatherXL, Valspar or Perspectra, Dofasco.
 - .4 Colour: As indicated on drawings.
- .2 Form flashings, copings and fascias to profiles indicated.

2.2 SCUPPERS

- .1 Form scuppers from 0.76 mm thick prefinished steel
- .2 Sizes and profiles as indicated.
- .3 Provide necessary fastenings.

2.3 FABRICATION

- .1 Fabricate sheet metal building flashings and trim in accordance with the recommendations of SMACNA's Architectural Sheet Metal Manual that apply to the design, dimensions, metal, and other characteristics as required.
- .2 Fabricate aluminum flashings and other sheet aluminum work in accordance with AAI-Aluminum Sheet Metal Work in Building Construction.
- .3 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .4 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.
- .5 Make flashings of prefinished metal for cap flashings, for all flashings adjacent to roofing at roof edges and area dividers and where exposed to view from ground. Make flashings for other locations, of plain galvanized metal as follows:
 - .1 Use 0.45 mm metal core thickness except where otherwise indicated.
 - .2 Use 0.62 mm metal core thickness wherever a flat length exceeding 305 mm wide occurs.
 - .3 Use 0.80 mm metal core thickness for concealed fastening strips.
- .6 All straight run joints shall be flashed into a cap flashing receiver as indicated below.



- .7 Make joints to allow for thermal movement, space S-Lock joints at 2440 mm with metal clips or 1200 mm if no metal clips for maximum centres.
- .8 Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant in accordance with SMACNA standards.
- .9 Make flashings for building into masonry and concrete so that joints can be lapped 100 mm or more.
- .10 Strengthen free edges of metal flashings by folding to form a 13 mm hem.
- .11 Make flashings to curbs, walls and parapets a minimum of 200 mm high, where possible.
- .12 Where curb-mounted roof penetrations are not required, provide flashing sleeves and collars for all pipes and conduit extending through the roof. Sleeves shall be soldered to a piece of sheet metal extending at least 150 mm onto the surrounding roof.
- .13 Make joints for corners and intersections with standing seams except where exposed of pre-finished metal when seams shall be flat locked.
- .14 All bends machine made; form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .15 Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, non-corrosive metal recommended by sheet metal manufacturer, and as follows:
 - .1 Size as recommended by SMACNA manual or sheet metal manufacturer for application but not less than thickness of metal being secured.
- .16 Back paint metal flashings in contact with dissimilar metals or materials with bituminous paint that would result in electrolytic action or corrosion.

2.4 ACCESSORIES

- .1 Isolation coating: alkali resistant bituminous paint.
- .2 Roofing Cement: to ASTM D4586/D4586M, asphalt based, asbestos free.
- .3 Underlay for metal flashing: High temperature self adhered membrane.
 - .1 Basis of Design Material:
 - .1 Lastobond Shield HT, Soprema
- .4 Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or

- compatible with material being installed; noncorrosive; size and thickness required for performance.
- .5 Sealants: as indicated in Section 07 92 00 - Sealants.
 - .6 Fasteners: of same material as sheet metal, to CSA B111, as recommended by sheet metal manufacturer; non-corrosive. Finish of exposed parts to match material being fastened.
 - .7 Counter Flashing Wind Restraint Clips: Provide clips being installed before counter flashing to prevent wind uplift of the counter flashing lower edge.
 - .8 Washers: of same material as sheet metal, 1 mm thick with rubber packings.
 - .9 Insect Screen:
 - .1 In accordance with CAN/CGSB 79.1.
 - .2 Stainless Steel Wire: Type 304, 18 x 16 mesh (1.13 mm x 1.3 mm) using nominal 0.28 mm wire diameter; having minimum 66.08% apparent opening size, using non-magnetic stainless steel wire.
 - .3 Clips: low conductivity fibreglass attachments clips for assemblies with concrete structure.
 - .10 Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather resistant seaming and adhesive application of flashing sheet metal.
 - .11 Touch-up paint: as recommended by prefinished material manufacturer.

Part 3 Execution

3.1 EXAMINATION

- .1 Check mounting and counterflashing of mechanical items and report any defect to the Consultant.
- .2 Verify that solid wood blocking or sheathing provided to back-up flashings, nails, screws set, and wood provides a smooth flat plane.

3.2 INSTALLATION GENERAL

- .1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking and fastener disengagement.
- .3 Install metal flashings on all surfaces such as roof cant edges, sleepers, parapets and cap type, wall junctions, roof dividers, curbs, roof control joints, through roof penetrations and the like, and as otherwise required to provide flashing type protection to details. Unless otherwise directed extend all flashings down as indicated on drawings. Additionally install counter and base flashings unless otherwise directed by the Consultant.
- .4 Sheet metal flashings are intended to protect the roof membrane from accelerated deteriorating effects of the elements, and to limit mechanical damage

- of the membrane, and are not intended to protect the work from direct migration of moisture. Ensure that the roofing system membrane terminations are fully water tight, without reliance on covering flashing.
- .5 Fasten and install roof edge flashing and copings capable of all resisting according to recommendations of FMG Loss Prevention Data Sheet 1-49, for wind conditions as outlined in the Ontario Building Code for the York Region.
 - .6 Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects:
 - .1 Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
 - .2 Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
 - .3 Temperature change (range): 67 degrees Celsius ambient; 100 degrees Celsius material surfaces.
 - .7 Provide sheet metal flashing and trim to create a rain screen assembly to the completed air/vapour and roofing membrane termination details.
 - .8 Install prefinished metal fascia to complete edge details. Install as separate piece from flashing.
 - .9 Call for inspection by roofing inspector, of completed roofing work prior to the installation of any metal flashings. Provide other flashing inspections, such as at start-up and periodic inspections, by the roofing inspector at frequencies required by OIRCA.
 - .10 Coordinate installation of flashing work of this Section with flashing work of other Sections which ties into this work. Coat surfaces of different metals such as aluminum and galvanized steel which are in contact to each other, with bituminous paint to prevent electrolysis.

3.3 INSTALLATION: METAL FLASHING

- .1 Apply metal roof flashing to OIRCA recommended requirements as a minimum.
- .2 Install sheet metal flashing and trim in accordance with performance requirements, manufacturer's installation instructions, and SMACNA's Architectural Sheet Metal Manual.
- .3 Do not install metal flashings over flexible roof flashing until the flexible roof flashing has been inspected and approved by the Roofing Inspector. This includes curbs for roof mounted items.
- .4 Fasten metal base flashing to walls or upstands along top of flashing. Do not secure to cant strip. Form lapped corner joints. Extend rolled edge of base flashing approximately 25 mm on to roof from toe of cant, and rest on top of roof surface.
- .5 Do not use exposed fastening unless indicated, or concealed fastening is not possible. Locations and methods shall be approved by Consultant.
- .6 Provide underlay under sheet metal.

- .1 Secure in place and lap joints 100 mm.
- .7 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs.
 - .1 Flash joints using S-lock forming tight fit over hook strips, as detailed.
- .8 Lock end joints and caulk with sealant.
- .9 Insert metal flashing under cap flashing to form weather tight junction.
- .10 Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
- .11 Underlayment: Install a slip sheet of red rosin paper and a course of polyethylene underlayment where installing stainless steel or aluminum directly on cementitious or wood substrates. Provide high-temp self adhered membrane at parapet flashing locations.
- .12 Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.
- .13 Turn top edge of flashing or mortar joint minimum of 25 mm. Lead wedge flashing securely into joint.
- .14 Caulk flashing at cap flashing with sealant.
- .15 Install wind clips as required for flashing.
- .16 Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the Item manufacturer, to drain roof in the most efficient manner.
- .17 Coordinate roof drain flashing installation with roof drainage system installation.
- .18 All exposed and pre-finished flashings to provide a smooth flat surface free of indentations, bumps, oil-canning, or twists, all edges, bends hard, sharp and true to line.

3.4 INSTALLATION: SCUPPERS

- .1 Install scuppers as indicated.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
- .4 Leave work areas clean, free from grease, finger marks and stains.

3.6 PROTECTION

- .1 Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Performance.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Thermally broken roof hatches with insulated double wall lids.
 - .2 Accessories: Hardware, screws, latch, gasket/seal, isolation coating, and safety railing system.
- .2 Related Requirements:
 - .1 Section 05 50 00 – Metal Fabrications
 - .2 Section 06 10 00 – Rough Carpentry
 - .3 Section 07 52 00 – Modified Bituminous Membrane Roofing
 - .4 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .5 Section 07 92 00 – Sealants

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A506-16(2021), Standard Specification for Alloy and Structural Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled.
 - .2 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .3 ASTM B370-22 Standard Specification for Copper Sheet and Strip for Building Construction.
 - .4 ASTM D2369-20, Standard Test Method for Volatile Content of Coatings.
 - .5 ASTM D2832-92(2016), Standard Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.
 - .6 ASTM D5116-17, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
 - .7 ASTM F1667/F1667M-21a, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 Underwriters Laboratories ECOLOGO Certification Program (UL):
 - .1 UL 2761, Sealants and Caulking Compounds (formerly CCD-045).
 - .2 UL 2768 Architectural Surface Coatings. (formerly CCD-047).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:

- .1 Submit manufacturer's printed product literature, specifications and technical data sheet.
- .2 Provide two copies of Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada. Indicate VOC's for caulking materials during application and curing.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate size and description of components, materials, attachment devices, detail continuity of air, vapour, and thermal barriers at changes in plane, at transitions, between assemblies, and at penetrations, description of frame and finish, and construction details.
- .3 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for hardware complete with pertinent details, spare parts lists and warnings against harmful maintenance materials and practices for incorporation into manual specified in 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.6 SITE CONDITIONS

- .1 Verify related work of other trades is complete prior to installing roof hatch and coordinate installation with roof membrane and roof insulation.
- .2 Verify that an air seal has been properly installed prior to installation of roof hatch.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 Acudor Access Doors.
 - .2 Babcock-Davis Hatchways Inc.
 - .3 Bilco Canada.
 - .4 Cendrex.
 - .5 Lexcan Ltd.

- .6 Maxam Metal Products Ltd.
- .7 Nystrom Products Co.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Roof hatches to withstand external load of 1.9 kPa and internal load of 0.95 kPa and temperature range of 80 degrees C without damage to unit or permanent deformation to seals.

2.3 ROOF HATCH

- .1 Provide thermally broken roof hatches with insulated double wall lids and insulated double wall curb frame with integral deck mounting flange and lid frame counter flashing with welded sealed corner joints, continuous weather tight perimeter gasketing and hot dip galvanized hardware, and as follows:
 - .1 Size: Single leaf lid, 750 mm x 2440 mm
 - .2 Curb and Lid Material: Galvanized steel sheet, nominal 2.0 mm minimum thickness, insulated sandwiched construction.
 - .3 Insulation: Polyisocyanurate insulation board, minimum 50 mm thickness.
 - .4 Exterior Curb Liner: Curb as detailed on Drawings.
 - .5 Hardware: zinc plated chromate sealed, counterbalanced spring latch with turn handles, butt or pintle type 316 stainless steel hinge system as standard for manufacturer, and padlock hasps inside and outside.
 - .6 Latching: Single point, using manufacturer's standard latching mechanism.
 - .7 Finish Colour: as directed by Consultant.
 - .8 Basis of Design Materials:
 - .1 L-50 TB, Bilco.

2.4 FABRICATION

- .1 Fabricate components free of twists, bends, or visual distortion and insulated. Weld corners and joints.
- .2 Assemble roof hatch components as indicated.
- .3 Ensure continuity of weather-tight seal.
- .4 Design flashings to collect and lead off accumulated condensation.
- .5 Zinc plate hardware and attachments and shop prime ready for field painting.

2.5 ACCESSORIES

- .1 Screws: stainless steel for curb to structure and for hatch lip frame to outer attachment.
- .2 Securing latch: hold open operating arm with vinyl grip handle to permit one-handed release.
- .3 Resilient gasket/seal to inner face of lid in contact with hatch lid support frame.
- .4 Isolation coating: alkali resistant bituminous paint or epoxy solution.

- .5 Safety Railing System: Manufacturer's standard safety rail system consisting of nominal 40 mm diameter rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation. Installed so that top of railing is 1070 mm above roof surface, finished with manufacturer's standard baked enamel finish, and as follows:
 - .1 Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
 - .2 Fabricate joints exposed to weather in a watertight manner.
 - .3 Close exposed ends of handrail and railing members with prefabricated end fittings.

Part 3 Execution

3.1 INSTALLATION

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Erect components plumb, level and in proper alignment.
- .3 Ensure continuity of building envelope air barrier and vapour retarder systems.
- .4 Adjust and seal assembly with provision for expansion and contraction of components.
- .5 Secure prefabricated curb assembly to structure.
- .6 Coat aluminum and copper in contact with dissimilar materials, with isolation coating.
- .7 Secure and seal frame to curb.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Through penetration firestopping and smoke seal systems for penetrations through the following fire resistance rated assemblies, including both empty openings and openings containing penetrating items:
 - .1 Floors.
 - .2 Wall and partitions.
 - .3 Smoke barriers.
 - .4 Construction enclosing compartmentalized areas.
 - .2 Fire resistive joint systems for the following:
 - .1 Floor-to-floor joints.
 - .2 Floor-to-wall joints.
 - .3 Head-of-wall joints.
 - .4 Wall-to-wall joints.
 - .3 Requirements for Rated Systems or systems requiring Engineered Judgements (EJ):
 - .1 Use of materials that have not been tested in a system or that are not capable of obtaining an Engineered Judgement will not be acceptable for use on this Project.
 - .2 Materials having only a ULC, CUL or FM Approved label will not be acceptable for use on this Project, unless supporting documentation is provided indicating its use in a ULC and FM Approved Rated Assembly Listing for Firestop Systems and Components of an Engineered Judgement specific to the installation conditions of the project.
 - .4 Requirements for installation of Fire Stop systems under a single source of responsibility; either through direct supervision of the Contractor or a single trade responsibility performed by a specialty Subcontractor at the choice of the Contractor.
 - .5 Requirements for third-party verification of installed Fire Stop system components forming a part of the work of this Section by an inspection agency that employs personnel who are qualified to perform this work in accordance a recognized training program acceptable to the Consultant and Authority Having Jurisdiction.
- .2 Related Requirements:
 - .1 Section 01 35 00 – Delegated Design
 - .2 Section 09 21 16 – Gypsum Board Assemblies
 - .3 Division 21-23 Mechanical
 - .4 Division 26-28 Electrical

1.2 REFERENCES

- .1 Definitions:

- .1 Fire-Resistance Rating: The time in minutes or hours that a material or assembly of materials will withstand the passage of flame and transmission of heat when exposed to fire meeting the requirements of ULC 101 or as determined by formal testing of material or assembly of materials meeting requirements of ULC 115, or an interpretation of information derived from formal testing in accordance with requirements of the Building Code and acceptable to the Authority Having Jurisdiction.
 - .2 Fire Separation: Assembly that acts as a barrier against the spread of fire, smoke and noxious gases resulting from combustion as defined by the Building Code and includes the following assemblies having a Fire-Resistance Rating requiring Fire Stopping as follows:
 - .1 Penetration-Type Fire Stop systems located within load bearing walls and partitions.
 - .2 Penetration-Type Fire Stop systems located within non-load bearing walls and partitions.
 - .3 Penetration-Type located within floor assemblies.
 - .4 Building Perimeter-Type located between floor assemblies and exterior wall and roof construction.
 - .5 Construction Joint-Type and other assemblies having a Fire-Resistance Rating indicated on Drawings or Schedules.
 - .3 Fire Compartment: Spaces within a building that are enclosed by exterior walls or separated from other parts of the building by enclosing Fire Separations having a Fire-Resistance Rating.
 - .4 Firewall: Assembly that is a Fire Separation constructed from non-combustible construction subdividing a building or separating adjoining buildings to resist the spread of fire and that has a Fire-Resistance Rating, and structural stability to remain intact under fire conditions for the required fire-rated time.
 - .5 Fire Stop: System consisting of a material, component and means of support used to fill gaps between Fire Separations or between Fire Separations and other assemblies, or used around items that wholly or partially penetrate a Fire Separation.
- .2 Reference Standards:
- .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A1008/A1008M-23e, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - .2 ASTM E119-22, Standard Test Methods for Fire Tests of Building Construction and Materials.
 - .3 ASTM E814-23a), Standard Test Method for Fire Tests of Penetration Firestop Systems.
 - .4 ASTM E1966-15(2019), Standard Test Method for Fire-Resistive Joint Systems.
 - .5 ASTM E2174-20a, Standard Practice for On-Site Inspection of Installed Firestop Systems..

- .6 ASTM E2307-23b, Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus.
- .7 ASTM E2393-20a, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 Factory Mutual (FM):
 - .1 FM Approval 4990, Firestopping. 2009.
 - .2 FM Approval 4991, Approval of Firestop Contractors. 2013.
- .4 Firestop Contractors International Association (FCIA):
 - .1 FCIA Manual of Practice, 8th Edition.
- .5 International Firestop Council (IFC):
 - .1 IFC Guidelines for Evaluating Fire Stop Systems in Engineering Judgments. 2018
 - .2 IFC Guidelines for Evaluating Engineering Judgements -: Perimeter Fire Barrier Systems. 2018
 - .3 Recommended IFC Guidelines for Evaluating Engineering Judgments on Fire Resistant Duct Enclosure Systems for Ventilation Ducts. 2009
- .6 National Fire Protection Agency (NFPA):
 - .1 NFPA (Fire) 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials, 2006 Edition.
- .7 Underwriters Laboratories Inc. (UL):
 - .1 UL 1479-2015, Standard for Fire Test of Through-Penetration Firestops.
- .8 Underwriter's Laboratories of Canada (ULC):
 - .1 ULC Firestop Systems and Components, 2017 Edition.
 - .2 ULC 101, Standard Methods of Fire Endurance Tests of Building Construction and Materials. (CAN/ULC-S101-14)
 - .3 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies. (ULC S102)
 - .4 ULC 114, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
 - .5 ULC 115, Standard Method of Fire Tests of Firestop Systems.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section, with contractor's representative and Consultant in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

- .2 Schedule: Submit a schedule listing surfaces or components to which firestopping and smoke seals is to be applied, and indicating the firestopping and smoke seals system and materials required and detailing installation not later than 30 working days following Award of Contract.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide electronic copy of Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .3 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: in accordance with ULC-101 for fire endurance and ULC-102 for surface burning characteristics and ULC 115.
 - .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.
 - .2 Document from Engineer of Record showing compliance of alternative fire stopping solution with ULC 115 and the EJ guidelines provided by the National Research Council, *Best Practices Guide on Fire Stops and Fire Blocks and Their Impact on Sound Transmission*.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
 - .4 Manufacturer's Field Reports: submit to manufacturer's written reports within three days of review, verifying compliance of Work, as described in PART THREE - FIELD QUALITY CONTROL.
- .4 Provide a third party inspection agency upon completion of the Work of this Section to inspect the fire stopping work and submit written reports and verifications/approval of the installation of products and systems and the products are installed to the manufacturer's requirements to achieve the required fire ratings.
- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00 – LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: Use materials and methods of determining required thickness of application that have the full acceptance of Authority Having Jurisdiction and that are tested in accordance with ULC 115, and that form a part of a ULC or CUL listed system, Engineered Judgement or Equivalent Fire Resistance Rated Assembly.
- .2 Use materials and methods of determining required thickness of application that have the full acceptance of authority having jurisdiction.
- .3 Qualifications: Installer: company or person specializing in fire stopping installations and approved by manufacturer with five years documented experience
- .4 Where possible determine thickness to be applied from tests of assemblies identical to the assembly to be protected, conducted in accordance with ULC 101, ASTM E119, UL 1479, NFPA 251, and ASTM E814.
- .5 Determine system from available engineering studies, or correspondence with the labelling agency indicating the effect of the differences on the fire separation of the assembly. Confirm acceptance of system by authorities having jurisdiction in writing.
- .6 Where the assembly includes conditions that do not correspond to those included in any previously tested assembly and for which no relevant engineering information is available use the same system and material as would be required for a tested assembly with similar conditions and that will achieve at least the minimum level of performance required in a previously tested assembly.
- .7 Use materials tested to ULC 115. Assemblies containing the materials shall be in accordance with assemblies tested and approved by agencies acceptable to authority having jurisdiction.
- .8 Source Responsibility: Obtain through penetration firestop and joint systems, for each kind of penetration and construction condition indicated, from a single source of installation responsibility.
- .9 Delegated Design Professional: Use a Professional Engineer, registered in the province of the Work and familiar with installations of similar scope and complexity to design firestopping and smoke seals.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, and ULC markings.
- .2 Storage and Protection:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Replace defective or damaged materials with new.
- .3 Use stock before its expiration date.
- .3 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

1.7 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Install firestopping and smoke seals materials only when the areas in which they are scheduled are closed-in and protected from dampness.
 - .2 Install firestopping and smoke seals systems when ambient or substrate temperatures are within temperature and moisture limits permitted by firestopping and smoke seals system manufacturers or when substrates are not wet due to rain, frost, condensation, or other causes.
 - .3 Ventilate firestopping and smoke seals systems in accordance with manufacturer's written instructions by natural means or forced air circulation where natural means are not adequate.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 3M Canada Inc.
 - .2 Carboline (formerly A/D Fire Protection Systems Inc.)
 - .3 EZ-Path Fire Rated Pathways.
 - .4 Firestop Systems Inc.
 - .5 Hilti Canada Ltd.
 - .6 Johns Manville Fire Protection Systems.
 - .7 Nuco Self Seal Firestopping Products.
 - .8 Roxtec, Preformed Fire Stopping Systems.
 - .9 Specified Technologies Inc.
 - .10 Tremco Ltd.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Delegated Design Requirements: Design firestopping and smoke seals required by the Contract Documents to withstand fire ratings indicated and in accordance with requirements of the Building Code, and as described in Section 01 35 00 – Delegated Design.
- .2 Performance Requirements: Manufacturer shall design proprietary assemblies to withstand the listed ratings in accordance with the Building Code, Underwriters Laboratories Canada, and authorities having jurisdiction, and as follows:

- .1 Provide through penetration firestop and joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire resistance rating of assembly penetrated:
 - .1 Fire resistance rated load bearing walls, including partitions, with fire protection rated openings.
 - .2 Fire resistance rated non-load bearing walls, including partitions, with fire protection rated openings.
 - .3 Fire resistance rated floor assemblies.
- .2 F-Rated Systems: Provide through penetration firestop systems with F-ratings indicated, as determined by ULC 115 or ASTM E814, but not less than that equalling or exceeding fire resistance rating of constructions penetrated.
- .3 T-Rated Systems: For the following conditions, provide through penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per by ULC 115 or ASTM E814, where systems protect penetrating items exposed to potential contact with adjacent materials:
 - .1 Penetrations located outside wall cavities.
 - .2 Penetrations located outside fire resistive shaft enclosures.
 - .3 Penetrations located in construction containing fire protection rated openings.
 - .4 Penetrating items larger than 100 mm diameter nominal pipe or 100 cm² in overall cross sectional area.
- .4 Firestopping and Smoke seals Systems Exposed To View: Systems exposed to view, traffic, moisture, and physical damage; provide products that after curing do not deteriorate when exposed to these conditions both during and after construction, and as follows:
 - .1 Provide moisture resistant through penetration firestop systems for piping penetrations for plumbing and wet pipe sprinkler systems.
 - .2 Provide firestopping and smoke seals systems capable of supporting floor loads involved either by installing floor plates or by other means for floor penetrations with annular spaces exceeding 100 mm in width and exposed to possible loading and traffic.
 - .3 Provide firestopping and smoke seals systems not requiring removal of insulation for penetrations involving insulated piping.
 - .4 Provide products with flame spread ratings of less than 25 and smoke developed ratings of less than 50 for firestopping and smoke seals and joint systems exposed to view.
- .5 Fire Resistance of Joint Systems: Assembly ratings and movement capabilities indicated, but with assembly ratings not less than that equalling or exceeding fire resistance rating of constructions in which joints are located.

2.3

MATERIALS: FIRESTOPPING AND SMOKESEALS, GENERAL

- .1 Compatibility: Provide firestopping and smoke seals systems that are compatible with one another, with the substrates forming openings, and with the items, if

any, penetrating firestopping and smoke seals systems, under conditions of service and application, as demonstrated by firestopping and smoke seals system manufacturer based on testing and field experience, and as follows:

- .1 Service penetration assemblies: certified by ULC in accordance with ULC 115 and listed in ULC Guide No. 40 U19.
- .2 Service penetration firestopping and smoke seals components: certified by ULC in accordance with ULC 115 and listed in ULC Guide No. 40 U19.13, under the Label Service of ULC.
- .3 Fire resistance rating of installed firestopping and smoke seals assembly not less than the fire resistance rating of surrounding floor and wall assembly.
- .4 Firestopping and Smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.
- .5 Firestopping and Smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal; do not use a cementitious or rigid seal at such locations. Exemption to fire dampers.
- .2 Accessories: Provide components for each firestopping and smoke seals systems that are needed to install fill materials. Use only components specified by firestopping and smoke seals system manufacturer and approved by the qualified testing and inspecting agency for firestopping and smoke seals systems indicated. Accessories include, but are not limited to, the following items:
 - .1 Permanent forming, damming and backing materials, including the following:
 - .1 Slag or rock wool fibre insulation.
 - .2 Sealants used in combination with other forming, damming or backing materials to prevent leakage of fill materials in liquid state.
 - .3 Fire-rated form board.
 - .4 Fillers for sealants.
 - .2 Temporary forming materials.
 - .3 Substrate primers.
 - .4 Collars.
 - .5 Steel sleeves.
 - .6 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
 - .7 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
 - .8 Metal fire stop: Commercial galvanized steel, to ASTM A1008/A1008M, zinc coating 260 g/m², minimum metal core thickness 0.912 mm.
 - .9 Steel Deck Moulded Flute Inserts: One piece moulded mineral fibre flute inserts, sized for steel deck profiles, for placement at top of fire rated wall assemblies:
 - .1 Basis-of-Design Materials:
 - .1 Hilti CP777 Speed Plugs.
 - .10 Labels: Peel-and-stick labels printed with the following information:

- .1 ATTENTION: FIRE RATED ASSEMBLY. DO NOT MODIFY.
- .2 Name of firestopping manufacturer.
- .3 Names of products used.
- .4 Hour Rating of Assembly.
- .5 Manufacturers standard detail number, or Engineered Judgement identifier; ULC or cULUS Number.
- .6 Date of installation.
- .7 Name of installing Subcontractor.
- .8 Contact telephone number for repair or replacement of firestopping materials.

2.4 FILL MATERIALS

- .1 General:
 - .1 Provide firestopping and smoke seals systems containing the types of fill materials indicated in the Firestopping and Smoke seals System Schedule below by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
 - .2 Firestopping and smoke seal systems shall be tested in accordance with ULC 115, and be comprised of asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases, and not to exceed opening sizes for which they are intended for the ratings as indicated on drawings.
- .2 Cast-in-Place Firestopping and Smoke seals Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- .3 Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- .4 Firestopping and Smoke seals Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrating item.
- .5 Cable Penetration Devices:
 - .1 Pre-manufactured intumescent blocks.
 - .1 Acceptable Materials:
 - .1 CFS-BL Intumescent Blocks, Hilti.
 - .2 Intumescent Blocks, Roxtec.
 - .2 Pre-manufactured sleeves, consisting of an adjustable core.
 - .1 Acceptable Materials:
 - .1 CP 653 Speed Sleeves, Hilti.
 - .2 EZ-Path Fire Rated Pathway, Specified Technologies.
 - .3 Pre-manufactured cable management system, consisting of a system of intumescent inserts and adjustable cores
 - .1 Acceptable Materials:

- .1 Transit, Hilti.
 - .2 Preformed Fire Stopping Systems, Roxtec.
- .6 Intumescent Composite Sheets: Rigid panels consisting of aluminum foil faced elastomeric sheet bonded to galvanized steel sheet.
- .7 Intumescent Putties: Non-hardening dielectric, water resistant putties containing no solvents, inorganic fibres, or silicone compounds.
- .8 Intumescent Spray Foam: Expanding spray-in-place intumescent foam sealant.
- .9 Intumescent Wrap Strips: Single component intumescent elastomeric sheets with aluminum foil on one side.
- .10 Mortars: Pre-packaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
- .11 Pillows/Bags: Reusable, heat expanding pillows/bags consisting of glass fibre cloth cases filled with a combination of mineral fibre, water insoluble expansion agents and fire retardant additives.
- .12 Silicone Foams: Multi-component, silicone based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- .13 Silicone Sealants: Moisture curing, single component, silicone based, neutral curing elastomeric sealants of grade indicated below:
 - .1 Grade for Horizontal Surfaces: Pourable (self levelling) formulation for openings in floors and other horizontal surfaces.
 - .2 Grade for Vertical Surfaces: non-sag formulation for openings in vertical and other surfaces.

2.5 MIXING

- .1 For those products requiring mixing before application, comply with firestopping and smoke seals system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine surfaces, components, materials to receive firestopping and smoke seals material; report any conditions which would detrimentally affect the application of the material or the proper firestopping and smoke seals of the system.
- .2 Commence Work when conditions of surfaces and the working conditions are suitable.
- .3 Where penetration sealants or caulking are required, ensure all service lines are in place, tested and approved.

- .4 Verify all proper blocking, framing (using non-combustible materials) are properly installed and prepared to receive firestopping and smoke seals. Notify Consultant in writing of any deficiencies affecting the proper performance of the firestopping and smoke seals, do not proceed until deficiencies are corrected.

3.2 PREPARATION

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
 - .1 Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.
- .4 Prime surfaces as required.
- .5 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 INSTALLATION

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
- .3 Apply firestopping and smoke seals materials/systems to maintain the fire separations in the project as indicated on drawings.
- .4 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .5 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .6 Tool or trowel exposed surfaces to neat finish.
- .7 Remove excess compound promptly as work progresses and upon completion.

3.4 FIELD QUALITY CONTROL

- .1 Review: notify Consultant when ready for review and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
 - .1 Cut tests may be made at random by the Owner. Frequency of cut tests shall be determined by the Consultant, but will not be more than 1% of total length of firestopping and smoke seals.
 - .2 Make all necessary repairs and correct all deficiencies noted after completion of cut tests.
- .2 Manufacturer's Field Services:

- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in Section 01 33 00 – Submittal Procedures.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, twice during progress of Work at 25% and 60% complete.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.6 SCHEDULE

- .1 Design and provide through penetration firestopping and smoke seals as follows for:
 - .1 Systems with No Penetrating Items: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent foam blocks or boards.
 - .5 Intumescent spray foam.
 - .2 Systems for Metallic Pipes, Conduit, or Tubing: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent foam blocks or boards.
 - .5 Intumescent spray foam.
 - .3 Systems for Non-metallic Pipe, Conduit, or Tubing: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent wrap strips.
 - .5 Firestopping and Smoke seals device.
 - .6 Intumescent spray foam.
 - .4 Re-enterable and Cable Managed Systems for Electrical, and Data and Communications Cables:

- .1 Prefabricated Firestop Sleeve CP653 (Hilti).
- .2 Preformed Intumescent Blocks CFS-BL (Hilti).
- .3 Preformed Intumescent Blocks (Roxtec).
- .4 Prefabricated Cable Pathways (EZ-Path).
- .5 Systems for Electrical, and Data and Communications Cables: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Silicone foam.
 - .5 Prefabricated Firestop Sleeve CP 653 (Hilti).
 - .6 Preformed Intumescent Blocks CFS-BL (Hilti).
 - .7 Preformed Intumescent Blocks (Roxtec).
 - .8 Prefabricated Cable Pathways (EZ-Path).
 - .9 Intumescent foam blocks or boards.
 - .10 Intumescent spray foam.
- .6 Systems for Cable Trays: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent putty.
 - .3 Silicone foam.
 - .4 Pillows/bags.
 - .5 Intumescent foam blocks or boards.
- .7 Systems for Insulated Pipes: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent putty.
 - .3 Silicone foam.
 - .4 Intumescent wrap strips.
 - .5 Intumescent foam blocks or boards.
 - .6 Intumescent spray foam.
- .8 Systems for Miscellaneous Electrical Penetrations: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent putty.
 - .3 Intumescent foam blocks or boards.
 - .4 Intumescent spray foam.
- .9 Systems for Miscellaneous Mechanical Penetrations: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent foam blocks or boards.
 - .3 Intumescent spray foam.

- .10 Systems for Groupings of Penetrations: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent wrap strips.
 - .3 Firestopping and Smoke seals device.
 - .4 Intumescent composite sheet.
 - .5 Intumescent foam blocks or boards.
 - .6 Intumescent spray foam.
- .2 Design and provide joint firestopping and smoke seals as follows for:
 - .1 Floor-to-Floor, Fire Resistive Joint System: Provide materials to meet the following criteria:
 - .1 Assembly Rating: As indicated.
 - .2 Nominal Joint Width: As indicated.
 - .3 Movement Capabilities: Compression and extension.
 - .2 Floor-to-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
 - .1 Assembly Rating: As indicated.
 - .2 Nominal Joint Width: As indicated.
 - .3 Movement Capabilities: To be confirmed, compression, extension, or horizontal shear.
 - .3 Head-of-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
 - .1 Assembly Rating: As indicated.
 - .2 Nominal Joint Width: As indicated.
 - .3 Movement Capabilities: Compression and extension.
 - .4 Wall-to-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
 - .1 Assembly Rating: As indicated.
 - .2 Nominal Joint Width: As indicated.
 - .3 Movement Capabilities: Compression and extension.
- .3 Design and provide perimeter fire containment firestopping and smoke seals as follows for:
 - .1 Perimeter Fire Containment System: Provide materials to meet the following criteria:
 - .1 Integrity Rating: As indicated.
 - .2 Insulation Rating: As Indicated.
 - .3 Linear Opening Width: As indicated.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Sealant types:
 - .1 Acrylic latex one part.
 - .2 Mould and mildew resistant.
 - .3 Silicone for general construction and air-seal.
 - .4 Silicone for structural glazing.
 - .5 Acoustical.
 - .6 Multi-component polyurethane.
 - .7 Single-component polyurethane or hybrid.
 - .8 Horizontal joint two component, self-levelling.
 - .9 One part moisture curing, low modulus polyurethane.
 - .10 Control joint.
 - .2 Accessories: Rod backings, high density foam, bond breaker tape, preformed sealants, primer, joint cleaner and bond breaker.
- .2 Related Requirements:
 - .1 Section 03 30 00 – Cast-In-Place Concrete
 - .2 Section 06 40 00 – Architectural Woodwork
 - .3 Section 07 21 19 – Foamed-In-Place Insulation
 - .4 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .5 Section 07 52 00 – Modified Bituminous Membrane Roofing
 - .6 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .7 Section 08 11 13 – Steel Doors and Frames
 - .8 Section 08 11 16 – Aluminum Doors and Frames
 - .9 Section 08 44 13 – Glazed Aluminum Curtain Walls
 - .10 Section 08 80 50 – Glazing
 - .11 Section 09 21 16 – Gypsum Board Assemblies
 - .12 Section 09 30 13 – Tiling
 - .13 Section 09 65 00 – Resilient Flooring
 - .14 Division 23 – Mechanical
 - .15 Other technical sections as required.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C794-18, Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
 - .2 ASTM C834-17(2023), Standard Specification for Latex Sealants.
 - .3 ASTM C919-22, Standard Practice for Use of Sealants in Acoustical Applications.

- .4 ASTM C920-18, Standard Specification for Elastomeric Joint Sealants.
- .5 ASTM C1193-16(2023), Standard Guide for Use of Joint Sealants.
- .6 ASTM C1330-23, Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
- .7 ASTM C1521-19 (2020), Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
- .8 ASTM D2240-15(2021), Standard Test Methods for Rubber Property, Durometer Hardness.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 Canadian General Standards Board (CAN/CGSB)
 - .1 CAN/CGSB-19.0-M77 (Withdrawn) Methods of Testing Putty, Caulking and Sealing Compounds.
 - .2 CAN/CGSB-19.13-M87 (Withdrawn) Sealing Compound, One Component, Elastomeric Chemical Curing.
 - .3 CAN/CGSB-19.18-M87 (Withdrawn) Sealing Compound, One Component, Silicone Base, Solvent Curing.
 - .4 CAN/CGSB-19.21-M87 (Withdrawn) Sealing and Bedding Compound Acoustical.
 - .5 CAN/CGSB-19.22-M89 (Withdrawn) Mildew-Resistant Sealing Compound for Tubs and Tiles.
 - .6 CAN/CGSB-19.24-M90 (Withdrawn) Multi-Component, Chemical-Curing Sealing Compound.
- .4 Department of Justice Canada (Jus):
 - .1 Canadian Environmental Protection Act, 1999 (2018) (CEPA).
- .5 Sealant, Waterproofing, and Restoration Institute (SWRI):
 - .1 Sealants: The Professionals' Guide 2013 Edition.
- .6 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1168-22, Adhesives and Sealants Applications.
- .7 Transport Canada (TC):
 - .1 Transportation of Dangerous Goods Act, 1992 (2019 ammend.) (TDGA).
- .8 Underwriters Laboratories
 - .1 UL 2761 – Sealants and Caulking Compounds
- .9 Underwriters Laboratories of Canada (ULC):
 - .1 ULC 115, Standard Method of Fire Tests of Firestop Systems.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets. WHMIS SDS acceptable to Labour Canada and Health and Welfare Canada for sealants. Indicate VOC content.

- .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Provide colour samples of the actual sealants for approval; painted or printed colour charts are not acceptable.
- .3 When required by Consultant, submit test certificates from an approved Canadian materials testing laboratory indicating that sealants meet the requirements of the standards specified, and that the tests have been conducted in accordance with ASTM D2240.
- .4 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
 - .4 Manufacturers Warranty.
- .5 Submit manufacturer's installation instructions for each product used.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00 – LEED Product Requirements.

1.4 QUALITY ASSURANCE

- .1 Caulking shall be performed by a manufacturer approved contractor with minimum three years successful experience in Work of similar size and complexity.
- .2 Before performing Work of this Section, submit the names of proposed materials. If specified using Standards, indicate Qualification Number.
- .3 Compatibility: Ensure sealants are compatible with adjacent materials and are approved by manufacture for use with adjacent materials.
- .4 Mock-Ups:
 - .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
 - .2 Before performing caulking work do sample applications of each type of sealant for approval. Site locations for sample applications shall be designated by Consultant. Approved samples shall form standard for this project and no work of inferior quality will be allowed. Start no final work until approval of samples is given by the Consultant.
 - .3 Sealant manufacturer to perform pull test to confirm adhesion of all exterior sealants types. Allow Consultant to perform pull tests as required to verify sealant installation.
- .5 Consultant may do pull tests on site installed beads at minimum 5 locations. Contractor to cut sealants when Consultant is present and repair sealant beads after tests are complete.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle, store and protect materials in accordance with Section 01 61 00 - Common Product Requirements.

- .2 Deliver containers labelled and sealed, complete with written application and maintenance instructions.
- .3 Store materials in a dry heated enclosure in accordance with manufacturer's instructions.
- .4 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.
- .7 Unused sealant material must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .8 Divert unused joint sealing material from landfill to official hazardous material collections site approved by Consultant.
- .9 Empty plastic joint sealer containers are not recyclable. Do not dispose of empty containers with plastic materials destined for recycling.
- .10 Fold up metal banding, flatten, and place in designated area for recycling.
- .11 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.6 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Do not proceed with installation of joint sealants under following conditions:
 - .1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C.
 - .2 When joint substrates are wet.
- .2 Joint-Width Conditions:
 - .1 Do not proceed with installation of joint sealants where joint widths are less than or greater than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
 - .1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.
 - .2 Substrate must be clean, dry, and frost free.

1.7 WARRANTY

- .1 Contractor hereby warrants that caulking work will not leak, crack, crumble, melt, shrink, run, lose adhesion or stain adjacent surfaces in accordance with General Conditions, but for three years.

- .2 Provide Warranty for sealants to include in maintenance manuals as specified in Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements in this Section and as recommended by the manufacturer, manufacturers offering products that may be incorporated into the Work include the following:
 - .1 Master Builders Solutions (previously BASF, Sonneborn).
 - .2 Chemtron Manufacturing Ltd.
 - .3 Dow
 - .4 GE Silicones Limited.
 - .5 Loxon, Sherwin Williams
 - .6 MAPEI Inc.
 - .7 Pecora
 - .8 Sika Chemical of Canada Ltd.
 - .9 Tremco Ltd.
 - .10 W.R. Meadows

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Sealant Design: Design Structural sealant to withstand loads without breakage, loss, failure of seals, product deterioration, and other defects.
- .2 Design installed sealant to withstand:
 - .1 Dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall as calculated in accordance with BC Building Code. as measured in accordance with ASTM E330/E330M.
 - .2 Movement from ambient temperature range of 49 degrees C.
 - .3 Movement and deflection of structural support framing.
 - .4 Water and air penetration.
- .3 Sealant system shall satisfy following requirements for duration of warranty period:
 - .1 Waterproof, flexible, and thermally compatible with substrate under applicable service conditions.
 - .2 Provide a weather-tight seal that does not allow moisture penetration.
 - .3 Shall not debond, crack, or craze.
 - .4 Shall not leak.
- .4 Reference to products does not relieve manufacturer of responsibility to comply fully with specified criteria.

2.3 SEALANT MATERIALS

- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.

- .2 When low toxicity caulks are not possible, confine usage to areas which off gas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize offgas time.
- .3 Unless otherwise specified, VOC content limits of sealants shall be in accordance with SCAQMD Rule 1168 and as follows:
 - .1 Architectural Materials:
 - .1 Sealants: VOC content limit 250 g/L.
 - .2 Sealant Primers for Non-Porous Surfaces: VOC content limit 250 g/L.
 - .3 Sealant Primers for Porous Surfaces: VOC content limit 775 g/L.
 - .2 Roofing:
 - .1 Non-Membrane Related Sealants: VOC content limit 300 g/L.
 - .2 Single Ply Roofing Sealants: VOC content limit 450 g/L.
 - .3 SBS Membrane Sealant Primer: VOC content limit 500 g/L.
 - .3 All Other Applications:
 - .1 Sealants: VOC content limit 420 g/L.
 - .2 Sealant Primers: VOC content limit 750 g/L.

2.4 SEALANT MATERIAL DESIGNATIONS

- .1 Type S-1: Acrylic Latex One Part, Shore A Hardness 20, to ASTM C834.
 - .1 Acceptable Materials:
 - .1 Latacalk, Chemtron.
 - .2 Sonolac, BASF Sonneborn.
 - .3 Latex 100, Tremco.
- .2 Type S-2: Silicone Sealant, mould and mildew resistant to ASTM C920; type S; grade NS; class 50; use NT, G, and A.
 - .1 Acceptable Materials:
 - .1 Multiseal, Chemtron.
 - .2 Dowsil 795 Silicone, Dow
 - .3 SCS2000, GE.
 - .4 895 NST, Pecora
 - .5 Spectrem 2 Silicone, Tremco Inc.
 - .6 Knight Shield Silicone 5700 Series, W. R. Meadows
- .3 Type S-3: Silicone Sealant, general construction and air-seal sealant.
 - .1 To ASTM C920: type S; grade NS; class 25; use NT, M, G, A, O.
 - .1 Acceptable Materials:
 - .1 Dowsil 790 Silicone, Dow (for porous substrates)
 - .2 Dowsil 795 Silicone, Dow (for non-porous substrates)
- .4 Type S-5: Acoustical Sealant, interior, non-skimming, non-hardening, simple component synthetic rubber sealant.
 - .1 Acceptable Materials:

- .1 Metaseal, Chemtron.
- .2 AIS 919, Pecora
- .3 Acoustical Sealant, Tremco.
- .5 Type S-6: Multi-component polyurethane sealant, chemical curing, exterior wall sealant.
 - .1 To ASTM C920: type M; grade NS; class 50; use T, NT, M, A, O.
 - .2 Acceptable Materials:
 - .1 MasterSeal NP2, BASF.
 - .2 Thioplast 400, Chemtron.
 - .3 830, Isoflex.
 - .4 Dynatrol II, Pecora
 - .5 Sikaflex 2c NS, Sika.
 - .6 Dymeric, Tremco.
 - .7 Deck-O-Seal, W. R. Meadows
- .6 Type S-7: Single-component polyurethane or hybrid sealant, non-sag, for general construction.
 - .1 To ASTM C920: type S; grade NS; class 25; use NT, M, A, O, T.
 - .2 Acceptable Materials:
 - .1 Masterseal NPI or 150, BASF Sonneborne.
 - .2 Multiflex, Chemtron.
 - .3 H1 or S1, Loxon
 - .4 Mapeflex P1, MAPEI Inc.
 - .5 Dynatrol I-XL Hybrid, Pecora
 - .6 Sikaflex 1a or SikaHyflex 150LM, Sika.
 - .7 Dymonic FC, Tremco Inc.
 - .8 Pourthane NS, W.R. Meadows Canada.
- .7 Type S-8: Horizontal joint sealant, two component, self-levelling.
 - .1 To ASTM C920: type M; grade P; class 25; use T, M, O.
 - .2 Acceptable Materials:
 - .1 Sonolastic SG, BASF Sonneborn.
 - .2 Mapeflex P2 SL, MAPEI Inc.
 - .3 Dynatrol II, Pecora
 - .4 Sikaflex 2c SL, Sika.
 - .5 THC-901, Tremco Inc
- .8 Type S-9: One part moisture curing, low modulus polyurethane sealant for sealing joints in level and slightly slope surfaces conforming to ASTM C920, type S, grade P, class 50, use T, M, A, O, MC-1-25-B-N.
 - .1 Acceptable Materials:
 - .1 Sonolastic SL 1, BASF Sonneborn.
 - .2 Urexpan NR-201, Pecora
 - .3 Vulkem 45 SSL, Tremco Inc.

- .4 Pourthane SL, W. R. Meadows
- .9 Type S-10: Control joint sealant, two-component, epoxy-urethane, self-levelling, load bearing saw cut or preformed control joints.
 - .1 Acceptable Materials:
 - .1 Loadflex, Sika
 - .2 Rezi-Weld Flex, W. R. Meadows
- .10 Type S-11: Control Joint Sealant, two component, polyurea based, load bearing, self levelling sealant.
 - .1 Acceptable Materials:
 - .1 Euco Qwikjoint 200, Euclid Chemical.
 - .2 Planiseal Rapid Joint 15, MAPEI Inc.
- .11 Type S-12: Control Joint Sealant, two component, semi-rigid epoxy, load bearing, self levelling sealant.
 - .1 Acceptable Materials:
 - .1 Dural 340 SL, Euclid Chemical.
 - .2 Rezi-Weld Flex, WR Meadows.
- .12 Type S-13: Single-component polyurethane sealant, medium-modulus, non-sag, low-VOC, UV stable.
 - .1 To ASTM C920: type S; grade NS; class 50; use NT, T, M, A, O, I.
 - .2 Acceptable Materials:
 - .1 Multiflex, Chemtron.
 - .2 Vulkem 116, Mameco.
 - .3 Dymonic 100, Tremco Inc.
 - .4 Pourthane NS, W. R. Meadows

2.5 COLOURS

- .1 Colours: To match adjacent materials, as selected by Consultant, from manufacturer's standard colour range. Confirm with Consultant prior to application.

2.6 SEALANT SELECTION

- .1 Where no specified type of sealant is shown or specified, confirm sealants specified in this Section appropriate for its location.
- .2 Make sealant selections consistent with manufacturer's recommendations.
- .3 Use acrylic sealant Type S-1 only on the interior and only in situations where little or no movement can occur.
- .4 Use mould & mildew resistant silicone sealant Type S-2 for non-moving joints in washrooms and kitchens. Do not use on floors.
- .5 Use silicone general construction sealant Type S-3 or Type S-6 and S-7 for all joints, interior and exterior, where no other specific sealant type specified. Use Type S-6 for joints over 19 mm.

- .6 Use acoustical sealant Type S-5 and air seal sealant Type S-3 only where they will be fully concealed and only where no constant or consistent air pressure difference will exist across the joint.
- .7 Use multi-component sealant type S-6, primed penetration element surfaces other than concrete, for mechanical and electrical service penetrations in concrete foundation walls.
- .8 Use multi-component sealant Type S-8 for horizontal joint sealant of plaza, floors and decks, exterior areas only, subject to pedestrian and vehicular traffic.
- .9 Use polyurethane, semi-self levelling sealant Type S-9 for in expansion joints in sidewalks, plazas, floors and other pedestrian and vehicular horizontal surfaces with slopes up to 6%.
- .10 Use control joint sealant S-10 as filler for interior, horizontal saw cut or preformed control joints where joints are subject to load bearing conditions.
- .11 Use control joint sealant S-11 as filler for interior, horizontal saw cut or preformed control joints, where joints are subject to low temperatures (freezer floors) and where joints require nosing support.
- .12 Use control joint sealant S-12 as filler for interior, horizontal saw cut or preformed control joints where joints are subject to thermal shock conditions, traffic loops, and where a high bond strength is required.
- .13 Use sealant S-13 for sealing exterior holes and penetrations around pipes and other services passing through concrete foundations and requiring greater movement capability.

2.7 ACCESSORIES

- .1 Preformed Compressible and Non-Compressible back-up materials that are non-staining, compatible with joint substrate, sealants, primers, and other joint fillers, and are approved for applications indicated by sealant manufacturer based on site experience and laboratory testing.
 - .1 Rod Type Sealant Backings:
 - .1 ASTM C1330, Type C (closed cell material with a surface skin), Type O (open cell material) or Type B (bi-cellular material with a surface skin).
 - .2 Use any of the preceding types, as approved in writing by joint sealant manufacturer for joint application indicated.
 - .3 Size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - .4 Non-adhering to sealant, to maintain two sided adhesion across joint.
 - .5 Allow backer rod to breathe outside of packaging 24 hours before application.
 - .6 Oversize 30% to 50% of joint size.
 - .2 High Density Foam.
 - .1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength

140 to 200 kPa, extruded polyolefin foam, 32 kg/m³ density, or neoprene foam backer, size as recommended by manufacturer.

- .3 Bond Breaker Tape.
 - .1 Polyethylene bond breaker tape or other tape recommended by sealant manufacturer which will not bond to sealant.
- .2 Preformed Sealants
 - .1 Preformed Silicone Sealant System: Manufacturer's standard system consisting of pre-cured low modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral curing silicone sealant for bonding extrusions to substrates:
 - .1 Acceptable Materials:
 - .1 Dowsil; 123 Silicone Seal, Dow.
 - .2 UltraSpan US1100, GE Silicones
 - .3 Spectrem Simple Seal, Tremco.
 - .3 Primer: Non-staining type as recommended by sealant manufacturer.
 - .4 Joint Cleaner: Non-corrosive solvent type recommended by sealant manufacturer for applicable substrate materials.
 - .5 Bond Breaker: Pressure-sensitive plastic tape that will not bond to sealants.

Part 3 Execution

3.1 PROTECTION

- .1 Protect installed Work of other trades from staining or contamination.

3.2 EXAMINATION

- .1 Carefully inspect surfaces, materials to receive sealants and verify they are physically capable of retaining sealant bond.
- .2 Verify that fillers and backing provided under other Sections properly installed.
- .3 Grind joint surfaces if required to achieve adequate surface preparation.

3.3 PREPARATION

- .1 Prepare surfaces in accordance with manufacturer's instructions.
- .2 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .3 Maintain workmanship of highest quality in accordance with best trade practice.
- .4 Ensure that joint forming materials are compatible with sealant.
- .5 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work. Wire brush loose materials and other foreign matter which might impair adhesion of sealant.
- .6 Use air stream to blow out dirt and water from crevices.
- .7 Ensure joint surfaces are dry and frost free.

- .8 Prime all porous material (e.g. wood, masonry, concrete, ceramic or paver tile, etc).
- .9 Prime other joints when recommended by manufacturer. Use a brush that will reach all parts of the joints. Mask adjoining surfaces with tape prior to priming to prevent staining.

3.4 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.5 BACKUP MATERIAL

- .1 Use backer rod as specified, to limit depth of sealant and to act as bond breaker at back of joint.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% - 50% compression.
- .3 Where depth of joint does not permit the use of backer rod apply paper masking tape to back of joint to act as bond breaker.
- .4 Ensure that no joints are formed which are bonded on adjacent sides where there is any possibility of movement.

3.6 MIXING

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.7 APPLICATION

- .1 Apply sealant in strict accordance with manufacturer's recommendations.
- .2 For joints where movement is possible, apply backer rod to achieve a joint depth of one half the joint width but not less than 9 mm; for joints larger than 25 mm use a depth of 13 mm.
- .3 Use pressure gun fitted with suitable nozzle. Use sufficient pressure to fill voids and joints solid.
- .4 Form surface of sealant smooth, free from ridges, wrinkles, sags, or air pockets and imbedded impurities. Neatly tool surface to a slight concave appearance.
- .5 Tool sealants to achieve air tight joints. Use wet tools as required.
- .6 Ensure bead is solid, filling entire space between sides and bedding material, exerting sufficient pressure to obtain maximum bond, by allowing sealant to bulge out in advance of nozzle.
- .7 Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature range.
- .8 Seal perimeters of hollow metal door frames on both sides.
- .9 Seal control joints in gypsum board and stucco, and junctures between interior partitions with exterior walls.

- .10 Seal window and door frames around the inside perimeter, so that an airtight seal is obtained, as indicated on drawings.
- .11 Seal joints in floors and walls and around service and mechanical and electrical fixture penetrations.
- .12 Seal at all locations where dissimilar material meet.
- .13 Curing
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.
 - .3 On porous surfaces allow sealant to cure overnight, and remove excess by light wire brushing.

3.8 CLEANING

- .1 Clean adjacent surfaces immediately and leave Work neat and clean.
- .2 Remove excess and droppings, using recommended cleaners as work progresses.
- .3 Remove masking tape after initial set of sealant.
- .4 Correct staining and discolouring of adjacent surfaces as directed by Consultant.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Steel doors.
 - .2 Steel door frames.
 - .3 Sidelite frames.
 - .4 Fire-rated door and frame assemblies.
- .2 Related Requirements:
 - .1 Section 07 21 19 – Foam-In-Place Insulation
 - .2 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
 - .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .4 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .5 Section 07 92 00 – Sealants
 - .6 Section 08 11 16 – Aluminum Doors and Frames
 - .7 Section 08 71 00 – Door Hardware
 - .8 Section 08 80 50 – Glazing
 - .9 Section 09 21 16 – Gypsum Board Assemblies
 - .10 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American National Standards Institute (ANSI)/ National Fenestration Rating Council (NFRC):
 - .1 ANSI/NFRC 100-2023 (EOA2), Procedure for Determining Fenestration Product U-Factors.
 - .2 ANSI/NFRC 102-2023 (EOA0), Procedure for Measuring the Steady State Thermal Transmittance of Fenestration Systems.
 - .3 ANSI/NFRC 200-2023 (EOA2), Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
 - .4 ANSI/NFRC 400-2023 (EOA1), Procedure for Determining Fenestration Product Air Leakage.
 - .2 American National Standards Institute (ANSI)/ Steel Door Institute (SDI):
 - .1 SDI A250.4-2011, Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors.
 - .2 SDI A250.8-2003 (R2008), Recommended Specifications for Standard Steel Doors and Frames.
 - .3 SDI A250.11-2012, Recommended Erection Instructions for Steel Frames.
 - .3 American Society for Testing and Materials International (ASTM):

- .1 ASTM A653/A653M-23, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 ASTM A780/A780M-20, Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.
- .3 ASTM A879/A879M-22, Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
- .4 ASTM A924/A924M-22a, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- .5 ASTM B29-19, Standard Specification for Refined Lead.
- .6 ASTM B749-20, Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products.
- .7 ASTM C553-13(2019), Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .8 ASTM C578-23, Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- .9 ASTM C591-22, Standard Specification for Unfaced Pre-formed Rigid Cellular Polyisocyanurate Thermal Insulation.
- .10 ASTM C592-22a, Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- .11 ASTM C1289-23a, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- .12 ASTM C1363-19, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
- .13 ASTM D1622-20, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
- .14 ASTM D4726-18, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Exterior-Profile Extrusions Used for Assembled Windows and Doors.
- .15 ASTM D6386-22, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
- .16 ASTM D7396-14 (2020), Standard Guide for Preparation of New, Continuous Zinc-Coated (Galvanized) Steel Surfaces for Painting.
- .17 ASTM E90-23, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .18 ASTM E283/E283M-19, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- .19 ASTM E413-22, Classification for Rating Sound Insulation.

- .20 ASTM E2074-00e1, Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies (Withdrawn 2007).
- .4 Builders Hardware Manufacturers Association (BHMA):
 - .1 BHMA A156.115_-2016, Hardware Preparation in Steel Doors and Steel Frames.
 - .2 BHMA A156.16-2023, Auxiliary Hardware.
- .5 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .6 Canadian General Standards Board (CGSB):
 - .1 CGSB 41-GP-19MA, (Withdrawn) Rigid Vinyl Extrusions for Windows and Doors.
 - .2 CAN/CGSB 82.5- M88 (Withdrawn) Insulated Steel Doors
- .7 Canadian Standards Association (CSA Group):
 - .1 CSA Plus A440H-14, User Guide to AAMA/WDMA/CSA 101/I.S.2/A440 NAFS 2011 – North Fenestration Standard/Specification for Windows, Doors, and Skylights.
 - .2 CSA A440S1-19(R2022), Canadian Supplement to AAMA/WDMA/CSA 101/1.S.2/A440-17, North American Fenestration Standard/Specification for Windows, Doors, and Skylights.
 - .3 CSA-G40.20-13/G40.21-13 (R2023), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel, Includes Update No. 1 (2014).
 - .4 CSA W47.1:19, Certification of companies for fusion welding of steel.
 - .5 CSA W59-18(R203), Welded Steel Construction, Includes Errata (2020).
- .8 Canadian Steel Door Manufacturers' Association (CSDMA):
 - .1 CSDMA, Recommended Specifications for Commercial Steel Doors and Frames, 2006.
 - .2 CSDMA, Recommended Selection and Usage Guide for Commercial Steel Door and Frame Products, 2009.
 - .3 CDSMA, Guide Specification for Installation and Storage of Hollow Metal Doors and Frames, 2012.
- .3 Green Seal (GS):
 - .1 Standard GS-11, Paints, Coatings, Stains and Sealers, 2015.
- .4 International Code Council (ICC):
 - .1 ICC A117.1-2017, Accessible and Usable Buildings and Facilities.
- .5 National Association of Architectural Metal Manufacturers (NAAMM):
 - .1 NAAMM HMMA 840-17, Guide Specification for Receipt, Storage and Installation Hollow Metal Doors and Frames.
- .6 North American Fenestration Standard (NAFS).

- .7 National Fire Protection Association (NFPA):
 - .1 NFPA (Fire) 80, Standard for Fire Doors and Other Opening Protectives, 2022 Edition.
 - .2 NFPA (Fire) 105, Standard for Smoke Door Assemblies and Other Opening Protectives, 2022 Edition.
 - .3 NFPA (Fire) 252, Fire Tests of Door Assemblies, 2022 Edition.
- .8 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.
 - .2 SCAQMD Rule 1168-22, Adhesives and Sealants Applications.
- .9 The Society for Protective Coatings (SSPC):
 - .1 SSPC-PS 12.01, One Coat Zinc-Rich Painting System. (Includes 2004 Revisions)
 - .2 SSPC-PS Guide 12.00, Guide to Zinc-Rich Coating Systems.
- .10 Underwriters' Laboratories of Canada (ULC):
 - .1 ULC CAN4-S106-M80(R1985), Standard Method for Fire Tests of Window and Glass Block Assemblies.
 - .2 ULC 104, Standard Method for Fire Tests of Door Assemblies. (CAN/ULC S104-15)
 - .3 ULC 105, Standard Specification for Fire Door Frames Meeting the Performance Required by CAN/ULC-S104 (CAN/ULC S105:2016).
 - .4 ULC 701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering. (CAN/ULC-S701-11) (Withdrawn)
 - .5 ULC 702.2, Mineral Fibre Thermal Insulation for Buildings, Part 2: Application Guidelines (ULC S702.2-15).
 - .6 ULC 704.1, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced. 2017

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .2 Submit manufacturer's printed product literature, specifications and data sheets for each type of door and frame specified.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .2 Indicate general construction of each type of door and frame, configurations, locations, door handing, sizes, material, material thickness, core description and details, edge construction, jointing methods, mortises, reinforcements, anchors, arrangement of hardware, fire ratings, finish and special features.
 - .3 Detail continuity of air, vapour, and thermal barriers at changes in plane, at transitions, and at penetrations.

- .4 Reference door and frame types to Door Schedule. Indicate door numbers where applicable.
- .3 Submit test and engineering data, and installation instructions.
- .4 Test and Evaluation Reports:
 - .1 Submit test reports from approved independent testing laboratories, certifying compliance with specifications.
 - .2 All test reports that reference the NAFS must include, on the first page, a summary of the results including, at minimum:
 - .1 The product manufacturer.
 - .2 The type of product.
 - .3 The model number/series number.
 - .4 The primary product designation.
 - .5 The secondary product designation.
 - .1 Positive design pressure.
 - .2 Negative design pressure.
 - .3 Water penetration resistance test pressure.
 - .4 Canadian air infiltration and exfiltration levels.
 - .6 The test completion date.
 - .7 The report will also contain the following information:
 - .1 Test dates.
 - .2 Report preparation dates.
 - .3 Test information retention period.
 - .4 Location of testing facilities.
 - .5 Full description of test samples, including:
 - .1 finish, weathering characteristics
 - .2 Condensation resistance.
 - .3 Forced entry resistance.
 - .6 Complete description of amendments, as applicable.
 - .7 Conclusion.
 - .8 Drawings signed by the testing laboratory, if provided.
- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for cleaning and maintenance of finishes for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Quality Standard: Comply with ANSI A250.8, unless more stringent requirements are indicated. Comply with ICC A117.1.
- .2 Qualifications

- .1 Manufacturer/Fabricator: Use a member in good standing of the Canadian Steel Door and Frame Manufacturer's Association.
- .2 Installer: Use installers who are experienced with the installation of hollow metal doors and frames of similar complexity and extent to that required for the Project.
- .3 Preconstruction Testing: Provide fire labelled frame products for those openings requiring fire protection ratings, as scheduled:
 - .1 List by nationally recognized agency having factory inspection service and construct as detailed in Follow-up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 01 - LEED Product Requirements and as follows:
 - .1 Receive and store materials as recommended by materials manufacturer.
 - .2 Inspect and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Consultant. Remove and replace damaged items that cannot be repaired as directed.
 - .3 Adequately protect surfaces from damage during moving, handling and storage.
- .2 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 PERFORMANCE/DESIGN CRITERIA

- .1 Perform work in accordance with CSDMA, Recommended Specifications for Commercial Steel Doors and Frames, except as otherwise specified herein.
- .2 Provide doors and frames complying with ANSI A250.8 for quality and ANSI A250.4 for physical-endurance level.
- .3 Design exterior frame assembly to accommodate expansion and contraction when subjected to minimum and maximum surface temperature of -35 degrees C to 35 degrees C.
- .4 Maximum deflection for exterior steel entrance screens under wind load of 1.2 kPa not to exceed 1/175th of span.
- .5 Steel fire rated doors and frames: Label and list fire rated doors and frames by an organization accredited by the Standards Council of Canada in conformance with CAN4-S104 and CAN4-S105 for ratings indicated. Fire labels must be factory applied by the manufacturer.
- .6 Thermal Transmittance: R-value of 3.4 to ASTM C1363 and NFRC 102.
- .7 Air Infiltration: < 0.1 cfm/ft2 to ASTM E283/E283M and NFRC 400.

- .8 Be responsible for securing approval from authorities having jurisdiction for materials, fabrication and installation of fire rated oversized door and frame assemblies.

2.2 MATERIALS

- .1 Steel:
- .1 Doors and Frames: coated steel sheets to ASTM A924/A924M; coating designation to ASTM A653/A653M: Commercial Steel (CS), Type B, ZF120 (A40) galvanized; stretcher levelled.
 - .2 Exterior doors and frames: coated steel sheets to ASTM A924/A924M; coating designation to ASTM A653/A653M: Commercial Steel (CS), Type B, ZF120 (A40) galvanized; stretcher levelled.
 - .3 Metallic coated steel sheets in accordance with ASTM A924/A924M; coated to meet requirements of ASTM A653/A653M, Commercial Steel (CS), Type B, ZF75 galvanized; suitable for unexposed applications; stretcher levelled standard of flatness. Provide Canadian produced steel.
- .2 Nominal Base Metal Thickness Requirements:
- .1 Frames: refer to frame fabrication requirements specified in this section.
 - .2 Doors: refer to door fabrication requirements specified in this section.
 - .3 Hardware Reinforcement for Doors and Frames: Carbon steel, welded in place, prime painted, to the following minimum nominal thicknesses:

Hardware Reinforcement	Door (mm)	Frame (mm)
Mortise Hinge:	3.51	3.51
Mortise or Bored Lock or Deadbolt:	1.98	1.98
Flush or Surface Bolt Front:	1.98	1.98
Surface or Concealed Closer:	2.74	2.74
Strike Reinforcements:	1.98	1.98
Hold Open Arm:	1.98	1.98
Electronic Hardware Reinforcements:	1.98	1.98
Pull Plates and Bars:	1.30	1.30
Mortar Box:	--	0.84
Surface Exit Devices:	1.98	1.98
Door Surface Hardware Reinforcements:	1.30	1.30
Frame surface hardware reinforcements:	2.74	2.74
Notes: Provide guard boxes to protect mortised cut-outs from spray applied insulation, fully sealed.		

- .3 Door Core Materials
- .1 Honeycomb (interior only): Structural small cell 25 mm maximum. kraft paper honeycomb:
 - .1 Weight: 36.3 kg/ream minimum.
 - .2 Density: 16.5 kg/m³ minimum.

- .3 Sanded to required thickness.
- .2 Polyurethane: rigid, cellular type, board, conforming to ASTM D1622/D1622M, or foamed-in-place, 29 kilograms per cubic meter density minimum, containing no urea formaldehyde resins.

2.3 ADHESIVES

- .1 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
 - .1 Adhesive: maximum VOC content 50 g/L to SCAQMD Rule 1168.
- .2 Polyurethane cores: heat resistant, epoxy resin based, low viscosity, contact cement.
- .3 Interlocking Edge Seam Adhesive: fire resistant, resin reinforced polychloroprene, high viscosity, sealant/adhesive.

2.4 PRIMER

- .1 Touch-up primer: to ASTM A780/A780M and SSPC-PS 12.01.
 - .1 Maximum VOC limit 50 g/L to GS-11.

2.5 FINISHING

- .1 Shop apply zinc rich primer to repair damaged zinc coatings arising from fabrication; cure primer fully before shipping to site; include compatible primer for site finishing and correction of surface abrasions to zinc coatings and factory applied primer.
- .2 Remove weld slag and splatter from exposed surfaces.
- .3 Fill and sand smooth tool marks, abrasions and surface blemishes to present smooth uniform surfaces. Prepare surfaces for field painting to ASTM D6386 and ASTM D7396 and Section 09 91 00 - Painting.

2.6 ACCESSORIES

- .1 Door silencers (bumpers): Grey rubber, to ANSI/BHMA A156.16 Type 6-180; three silencers on strike jambs of single door frames; two silencers on heads of double door frames; screw fastener applied. Stick on bumpers are not acceptable.
- .2 Floor anchors: 3.5 mm minimum adjustable floor clip angles with 2 holes for anchorage to floor.
- .3 Exterior Top Caps: Rigid polyvinylchloride (PVC) extrusion in accordance with CGSB 41-GP-19Ma.
- .4 Provide full height astragals on all double doors.
- .5 Fabricate glazing stops as formed channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.
- .6 Make provisions for glazing as indicated and provide necessary glazing stops.

- .1 Provide removable glazing beads for use with glazing tapes and compounds and secured with countersunk stainless steel screws.
- .2 Design exterior glazing stops to be tamperproof.
- .7 Metallic paste filler: to manufacturer's standard.
- .8 Fasteners: tamperproof type 304 stainless steel screws with countersunk flat head.
- .9 Labels for fire doors and door frame: brass plate, riveted to door and door frame.
- .10 Sealant: Section 07 92 00 – Sealants.
 - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .11 Glazing: Section 08 80 50 – Glazing.

2.7 FABRICATION GENERAL

- .1 Welded construction: assemble units by welding in accordance with CSA W59 to produce a finished unit square, true and free of distortion. Welding shall be undertaken only by a fabricator fully approved by the Canadian Welding Bureau to the requirements of CSA W47.1.
- .2 Fabricate steel doors and frames units complying with ANSI/SDI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.
- .3 Permit access by an approved inspection and testing company for the purpose of inspecting at random, doors being fabricated for this project.
- .4 Make provisions in doors and frames to suit requirements of trade or section providing electrically operated hardware or security devices. Provide removable plates or knock outs for electrical contacts. Provide junction boxes on security door frames as required for door strikes, mag locks and door contacts. Ensure frames arrive on site prepared for wiring.
- .5 Fabricate galvanized steel channels to reinforce frames and screens as required for size, and for fire protection rating requirements. Extend reinforcements from floor to structure above. Design top connection to accommodate structural deflection. Conceal reinforcements in frames and screens.
- .6 Fabricate all rated doors, frames and screens to fire rating labelling authority standard.

2.8 FRAMES AND SCREENS FABRICATION: GENERAL

- .1 Fabricate frames in accordance with CSDMA specifications and ANSI/SDI A250.8.
- .2 Accurately form frames to profiles indicated. Construct frames straight and free from twist or warp.
- .3 Exterior frames: 1.98 mm minimum thermally broken type construction. 50 mm face standard frame profile, throat and frame width to suit wall construction.
- .4 Interior frames: 1.6 mm minimum for single doors; 1.98 mm for frames with opening width in excess of 1220 mm; welded type construction. 50 mm face

- standard frame profile, throat and frame width to suit wall construction. Knock-down frames are not allowed.
- .5 Blank, drill, reinforce and tap frames to receive mortised, templated hardware, security, and electrical devices, using templates provided by finish hardware supplier. Reinforce frames for installation of closers. For transportation, install stiffener plates or two angle spreaders where required to prevent bending of frame and to maintain alignment when setting. Weld reinforcement in place. Remove prior to installation.
 - .6 Provide removable portion of stop and frame where required for overhead concealed door closers, properly connected to frame, and prepare for attachment of closer prior to shipment.
 - .7 Protect mortised cutouts with steel guard boxes.
 - .8 Manufacturer's nameplates on frames and screens are not permitted.
 - .9 Conceal fastenings except where exposed fastenings are indicated.
 - .10 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.
 - .11 Partition Screens:
 - .1 Fabricate metal screens to profiles indicated.
 - .2 Supply jamb and mullion extensions and anchors required to secure screens to structure or framing provided under other Sections. Fabricate anchorage to prevent transfer of load from support framing to the screens when deflection of structure occurs.
 - .3 Provide concealed reinforcement for screens to receive handrails.
 - .4 Provide closely fitted steel glass stops where required. Mitre corners. Drill and countersink fasteners symmetrically at 150 mm o.c. Screw stops in place.
 - .12 Provide fire labelled frames for those openings requiring fire protection ratings, as scheduled on Drawings.

2.9 FRAME ANCHORAGE

- .1 Provide appropriate anchorage to floor and wall construction.
- .2 Where frames terminate at finished floor, supply floor plates for anchorage to slab. Check depth of extension of finished floor to structural slab and provide jamb extension anchorage as required. Provide 50 mm minimum adjustment.
- .3 Locate wall anchors immediately above or below each hinge reinforcement on the hinge jamb, and directly opposite on the strike jamb. Provide three anchors per jamb for frames up to 2300 mm. Add one anchor per jamb for each additional 760 mm or fraction thereof in frame height.

2.10 FRAMES: WELDED TYPE

- .1 Welding in accordance with CSA W59.
- .2 Cut frame mitres accurately and weld on inside of frame profile. Fill frame corners, exposed surface depressions and butted joints with air drying paste

filler. Sand to a smooth uniform finish. Touch up damaged galvanized finish with zinc rich primer.

- .3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.
- .4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.
- .5 Securely attach floor anchors to inside of each jamb profile.
- .6 Weld in two temporary jamb spreaders per frame to maintain proper alignment during shipment.

2.11 DOOR FABRICATION GENERAL

- .1 Fabricate steel doors rigid, neat in appearance, and free from defects including warp and buckle; 45 mm thickness of types and sizes indicated on drawing, and as follows:
 - .1 Door faces of all steel doors shall be fabricated without visible seams, free of scale, pitting, coil brakes, buckles and waves.
 - .2 Form edges true and straight with minimum radius suitable for thickness of steel used.
 - .3 Bevel lock and hinge edges 3 mm in 50 mm; confirm requirement with builder's hardware or door swing that could dictate a different bevel.
 - .4 Top and bottom of doors shall be provided with inverted, recessed, nominal 1.60 mm steel end channels, welded to each face sheet at 150 mm O/C.
 - .5 Equip exterior doors with factory installed flush PVC top caps. Equip fire labelled exterior doors with factory installed flush steel top caps.
 - .6 Provide fire labelled doors for those openings requiring fire protection ratings, as indicated on Drawings.
 - .7 Fabricate doors with the following clearances:
 - .1 Clearance between door and frame and between meeting edges of doors swinging in pairs shall not exceed 3 mm.
 - .2 Clearance between the bottom of door and floor shall not exceed 19 mm or as required to accommodate specified hardware.
 - .3 Clearance between bottom of door and a raised non-combustible sill in accordance with NFPA (Fire) 80.
 - .4 Clearance between bottom of door and nominal surface of combustible floor coverings in accordance with NFPA (Fire) 80.
- .2 Fabricate doors with longitudinal edges locked seam and spot welded. Seams: not visible, grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish. Bevel both stiles of single doors 1 in 16.
- .3 Exterior Doors: Flush, lock seam construction, insulated doors fabricated in accordance with CAN/CGSB 82.5, and as follows:
 - .1 Face Sheets: Minimum 1.60 mm base steel sheet thickness.
 - .2 Insulation Stiffened Core: Insulated and sound deadened with polystyrene core laminated under pressure to each face sheet.

- .4 Interior Doors: Flush, lock seam construction, hollow steel doors fabricated in accordance with CSDMA Manufacturing Specifications for Doors and Frames, and as follows:
 - .1 Face sheets: Minimum 1.30 mm base steel sheet thickness.
 - .2 Stiffened and sound deadened with honeycomb core laminated under pressure to each face sheet.
- .5 Fire Rated Doors: Flush, lock seam construction, hollow steel doors fabricated in accordance with CAN4 S104 and NFPA (Fire) 80, and as follows:
 - .1 Face sheets: Minimum nominal 1.60 mm base steel sheet thickness.
 - .2 Stiffened and sound deadened with honeycomb core laminated under pressure to each face sheet.
 - .3 Equip pairs of fire labelled doors with minimum 2.74 mm steel surface mounted flat bar astragal, welded to door face; plug welded on face and stitch welded to butt edge of door.
 - .4 Labelled by Underwriters Laboratories of Canada, ITS/Warnock Hersey, or other testing laboratory approved by the authority having jurisdiction.
- .6 Smoke-Control Doors: comply with NFPA (Fire) 105.

2.12 THERMALLY BROKEN FRAMES

- .1 Thermal break: rigid polyvinylchloride extrusion, to ASTM D4726.
- .2 Fabricate thermally broken frames separating exterior parts from interior parts with continuous interlocking thermal break.
- .3 Insulate exterior frame components with polyurethane insulation as indicated in Section 07 21 19 - Foam-in-Place Insulation.

Part 3 EXECUTION

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed work upon which this Section depends. Report defects to Consultant. Commencement of work means acceptance of existing conditions.

3.2 INSTALLATION GENERAL

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Install fire rated doors and frames in accordance with requirements of NFPA 80.
- .3 Install back angle for sill PMMA membrane to terminate on below the threshold in line with the primary air seal.
- .4 Install doors, frames and accessories in accordance with reviewed shop drawings, ANSI/SDI A250.11, CSDMA Guide Specification for Installation and Storage of Hollow Metal Doors and Frames, manufacturer's data, and as specified in this Section.

- .5 Damaged or twisted door and frames, or doors with interior cores or frame telegraphing through, will be rejected.

3.3 FRAME INSTALLATION

.1 Door Frames:

- .1 Remove temporary spreaders before installing door frames, leaving exposed surfaces smooth and undamaged.
- .2 Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set; limit of acceptable frame distortion 2 mm out of plumb measured on face of frame, maximum twist corner to corner of 3 mm; align horizontal lines in final assembly.
- .3 Brace frames rigidly in position until adjacent construction is complete; install wooden spreaders at third points of frame rebate to maintain frame width, install centre brace to support head of frames 1200 mm and wider in accordance with ANSI/SDI A250.11; do not use temporary metal spreaders for bracing of frames one.
- .4 Place frames before construction of enclosing walls and ceilings, except for frames located in existing walls or partitions allowing for deflection of adjacent construction to ensure that structural loads are not transmitted to frames, and as follows:
 - .1 Check and correct opening width and height, squareness, alignment, twist and plumb as frames are installed in accordance with CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames.
 - .2 Metal Stud Partitions: Provide a minimum of three wall anchors per jamb for frames up to 2150 mm high and one additional anchor for each 600 mm over 2150 mm high; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb; attach wall anchors to studs with screws.
 - .3 Remove wooden braces after frames are securely fastened or attached to adjacent construction.
- .5 Install glazing materials and studded door silencers.
- .6 Do not site weld unless approved by Consultant in writing for the specific screen.
- .7 For frames over 1220 mm in width, provide vertical support at the centre of head.

.2 Window Frames:

- .1 Installation of borrowed lights is same as for door frames.
- .2 Site assemble large borrowed lights to provide true and even alignment with flush butt hairline jointing, all fasteners concealed.
- .3 Site weld only when approved by Consultant in writing for the specific location.
- .4 Align all horizontal rails in final assembly.
- .5 Install sealant and back-up materials.

- .3 Frame Tolerances: Install frames to tolerances listed in ANSI/SDI A250.11, and as follows:

- .1 Squareness: Maximum 1.6 mm measured across opening between hinge jam and strike jamb.
- .2 Plumbness: Maximum 1.6 mm measured from bottom of frame to head level.
- .3 Alignment: Maximum 1.6 mm measured offset between face of hinge jamb and strike jamb relative to wall construction.
- .4 Twist: Maximum 1.6 mm measured from leading edge of outside frame rabbet to leading edge of inside frame rabbet.
- .4 Install door silencers.
- .5 Caulk perimeter of frames between frame and adjacent material at interior (primary air seal) and exterior (water shedding) seal sides of the door. Allow drainage at the sill. Primary air seal to be continuous with back angle at sill.
- .6 Maintain continuity of air barrier and vapour retarder.

3.4 DOOR INSTALLATION

- .1 Fit hollow metal doors accurately in frames within clearances required for proper operation; shim as necessary for proper operation. Install as specified in ANSI/SDI A250.8.
- .2 Install hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 00 - Door Hardware.
- .3 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.
 - .1 Hinge side: 1.0 mm.
 - .2 Latchside and head: 1.5 mm.
 - .3 Finished floor, noncombustible sill and thresholds: 6 mm; 13 mm at openings in non-fire rated separations where undercuts are indicated.
- .4 Install fire-rated doors in corresponding fire-rated frames according to NFPA (Fire) 80.
- .5 Install smoke-control doors according to NFPA (Fire)105.
- .6 Adjust operable parts for correct clearances and function.

3.5 GLAZING

- .1 Install glazing for doors and frames in accordance with Section 08 80 50 - Glazing.

3.6 FINISH REPAIRS

- .1 Touch-up areas where galvanized coating has been removed or damaged with primer.
- .2 Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to a uniform smooth finish.

3.7 FIELD PAINTING

- .1 Prepare surfaces for field painting, to ASTM D6386 and ASTM D7396.

- .2 Field painting: refer to Section 09 91 00 – Painting. Protect weatherstrips from paint. Provide final finish, free of scratches or other blemishes.

3.8 ADJUSTING

- .1 Adjust doors for smooth, easy, free swinging operation and balanced door movement.

3.9 CLEANING

- .1 Clean doors, frames, and screens.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes: Aluminum-framed glass doors, aluminum swing doors, hardware and aluminum brakeshapes as indicated on Drawings.
- .2 Related Requirements:
 - .1 Section 05 50 00 – Metal Fabrications.
 - .2 Section 06 10 00 – Rough Carpentry.
 - .3 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
 - .4 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .5 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .6 Section 07 92 00 – Sealants
 - .7 Section 08 71 00 – Door Hardware.
 - .8 Section 08 80 50 – Glazing
 - .9 Division 26 – Wire and Box Connectors - 0-1000 V, Outlet Boxes, Conduit Boxes and Fittings, Conduits, Conduit Fastenings and Conduit Fittings, Wiring Devices, and Electrical connections for security systems and sensors.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Aluminum Association (AA):
 - .1 AA DAF-45-2003 (R2009), Designation System for Aluminum Finishes.
 - .2 American Architectural Manufacturers Association (AAMA)/Fenestration and Glazing Industry Alliance (FGIA):
 - .1 AAMA 501-15, Methods of Test for Exterior Walls.
 - .2 AAMA 501.2-15, Quality Assurance and Water Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
 - .3 AAMA 603-98, Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
 - .4 AAMA 609 & 610-15, Cleaning and Maintenance Guide for Architecturally Finished Aluminum.
 - .5 AAMA 611-20, Voluntary Specification for Anodized Architectural Aluminum.
 - .6 AAMA 701/702-11, Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals.
 - .7 AAMA 1503-09, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
 - .8 AAMA 2604-22, Voluntary Specification, Performance Requirements and Test Procedures for High End Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)

- .9 AAMA 2605-22, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)
- .10 AAMA AFPA-1-15, Anodic Finishes/Painted Aluminum.
- .11 AAMA CW-RS-1-12, The Rain Screen Principle and Pressure Equalized Wall Design.
- .12 AAMA RPC-2000, Rain Penetration Control: Applying Current Knowledge.
- .3 American National Standards Institute (ANSI)/Builders Hardware Manufacturers Association (BHMA):
 - .1 ANSI/BHMA A156.3-2020, Standard for Exit Devices.
- .4 American National Standards Institute (ANSI)/ National Fenestration (NFRC):
 - .1 ANSI/NFRC-100-2023(EOA2), Procedure for Determining Fenestration Product U-Factors.
 - .2 ANSI/NFRC-200-202(EOA2), Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
 - .3 ANSI/NFRC-300-2023(EOA0), Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.
 - .4 ANSI/NFRC-400-2023(EOA1), Procedure for Determining Fenestration Product Air Leakage.
- .5 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A240/A240M-23a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process.
 - .3 ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .4 ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .5 ASTM B429/B429M-20, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - .6 ASTM C920-18, Standard Specification for Elastomeric Joint Sealants.
 - .7 ASTM D2000-18, Standard Classification System for Rubber Products in Automotive Applications.
 - .8 ASTM D2287-19, Standard Classification System and Basis for Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
 - .9 ASTM E283/E283M-19, Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Skylights, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.

- .10 ASTM E330/E330M-14(2021), Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- .11 ASTM E547-00(2016), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Cyclic Static Air Pressure Difference
- .12 ASTM E1105-15(2023), Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
- .6 American Society of Heating Refrigeration and Air-Conditioning (ASHRAE):
 - .1 ASHRAE 90.1-2022 (I-P), Standard 90.1-2022 (I-P Edition) -- Energy Standard for Buildings Except Low-rise Residential Buildings. (ANSI Approved; IES Cosponsored)
- .7 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .8 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 1.40-97, Anticorrosive Structural Steel Alkyd Primer (Withdrawn).
 - .2 CAN/CGSB-12.1-2017, Safety Glazing.
- .9 Canadian Standards Association (CSA Group):
 - .1 CSA Plus A440H-14, User Guide to AAMA/WDMA/CSA 101/I.S.2/A440 NAFS 2011 - North Fenestration Standard/Specification for Windows, Doors, and Skylights.
 - .2 CSA A440S1-19(R2022), Canadian Supplement to AAMA/WDMA/CSA 101/I.S.2/A440-17, North American Fenestration Standard/Specification for Windows, Doors, and Skylights.
 - .3 CSA-G40.20-13/G40.21-13 (R2023), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel., Includes Update No. 1 (2014).
 - .4 CSA G164-18(R2023) Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No. 1 (2020).
 - .5 CSA W47.1:19, Certification of Companies for fusion Welding of Steel.
 - .6 CSA W47.2-11 (R2020), Certification of Companies for Fusion Welding of Aluminum, Includes Update No.1 (2011), Update No.2 (2012).
 - .7 CSA W59-18(R2023), Welded Steel Construction, Includes Errata (2020).
 - .8 CSA W59.2-18, Welded Aluminum Construction, Includes Errata (2020).
- .10 The Society for Protective Coatings (SSPC)/National Association of Corrosion Engineers (NACE International):
 - .1 Surface Preparation Guidelines:

- .1 SSPC-SP COM, Surface Preparation Commentary for Metal Substrates.
- .2 SSPC-PS 12.01, One Coat Zinc-Rich Painting System. (Includes 2004 Revisions),
- .11 North American Fenestration Standard (NAFS):
 - .1 NAFS-11, Specification for Windows, Doors and Skylights
- .12 Underwriters Laboratories of Canada (ULC):
 - .1 ULC 702.1, Standard for Thermal Insulation Mineral Fibre for Buildings. Part 1: Material Specification (ULC-S702.1). 2021
 - .2 ULC 702.2, Mineral Fibre Thermal Insulation for Buildings, Part 2: Application Guidelines (ULC-S702.2-15).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with contractor's representative and Consultant in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review manufacturer's installation instructions and warranty requirements.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
 - .2 Submit WHMIS SDS - Safety Data Sheets. WHMIS SDS acceptable to Labour Canada and Health and Welfare Canada. Indicate VOC's for caulking materials during application and curing.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate materials and profiles and provide full-size, scaled details of components for each type of door and frame. Indicate:
 - .1 Interior trim and exterior junctions with adjacent construction.
 - .2 Junctions between combination units.
 - .3 Elevations of units.
 - .4 Core thicknesses of components.
 - .5 Type and location of exposed finishes, method of anchorage, number of anchors, supports, reinforcement, and accessories.
 - .6 Location of caulking.
 - .7 Each type of door system including location.
 - .8 Arrangement of hardware and required clearances.
 - .9 Detail continuity of air, vapour, and thermal barriers at changes in plane, at transitions, and at penetrations.

- .2 Submit catalogue details for each type of door and frame illustrating profiles, dimensions and methods of assembly.
- .3 Include schedule of U-values, SHGC, and VLT for all products in the form of a site label certificate to show compliance with the specified energy performance requirements
- .4 Submit copies of test reports to establish that the products assembled by this manufacturer comply with the specified Performance Class, Performance Grade, Water Test Pressure, and Air Infiltration/Exfiltration Level as tested to NAFS-11 and the Canadian Supplement.
- .3 Manufacturer's Instructions: Submit manufacturer's installation instructions.
- .4 Testing: provide water penetration field testing to ASTM E1105. Build air tight chamber of steel or wood studs and gypsum or sheathing to withstand the required air pressure differential. Locate test at location as directed by Consultant completed on mock-up prior to moving forward with remaining installations. Access, water, and electricity to be provided by contractor to the testing location on the day of testing. Alterations, retests, repairs, or additions necessary to achieve acceptable performance are to be paid by the Contractor.
- .5 Manufacturers' Field Reports: Submit two copies of manufacturers field reports.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for cleaning and maintenance of aluminum finishes for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Obtain door and curtainwall materials from single manufacturer and/or ensure materials ordered and supplied are compatible with one another.
- .2 Product Labels:
 - .1 All products shall be supplied with factory applied performance rating labels showing Primary and Secondary designators and attesting to conformance with NAFS-11 and CSA A440S1. Alternatively, NAFS performance ratings and test specimen descriptions may be shown on the fenestration shop drawings.
 - .2 All products shall be supplied with factory applied energy performance labels showing product U-values. Energy performance ratings must be certified and labels must bear the mark of one of the agencies recognized as follows: CSA, QAI, Intertek, or NFRC.
- .3 Qualifications:
 - .1 Fabricator shall have minimum of five years successful experience in fabrication and erection of metal entrances of similar sizes, shapes and finishes to units required for this project and shall have ample facilities to produce, furnish and supply units as required for installation without delay to Work.
- .4 Certifications:

- .1 Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .5 Preconstruction Testing:
 - .1 Certified test reports showing compliance with specified performance characteristics and physical properties.
- 1.7 DELIVERY, STORAGE, AND HANDLING**
 - .1 Storage and Protection:
 - .1 Apply temporary protective coating to finished surfaces. Remove coating after erection. Do not use coatings that will become hard to remove or leave residue.
 - .2 Leave protective covering in place until final cleaning of building.
 - .2 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.
- 1.8 WARRANTY**
 - .1 Provide manufacturer's written guarantee, signed and issued in name of Owner, to replace following items for defective material and workmanship for time stated from date of Substantial Performance:
 - .1 Framing, panels and glazing: failure of performance requirements; two years.
 - .2 Sealed glass units: misting, dusting and seal failure; ten years.
 - .3 Sealants, caulking: failure to maintain seal; two years.
 - .4 Aluminum brakeshapes: oil canning and delaminating; two years.
 - .5 Finishes: failure specified finishes not attributable to normal weathering: 20 years.
 - .2 Anodized Aluminum: Provide 2 year for Class II finishes and 5 years for Class 1 Finishes that metal will not change colour more than 5 DEcmc per AAMA 611 and finished metal will not crack, blister, check, or peel.

Part 2 Products

2.1 PERFORMANCE / DESIGN CRITERIA.

- .1 Design glass, framing members, and anchorage to the requirements of the Ontario Building Code for wind, seismic, guard, and human impact loads.
- .2 Where flush threshold doors are required, 330 Pa water resistance is unlikely. For these locations, "Limited water" (LW) rated doors are appropriate provided there is minimum 2:1 door height to overhang ratio protection extending in all directions from door frame.
- .3 Design frames and doors in exterior walls to:

- .1 Accommodate expansion and contraction within service temperature range of -35 to +35 degrees C.
- .2 Limit deflection of mullions to maximum 1/175th of clear span when tested to ASTM E330/E330M under wind load of 1.2 kPa. Submit certificate of tests performed.
- .3 Air Infiltration: For single acting offset pivot or butt hung entrances in the closed and locked position, the test specimen shall be tested in accordance with ASTM E283/E283< at a pressure differential of 75 Pa for single doors and 75 Pa for pairs of doors. A single 915 mm x 2134 mm entrance door and frame shall not exceed 0.2 L/s/sq m for fixed and 0.5 L/s/sq m for operable doors per NECB requirements.
- .4 Water Penetration Resistance: no leakage when tested to ASTM E331 or ASTM E547 to 500 Pa for fixed units and 300 Pa for doors.
- .4 Size glass thickness and glass unit dimensions to limits.
- .5 Provide continuous air barrier and vapour retarder through door system. Primarily in line with inside pane of glass and heel bead of glazing compound.

2.2 MATERIALS

- .1 Aluminum extrusions: Aluminum Association alloy AA6063-T5, T6, or T54 anodizing quality.
- .2 Sheet aluminum: Alloy 1100, F temper, 3 mm minimum thickness exposed sheet finished to match frames as specified.
- .3 Steel reinforcement: to CSA-G40.20/G40.21, grade 300 W, shop painted with zinc chromate primer, thickness as required to support imposed loads and in no case less than 4.8 mm thick.
- .4 Fasteners: aluminum, non-magnetic stainless steel, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum components of suitable size to sustain imposed loads. Do not use exposed fasteners except where unavoidable for application of hardware. Match finish of adjoining metal. Provide Phillips flat-head machine screws for exposed fasteners.
- .5 Door bumpers: black neoprene, entrance manufacturer's standard.
- .6 Door bottom seal: adjustable door seal of anodized extruded aluminum frame and vinyl weather seal, recessed in door bottom, closed ends, automatic retract mechanism when door is open.
- .7 Isolation coating: bituminous paint, acid and alkali resistant asphaltic paint in accordance with MPI Architectural Painting Specification Manual approved product listing.
- .8 Glazing materials: refer to Section 08 80 50 - Glazing.
- .9 Glass Gaskets: silicone as specified in Section 08 80 50 - Glazing.
- .10 Spacers for glazing, backpans/aluminum spandrels to be full length, purpose made, aluminum channels.
- .11 Sealant: Including primer, joint filler, as specified in Section 07 92 00 - Sealants.
- .12 Thermal separator: Polyvinylchloride, 50 Shore A durometer hardness +5.

2.3 ALUMINUM FRAMES

- .1 Exterior Aluminum Frame: As specified in Section 08 44 13 – Glazed Aluminum Curtain Walls.
- .2 Interior Aluminum Frame: As specified in Section 08 44 13 – Glazed Aluminum Curtain Walls.

2.4 ALUMINUM SWING DOORS

- .1 Aluminum doors fabricated of rigid extruded rectangular aluminum tube cut and welded together and with internal reinforcing at corners. Some manufacturers may have to modify their standard system to meet the minimum bottom rail size noted for standard door construction.
- .2 Doors 57.2 mm thickness with 88.9 mm top rail and 165.1mm bottom rail, standard interlock, meeting and 88.9 mm jamb stiles with triple glazed sealed unit safety glass, door sizes as scheduled. Door adapter shall be thermally broken.
 - .1 U-factor:
 - .1 combined door: 0.42 BTU/hr/ft²/F
 - .2 centre of glass: 0.23 BTU/hr/ft²/F
 - .2 Acceptable Materials:
 - .1 350T Insulpour, Kawneer Canada Ltd.
 - .2 Other materials are acceptable as long as they meet the minimum performance requirements provided by the door listed above.

2.5 HARDWARE MATERIALS

- .1 The following list of materials is intended to establish product quality and acceptable materials. Product substitutions will be considered when submitted in accordance with Section 01 62 00 –Product Options and Substitutions.

Hardware Item	Acceptable Manufacturers	Acceptable Materials
Locklatch: Lock function appropriate to room type listed in Schedule.	Adams Rite	4510
Cylinders	AR CAM	985 x 29 mm
Automatic Entrance Operator (All systems shall include switching network for card reader device, door locking interface, and push button actuator)	Besam Horton Gyro Tech Horton Hunter Keanne Munro Stanley	Power Swing 4000 LE GT-500 x SA1 4000 LE HA-8 360 Series Magic-Swing Visible LS

Hardware Item	Acceptable Manufacturers	Acceptable Materials
<hr/>		
Closers: Aluminum doors	Arrow	7000
	LCN	4040
	Norton	1601
	Sargent	350
Pull	Kawneer	Classic CO-12
Push	Kawneer	Classic CP-2
Butt Hinges	NRP	114 x 144 mm
	Kawneer	114 x 101 mm
Threshold	Kawneer	Butt Hung
Floor Stop		
Dome type to suit floor finish	Standard Metal	S100/S102
	Hagar	243F/241F
	Gallery	218/200

Additional miscellaneous hardware as listed in Hardware Schedule at the end of this section shall be commercial quality, matching hardware requirements established by named products above.

- .2 Panic Exit Devices: In accordance with BHMA A156.3, Grade One, listed and labelled by a testing and inspecting agency acceptable to Authorities Having Jurisdiction for panic protection, type and function as listed in Section 08 71 00 - Door Hardware.
- .3 Weather Stripping: Manufacturer's standard replaceable components, and as follows:
 - .1 Compression Type: Moulded neoprene meeting ASTM D2000 or moulded PVC meeting ASTM D2287.
 - .2 Sliding Type: Wool, polypropylene, or nylon woven pile with nylon fabric or aluminum-strip backing meeting AAMA 701/702.
- .4 Weather Sweeps: Manufacturer's standard exterior door bottom sweep with concealed fasteners on mounting strip.
- .5 Provide full height astragals on all double doors.
- .6 Provide all hardware of each type from one manufacturer.
- .7 Keying as indicated in Section 08 71 00 - Door Hardware.

2.6 ALUMINUM FINISHES

- .1 Clear Anodized: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class I, AA-M12C22A41, clear anodized matching Kawneer #14.
- .2 Isolation Coating
 - .1 Isolate aluminum from the following components, by means of isolation coating:
 - .1 Dissimilar metals except stainless steel, zinc, or white bronze.
 - .2 Concrete, mortar and masonry.
 - .3 Wood.
 - .3 Unexposed aluminum: Mill finish.

2.7 STEEL FINISHES

- .1 Finish steel clips and reinforcing steel with steel primer to CGSB 1.40.

2.8 ALUMINUM BRAKESHAPES

- .1 Shop laminate sheet aluminum to treated plywood backing over rigid insulation to profiles and sizes as indicated; Conceal plywood backing with aluminum.
- .2 Brake aluminum to profiles prior to painting and/or anodizing (except clear anodized anodic oxide finish).
- .3 Finish: To match window exterior exposed aluminum.

2.9 FABRICATION GENERAL

- .1 Doors and framing to be by same manufacturer.
- .2 Fit and assemble all Work in the shop insofar as practical.
- .3 Reinforce members and joints with steel plates, bars, rods or angles for rigidity and strength as needed to fulfill performance requirements. Use concealed stainless steel fasteners for jointing which cannot be welded.
- .4 Fit joints tightly and secure mechanically.
- .5 Provide cut-outs and integral reinforcing as required to receive hardware.
- .6 Separate unlike metals or alloys with a heavy coating of bituminous paint, separator gaskets or slip gaskets as required to prevent galvanic action.
- .7 Provide weepholes in glazing recess and an airseal at interior glassline.
- .8 Glazing to be held by pressure plate system with snap-on covers.
- .9 Glass fabrication specified under Section 08 80 50 - Glazing.

Part 3 Execution

3.1 EXAMINATION

- .1 Inspect Work and conditions affecting the Work of this Section. Proceed only after deficiencies, if any, have been corrected.
- .2 Construct flashings built-in or integrated with system to divert moisture to exterior.

- .3 Verify that anchor blocks or inserts required to receive system are correctly located and installed.
- .4 Verify that anchors and setting or installing components provided by this Section to others for installation are properly located and installed.
- .5 Verify that building air and vapour retarding membranes can be sealed to entrance units to maintain building envelope system integrity.

3.2 PREPARATION

- .1 Obtain all dimensions from the job site.
- .2 Provide data, dimensions and components, anchors and assemblies to be installed in proper time for installation.

3.3 INSTALLATION

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Install in accordance with the manufacturer's written instructions and the contract documents, plumb, true, level and rigid.
- .3 Seal door threshold to back angle with liquid sill membrane to continue up jambs 150 mm, in line with door adapter, seal door adapter to curtain wall mullion. Seal thermally broken door thresholds with air seal compression gasket.
- .4 Gun-apply three continuous beads of sealant under extruded aluminum thresholds. Make bead diameter sufficient to ensure a full width seal. Remove excess sealant.
- .5 Conceal all anchors and fitments. Exposed heads of fasteners not permitted. All joints in exposed work to be flush hairline butt joints.
- .6 Use anchors that will permit sufficient adjustment for accurate alignment. Make allowance for deflection of building structure.
- .7 Build in and provide any supplementary reinforcing and bracing required by assembly loads and deflections.
- .8 Secure Work adequately to structure in a manner not restricting thermal and wind movement. Make allowances for deflection of structure to ensure that structural loads are not transmitted to frames.
- .9 Correctly locate and install flashings, deflectors and weep holes and verify proper drainage of moisture to exterior.
- .10 Maintain alignment with adjacent Work.
- .11 Isolate aluminum surfaces from adjacent dissimilar materials and metals with coatings of bituminous paint.
- .12 Verify all stops, gaskets, splines, seals, etc. are perfectly aligned and ready to receive glazing and insulated panels as specified herein.
- .13 Install glazing to details and instruction, using material specified.
- .14 When a full mullion is used at perimeter framing, glazing, pocket may be stabilized for pressure plate with a block of rigid insulation.

- .15 Glazing stops, snap covers and pressure plates shall be of a continuous length from corner to corner, and be fitted at corners.
- .16 All preformed tapes or gaskets shall be of a continuous length corner to corner and shall be cut over length to prevent stretching. Joints, splices and corners shall be mitred and sealed.
- .17 Clean all contact surfaces of glazing with solvent and wipe dry. Verify all glazing channels are clean, true to line, and free of dirt or debris and that weep and drainage vents are open.
- .18 Rest glazing on setting blocks at 1/4 points.
- .19 Seal full perimeter of door lights to provide and maintain the designed air/vapour/thermal barrier integrity and weather tightness.
- .20 Pack fibrous insulation or low expansion foamed-in-place insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- .21 Hang doors using hardware scheduled. Adjust as required for proper operation.
- .22 Install weatherstrip to provide positive contact.
- .23 Install sealants and back-up materials in strict accordance with manufacturer's written instruction.
- .24 Make cut-outs for hardware i.e.: card readers and push buttons.

3.4 CLEANING

- .1 Perform cleaning of aluminum components in accordance with AAMA 609.1 - Voluntary Guide Specification for Cleaning and Maintenance of Architectural Anodized Aluminum.
- .2 Perform cleaning as soon as possible after installation to remove construction and accumulated environmental dirt.
- .3 Clean aluminum with damp rag and approved non-abrasive cleaner.
- .4 Remove traces of primer, caulking, epoxy and filler materials; clean doors and frames.
- .5 Clean glass and glazing materials with approved non-abrasive cleaner.
- .6 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Sectional door assembly.
 - .2 Standard duty industrial hardware.
 - .3 Windows.
 - .4 Electrical operator.
 - .5 Tracks and accessories.
- .2 Related Requirements:
 - .1 Section 05 50 00 – Metal Fabrications.
 - .2 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier.
 - .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barriers.
 - .4 Section 07 62 00 – Sheet Metal Flashing and Trim.
 - .5 Section 08 71 00 – Door Hardware.
 - .6 Section 09 91 00 – Painting.
 - .7 Division 26: Electrical power supply.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A1008/A1008M-23e1, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - .3 ASTM D523-14 (2018), Standard Test Method for Specular Gloss.
 - .4 ASTM D822-23, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
 - .5 ASTM E283/E283M-19, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 1.105-M91, Quick-Drying Primer (Withdrawn).
 - .2 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating (Withdrawn).
 - .3 CAN/CGSB 1.213-2004, Etch Primer (Pretreatment Coating or Tie Coat) for Steel and Aluminum (Withdrawn).

- .4 CAN/CGSB 12.12-M90, Plastic Safety Glazing Sheets (Withdrawn).
- .4 Canadian Standards Association (CSA Group):
 - .1 CSA G164-18(R2023), Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No.1 (2020).
- .5 Underwriters Laboratory (UL):
 - .1 UL 325, Door, Drapery, Gate, Louver, and Window Operators and Systems -2017.
 - .2 UL Subject 2985, Sustainability Outline Thermal Insulation. (Outline, 10/26/2015).
- .6 Underwriters Laboratory ECOLOGO Certification Program (UL):
 - .1 UL 2768, Architectural Surface Coatings (formerly CCD-047).
 - .2 UL 2760, Recycled Water-Borne Surface Coatings (formerly CCD-048).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation meeting: one week prior to beginning work of this Section and on-site installation, with Contractor, Consultant, installer, manufacturer's representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet.
 - .2 Door operator motor information indicating nameplate data and ratings, characteristics, and mounting arrangements.
 - .3 Provide electronic copy of WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada. Indicate VOC's:
 - .1 For caulking materials during application and curing.
 - .2 For door materials and adhesives.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate sizes, service rating, types, materials, operating mechanisms, glazing locations and details, hardware and accessories, required clearances and electrical connections.
- .3 Manufacturer's Instructions: Submit manufacturer's installation instructions.
- .4 Manufacturer's Field Reports: submit copies of manufacturer's field reports.

- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for overhead door hardware for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: electrical components, devices and accessories are listed and labelled by Canadian Standards Association (CSA).
- .2 Qualifications:
 - .1 Installer Qualifications: Company or person specializing in installation of sectional overhead doors with five years documented experience and approved by door manufacturer.
 - .2 Manufacturer: Obtain sectional overhead doors and component materials through one source from single manufacturer and as follows:
 - .1 Obtain operators from sectional overhead door manufacturer.
 - .2 Obtain controls from sectional overhead door manufacturer.
- .3 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .4 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 WARRANTY

- .1 Provide manufacturer's ten year warranty against delamination of panels and three year warranty for operator (material and workmanship)

Part 2 Products

2.1 MANUFACTURERS

- .1 Basis-of-Design Materials:
 - .1 Thermatite T175, Richards-Wilcox Canada Inc.
- .2 Alternatives:
 - .1 Subject to compliance with requirements specified in this section and as established by the Basis of Design materials, manufacturers offering similar products that may be incorporated into the Work include the following:
 - .1 Assa Abloy.

- .2 Creative Door Services Ltd.
- .3 Cornell Iron.
- .4 Overhead Door Company.
- .5 Steel-Craft Door Products Ltd.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Design Requirements:
 - .1 Design exterior door assembly to withstand windload of 1 kPa with a maximum horizontal deflection of 1/240 of opening width.
 - .2 Air Infiltration: Maximum rate not more than 0.25 L/s/m² at 25 kph and 0.4 L/s/m² at 40 kph when tested in accordance with ASTM E283/E283M.
 - .3 Design door assembly to withstand minimum 25 000 cycles per annum, and 5 years total life cycle.

2.3 MATERIALS

- .1 Overhead Door Panels: galvanized steel sheet to ASTM A653/653M commercial quality Z180 zinc coating.
- .2 Tracks and Accessories: coated (galvanized), cold rolled, commercial steel (CS) sheet, in accordance with ASTM A653/A653M, Z180 coating designation.
- .3 Primer: to CAN/CGSB-1.105-M91 for steel surfaces.
- .4 Insulation: rigid polyurethane containing no ozone depleting substances including CFC (Chlorofluorocarbon) or HCFC (Hydrochlorofluorocarbon).
- .5 Cable: multi-strand galvanized steel aircraft cable.

2.4 DOORS

- .1 Sectional Door Assembly: Metal/foam/metal sandwich panel construction, with EPDM thermal break and ship-lap design. Units shall have the following characteristics:
 - .1 Exterior Face Sheets: 0.48 mm core metal thickness:
 - .1 Colour: silver
 - .2 Surface: Manufacturer's standard ribbed.
 - .2 Interior Face Sheets: 0.41 mm core metal thickness:
 - .1 Colour: silver
 - .2 Surface: Manufacturer's standard ribbed.
 - .3 Panel Thickness: 45 mm
 - .4 End Stiles: 1.6 mm core metal thickness.
- .2 Install glazing for vision panels. Sizes and number of vision panels as indicated.
- .3 Assemble components by means of spot or arc welding or coated rivet system or adhesive and self tapping screws to manufacturer's recommendations.
- .4 Apply shop coat of primer after fabrication of door. Fabricate doors from prepainted steel stock.

2.5 HEAVY DUTY INDUSTRIAL HARDWARE

- .1 Track: standard lift hardware with 80 mm size minimum 2.66 mm core thickness galvanized steel track.
- .2 Track Supports: 2.3 mm core thickness continuous galvanized steel angle track supports.
- .3 Spring counter balance: heavy duty oil tempered torsion spring with manufacturers standard brackets.
 - .1 Drum: sized according to door size by manufacturers requirements, die cast aluminum.
 - .2 Shaft: 25 mm diameter galvanized steel.
- .4 Top roller carrier: galvanized steel minimum 3.04 mm thick adjustable.
- .5 Rollers: Steel rollers 73 mm diameter, with ten, 8 mm diameter ball bearings, 11 mm diameter roller axles and both inner and outer ball races of hardened steel. Length of roller stem as required.
- .6 Roller brackets: adjustable, galvanized steel, minimum 2.7 mm thick.
- .7 Hinges: heavy duty industrial 2.75 mm thick galvanized steel as recommended by manufacturer.
- .8 Cable: minimum 6 mm diameter galvanized steel aircraft cable.

2.6 WINDOWS

- .1 Windows: Double glazed insulating windows fabricated in accordance with CAN/CGSB 12.8, set in EPDM rubber or neoprene glazing channel, and as follows:
 - .1 Stops: Removable stops of same material as door section frames.
 - .2 Layout: Type and size indicated and in arrangement shown on Drawings.
 - .3 Glass:
 - .1 Clear Polycarbonate Plastic: to CAN/CGSB 12.12, Category II - 540 J impact resistance having a minimum light transmission of 80%.

2.7 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory applied silicone modified polyester (SMP).
 - .1 Class F1S.
 - .2 Colour: as indicated on Drawings.
 - .3 Specular gloss: 25-35 units +/-5 to ASTM D523 for matte finish.
 - .4 Coating thickness: dry film thickness not less than 0.9 mil to ASTM D4138.
 - .5 Resistance to accelerated weathering for chalk rating of eight, colour fade five units or less and erosion rate less than 20% to ASTM D2244 and ASTM D659.

2.8 ELECTRICAL OPERATOR

- .1 Electrical jack shaft side mounted operator.

- .2 Electrical motors, controller units, remote pushbutton stations, relays and other electrical components: to CSA approval.
- .3 Motor: Industrial Duty with horsepower as recommended by manufacturer, 208/230 volt three phase and as recommended by door manufacturer; with automatic reset thermal overload protection, high starting torque, continuous duty motor; separate from reduction mechanism; factory pre-wired motor controls, starter; rated for door size and usage classification.
- .4 Controller units with integral motor reversing starter, solenoid operated brake three heater elements for overload protection, including three pushbuttons and control relays as applicable.
- .5 Operation:
 - .1 Openers: 3 pre-programmed visor clip-on style operators per door, with one button to open and one button to close the door.
 - .2 Remote pushbutton stations: surface mounted, in two locations indicated on interior and exterior of building for each door, with "OPEN-STOP-CLOSE" designations on pushbuttons in English.
 - .3 Radio Control Station: One button radio control with three channel, universal coaxial receiver to open, close, and stop door; one per operator and remote antenna mounting kit.
 - .4 Cable control: pendant hung control to open and electric eyes to close.
- .6 Safety switch: in accordance with UL325, combination roll rubber with limit switches for full length of bottom rail of bottom section of door, to reverse door to open position when coming in contact with object on closing cycle.
- .7 For jack shaft operators:
 - .1 Provide floor level disconnect device to allow for manual operation in event of power failure.
 - .2 Equip Operator with:
 - .1 Electrical interlock switch to disconnect power to operator when in manual operation.
 - .2 Built-in chain hoist for manual operation in event of power failure.
- .8 Electrical Enclosures: Hinged enclosure cover, lockable in closed and open position and as follows:
 - .1 Location: wet areas.
 - .2 NEMA 4 enclosure rating in accordance with NEMA 250.
- .9 Automatic illumination complete with time delay, self extinguishing.
- .10 Door speeds: 300 mm per second.
- .11 Control transformer: for 24 VAC control voltage.
- .12 Mounting brackets: galvanized steel, size and gauge to suit conditions.
- .13 Obstruction Detection Device: Equip each motorized door with external automatic safety sensor capable of protecting full width of door opening; activation of sensor immediately stops and reverses downward door travel, in accordance with UL325 and as follows:

- .1 Pressure Sensor Edge: Self monitoring electrically actuated located within astragal or weather stripping mounted to bottom bar; contact with sensor immediately stops and reverses downward door travel, connect to control circuit using manufacturer's standard take up reel or self coiling cable.
- .2 Photoelectric Sensor: Reflective type system designed to detect an obstruction in door opening without contact between door and obstruction; interfaced with door operator control circuit to detect damage to or disconnection of sensing device; non-responsive to ambient light.
- .14 Acceptable Materials:
 - .1 Chamberlain Lift-Master, Inc.
 - .2 Doorlec Corporation.
 - .3 Lynx Industries Inc.
 - .4 Manaras Commercial Operators.

2.9 ACCESSORIES

- .1 Overhead horizontal track and operator supports: galvanized steel, type and size to suit installation.
- .2 Track guards: 5 mm thick formed sheet 1500 mm high track guards.
- .3 Pusher springs.
- .4 Handles: operated from inside.
- .5 Weather stripping: heavy duty, factory installed continuous top seal to seal against header, continuous co-polymer joint bulb seal between sections and vinyl bulb shaped astragal on the bottom edge of the door
- .6 Finish ferrous hardware items with minimum zinc coating of 300 g/m² to CSA G164.

Part 3 Execution

3.1 INSTALLATION

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Install doors and hardware in accordance with manufacturer's instructions.
- .3 Rigidly support rail and operator and secure to supporting structure. Provide steel/metal support components to connect to structure shown on detailed drawings.
- .4 Touch-up steel doors with primer where galvanized finish damaged during fabrication.
- .5 Install operator including electrical motors, controller units, pushbutton stations, relays and other electrical equipment required for door operation.
- .6 Lubricate and adjust door operating components to ensure smooth opening and closing of doors.
- .7 Adjust weatherstripping to form a weather tight seal.

- .8 Adjust doors for smooth operation.

3.2 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Obtain reports within three days of review and submit.

3.3 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Remove traces of primer, caulking; clean doors and frames.
- .3 Clean glass and glazing materials with approved non-abrasive cleaner.
- .4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes conventionally glazed aluminum curtain walls installed as stick built systems consisting of; but not limited to, the following:
 - .1 Fixed, clear, low emissivity (Low E) sealed glass units.
 - .2 Full length pressure plate system
 - .3 Dry glazed from exterior with screw on pressure plate, keyed-in neoprene gasket and thermal break.
 - .4 Internal weep drainage and compartmentalization in accordance with established design principles for rain screen and pressure equalization in curtain wall systems.
 - .5 Snap-On covers.
- .2 Drawings contain details that suggest directions for solving some of the major design requirements; these details can be developed further by the Contractor provided that the final installation adheres to aesthetic criteria established by the drawings and specified dimensions with all elements in planes as drawn, maintaining their relationships with all other building elements.
- .3 Related Requirements:
 - .1 Section 01 35 00 – Delegated Design.
 - .2 Section 05 50 00 – Metal Fabrications: Metal fabricated attachment devices, and framed openings.
 - .3 Section 06 10 00 – Rough Carpentry.
 - .4 Section 07 21 19 – Foam-In-Place Insulation.
 - .5 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier.
 - .6 Section 07 27 19 – Sheet Membrane Air and Vapour Barriers.
 - .7 Section 07 62 00 – Sheet Metal Flashing and Trim.
 - .8 Section 07 92 00 – Sealants.
 - .9 Section 08 11 16 – Aluminum Doors and Frames.
 - .10 Section 08 80 50 – Glazing.
 - .11 Section 09 21 16 – Gypsum Board Assemblies.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Aluminum Association (AA):
 - .1 AA DAF-45-2003(R2009), Designation System for Aluminum Finishes.
 - .2 American Architectural Manufacturers Association (AAMA) / Fenestration and Glazing Industry Alliance (FGIA):
 - .1 AAMA CW-10-15, Care and Handling of Architectural Aluminum from Shop to Site.
 - .2 AAMA CW-11-85, Design Wind Loads for Buildings and Boundary Layer Wind Tunnel Testing.
 - .3 AAMA CWM-19, Curtain Wall Manual.

- .4 AAMA T1R-A1-15, Sound Control for Fenestration Products.
- .5 AAMA/WDMA/CSA 101/I.S.2/A440-08, North American Fenestration Standard/Specification for windows, doors, and skylights.
- .6 AAMA 501-15, Methods of Test for Exterior Walls.
- .7 AAMA 501.1-17, Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure.
- .8 AAMA 501.2-15, Quality Assurance and Water Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
- .9 AAMA 501.5-23, Test Method for Thermal Cycling of Exterior Walls.
- .10 AAMA 503-14, Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
- .11 AAMA 611-20, Voluntary Specifications for Anodized Finishes Architectural Aluminum.
- .12 AAMA 612-20, Voluntary Specifications, Performance Requirements, and Test Procedures for Combined Coatings of Anode Oxide and Transparent Organic Coatings on Architectural Aluminum.
- .13 AAMA 701/702-11, Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals.
- .14 AAMA 2603-22, Voluntary Specification Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
- .15 AAMA 2604-22, Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
- .16 AAMA 2605-22, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum extrusions and Panels.
- .3 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A36/A36M-19, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A480/A480M-23b, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - .4 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .6 ASTM B221-21, Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .7 ASTM C165-23, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.

- .8 ASTM C719-22, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle).
- .9 ASTM C794-18, Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
- .10 ASTM C864-05(2019), standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
- .11 ASTM C920-18, Standard Specification for Elastomeric Joint Sealants.
- .12 ASTM C1087-23, Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
- .13 ASTM E90-23, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .14 ASTM E283/E283M-19, Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Skylights, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
- .15 ASTM E330/E330M-14(2021), Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls, by Uniform Static Air Pressure Difference.
- .16 ASTM E331-00(2023), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform Static Air Pressure Difference.
- .17 ASTM E413-22, Classification for Rating Sound Insulation.
- .18 ASTM E547-00(2016), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.
- .19 ASTM E783-02(2018), Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
- .20 ASTM E1105-15(2023), Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
- .4 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .5 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 12.1-2017, Safety Glazing.
 - .2 CAN/CGSB 12.20-M89, Structural Design of Glass for Buildings (Withdrawn).
 - .3 CAN/CGSB 12.3-M91(R2017), Flat, Clear Float Glass.
 - .4 CAN/CGSB 12.4-M91(R2017), Heat Absorbing Glass.
 - .5 CAN/CGSB 12.8-2017, Insulating Glass Units.
- .6 Canadian Standards Association (CSA Group):

- .1 CSA-G40.20-13/G40.21-13(R2023), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels, Includes Update No. 1 (2014).
- .2 CSA G164-18 (R2023), Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No. 1(2020).
- .3 CSA S136-16, North American Specification for the Design of Cold Formed Steel Structural Members.
- .4 CSA-S157-17/S157.1-17(R2022), Strength Design in Aluminum / Commentary on CSA S157-17, Strength Design in Aluminum.
- .5 CSA W47.1-19, Certification of companies for fusion welding of steel.
- .6 CSA W47.2-11 (R2020), Certification of companies for fusion welding of aluminum, Includes Update No. 1 (2011), Update No. 2 (2012).
- .7 CSA W59-18 (R2023), Welded Steel Construction, Includes Errata (2020).
- .8 CAN/CSA Z91-17 (R2022), Health and Safety Code for Suspended Equipment Operations.
- .7 Fenestration and Glazing Industry Alliance (FGIA).
- .8 Society for Protective Coatings (SSPC):
 - .1 SSPC Paint 20, Zinc Rich Coating (Type I - Inorganic and Type II - Organic), Includes Editorial Revision (2004).
 - .2 SSPC Paint 25, Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel (Type I and Type II), Includes Editorial Revision (2004).
- .9 Underwriters Laboratories ECOLOGO Certification Program (UL):
 - .1 UL 2760 (formerly CCD-048), Recycled Water-Borne Surface Coatings.
 - .2 UL 2761 2011, Sealants and Caulking Compounds (formerly CCD-045).
 - .3 UL 2768 Architectural Surface Coatings (formerly CCD-047).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate installation of system with work specified in other Sections to ensure proper placement and installation of vapour barrier, insulation and flashing in order that air, vapour and thermal barrier of building is intact and moisture will be diverted to the exterior, and as follows:
 - .1 Coordinate installation of sealants so that ambient and surface temperatures are greater than 5°C from time of application until sealants have cured.
 - .2 Coordinate connection of curtain wall system structural connections at floor slabs to vertical members.
 - .3 Coordinate Work of this Section with installation of firestopping, installation of ductwork to rear of louvres, and adjacent components or materials.

- .2 Pre-installation Meetings: Convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with Contractor, Consultant, installer, manufacturer's representative in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements;
 - .2 Review location and alignment of vertical and horizontal elements as they relate to the aesthetic criteria indicated on the Drawings, and the technical requirements indicated on the shop drawings.

1.4 ACTION SUBMITTALS / INFORMATION SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and technical data sheet.
 - .2 Submit product data indicating construction details, material descriptions, dimensions of individual components and profiles, finishes, anchorage and fasteners, glass and infill, internal drainage details.
 - .3 Provide electronic copy of WHMIS SDS - Safety Data Sheets.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Delegated Design: Submit shop drawings, signed and sealed by the delegated design engineer, detailing fabrication and assembly of glazed aluminum curtain wall systems clearly indicating all construction details including; but not limited to, the following:
 - .1 Fully dimensioned layouts for positioning of secondary support members and anchorage of tie-back devices to structures;
 - .2 Large scale details of members and materials, of brackets and anchorage devices and of connection and jointing details;
 - .3 Include thermal values and weathertightness rating data.
 - .4 Fully dimensioned layouts for positioning of brackets and anchorage devices to structures;
 - .5 Dimensions, gauges, thicknesses;
 - .6 Type, size and spacing of fastening devices;
 - .7 Glazing details;
 - .8 Air/vapour barrier details, acoustic control details, aluminum alloy and temper designations, metal finishing specifications and other pertinent data and information;
 - .9 Internal drainage;
 - .10 Show details of perimeter and interface connecting work of this section with work of adjacent sections.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit samples of materials for Consultant's verification of specified finishes including; but not limited to, the following:
 - .1 300 mm x 300 mm for sheets, plates and glass;

- .2 300 mm long for extrusions and formed or rolled shapes;
 - .3 300 mm long for tapes and gaskets;
 - .4 150 mm long for sealants;
 - .5 Samples shall fully represent physical and chemical properties, finish, and colours of materials to be supplied.
- .2 Submit a sample of each finish hardware item that is to be supplied under this section.
- .3 Submit two samples 610 x 610 mm in size illustrating window frame section, insulation, vapour barrier, glass, spandrel panels, vents and sealant.
- .4 Delegated Design Submittals: Submit letters of commitment and compliance in accordance with Section 01 35 00 – Delegated Design Submittals as follows:
 - .1 Provide Letter of Commitment in conjunction with shop drawings, signed and sealed by the professional engineer required by the Work of this Section indicating the following are designed to the intent of the Building Code:
 - .1 Curtain wall connections to building structure.
 - .2 Curtain wall reinforcement.
 - .3 Deflection of members.
 - .4 Glass thickness as it relates to glass area.
 - .2 Provide Letter of Compliance, signed and sealed by the professional engineer required by the Work of this Section indicating that connections, reinforcement and deflection criteria, and glass thickness of installed system is in compliance with the intent of the Building Code and reviewed shop drawings before declaration of Substantial Performance.
 - .3 Calculations:
 - .1 Submit complete design study calculations, certified by a professional engineer licensed to design structures and registered in the jurisdiction of the Place of the Work, including pertinent information affecting design, wind reactions, shading effects and failure probability for thermal glazing units and spandrel panels, to Consultant as evidence of compliance with design criteria, prior to manufacture.
 - .2 Pressure equalized rain screen (PER) design: calculations to include the following:
 - .1 Pressure equalization during exposure to the design wind pressures and gusts;
 - .2 PER design provides pressure equalization of the cavity compartments within 0.5 seconds.
 - .4 Sealant Data:
 - .1 Submit product information on the sealants to be used, complete with all recommendations and installation instructions, including cleaning and priming procedures.
 - .2 Submit sealant manufacturer's test reports on adhesion to metal and glass production samples tested in accordance with ASTM

- C794, seven day cure and seven day water submersion, tensile strength at 100% elongation and bite size of sealants.
- .3 Submit sealant manufacturer's statement and test data indicating that stress on the sealants when exposed to maximum load does not exceed 38 kPa and a safety factor of 5:1.
- .4 Submit sealant manufacturer's compatibility statement that all materials in contact with the sealants are compatible with the sealants in accordance with procedures of ASTM C1087.
- .5 Submit sealant manufacturer's verification that sealants are suitable for purposes intended.
- .5 Submit copies of test reports to establish that products used comply with air leakage and water penetration performance requirements. Submit test reports or calculations to establish that products used comply with energy performance criteria. Submit test reports to establish that products used comply with condensation resistance criteria. Energy and condensation calculation reports to be submitted under the seal of a Professional Engineer in the Province of the Work.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and as follows:
 - .1 Submit data for cleaning of aluminum finishes and maintenance of operational hardware.
 - .2 Instruction for replacement of glass units (insulating and structural glass).
- .2 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00.

1.6 QUALITY ASSURANCE

- .1 Obtain door and curtainwall materials from single manufacturer and/or ensure materials ordered and supplied are compatible with one another.
- .2 Qualifications: The firm producing and executing the Work of this Section shall have a minimum of five years successful experience in the fabrication and erection of systems of similar sizes, shapes and finishes to the units required for this project and shall have ample facilities to produce, furnish and supply the units as required for installation without delay to the Work.
- .3 Delegated Design Professional: Retain a Professional Engineer, registered in the Province of the Work, to design fabrication and erection of the Work of this Section in accordance with applicable Building Code and Contract Documents requirements including, but not limited to, the following:
 - .1 Seal and signature to shop drawings and design submittals.
 - .2 Site review of installed components.
- .4 Provide Tests in Accordance with Section 01 45 00 – Quality Control:
 - .1 Initial Test: Complete diagnostic water leakage field checks of the primary gasket and wet seals of the curtain wall systems to AAMA 501.2, prior to application of secondary seals and caps.

- .2 Static Pressure Air Exfiltration Smoke Test to ASTM E283, Standard test method for Rate of Air Leakage (6.24 psi with a leakage rate of <0.03 cfm/ft²), provide one test.
- .3 Static Pressure Water Infiltration: ASTM E331 Standard Test Method for Water Penetration by Uniform Static Air Pressure Difference. A minimum 15 minute wait period shall be included after this and each subsequent water penetration test.
- .4 Pressure differential for water field testing to ASTM E1105 at 750 Pa.
- .5 Dynamic Pressure Water Infiltration: AAMA 501.1 Standard Test Method for Exterior for Water Penetration using Dynamic Pressure. Include two setups.
- .5 Mock-Ups
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Provide 3000 x 3000 mm mock-up including intermediate mullion, corner mullion, sill muntin, vision glass light, and insulated infill panel glass. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
 - .3 Mockup to include sloped glazed system and junction with vertical curtain wall and other vertical work mullions, muntins, structural member covers, vision glass light, and insulated panel and glass. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
 - .4 Locate where directed.
 - .5 Allow 24 hours for review of mock-up by Consultant before proceeding with work.
 - .6 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of finished work.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Comply with AAMA CW-10 for care and handling of all aluminum Products through the entire manufacturing, finishing, fabrication, delivery and installation phases.
- .2 Protect metal and metal finishes to prevent damage during fabrication, storage, shipping, handling and installation.
- .3 Protect insulating glass units during shipment. Repair or replace damaged components or units as required to meet Contract requirements, and replace any gas leakage during shipping to specified concentrations.
- .4 Deliver, handle and store units by methods approved by manufacturer. Store units at site on wood platforms raised above grade or in enclosures protected from elements and corrosive materials. Stack units vertically in manner to prevent racking. Do not remove from crates or other protective covering until ready for installation.
- .5 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 SITE CONDITIONS

- .1 Site Measurements: Verify dimensions of other construction by site measurements before fabrication and indicate measurements on shop drawings where aluminum curtain wall systems are indicated to fit to other construction.
- .2 Established Dimensions: Establish dimensions and proceed with fabricating aluminum curtain wall without site measurements where site measurements cannot be made without delaying the Work, coordinated with other construction to ensure that actual dimensions correspond to established dimensions.
- .3 Ambient Conditions: Confirm installation requirements for ambient and surface temperatures of sealants with manufacturer and apply sealants when temperatures are greater than manufacturer's stated minimum from time of application until sealants have cured.

1.9 WARRANTY

- .1 Provide manufacturers written guarantee, signed and issued in the name of Owner, to replace the following items for defective material and workmanship for the time stated from date of Substantial Performance:
 - .1 Framing, panels and glazing: failure of performance requirements specified in Contract Documents; ten years.
 - .2 Sealed glass units: misting, dusting and seal failure; ten years.
 - .3 Sealants, caulking: failure to maintain seal; two years.
 - .4 Aluminum brake shapes: oil-canning and delaminations; two years.
- .2 Anodized Aluminum: Provide 2 year for Class II finishes and 5 years for Class 1 Finishes that metal will not change colour more than 5 DEcmc per AAMA 611 and finished metal will not crack, blister, check, or peel.
- .3 Provide Warranty for aluminum windows to include in maintenance manuals as specified in Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 Alumicor
 - .2 Aluprof
 - .3 Schüco

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

- .1 Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads. Failure also includes the following:
 - .1 Thermal stresses transferring to building structure.
 - .2 Glass breakage.
 - .3 Loosening or weakening of fasteners, attachments, and other components.
- .2 Retain a professional engineer registered in province of Work, experienced in structural design in glass and aluminum window units, connections to door units and connections to building, to ensure the adequacy of the structural aspects of the design, manufacture, and installation of complete assembly. Verify site specific thermal values and weather tightness data.
- .3 Design and size components to withstand dead and live loads caused by pressure and suction of wind, acting normal to plane of system as calculated in accordance with Climatic Data for one/50 year occurrence included in Building Code as measured in accordance with AAMA CW 11 and ASTM E330/E330M.
- .4 Design and size components to withstand seismic loads and sway displacement as calculated in accordance with NBC.
- .5 Limit mullion deflection to flexure limit of glass; with full recovery of glazing materials.
- .6 Size glass units and glass dimensions to limits established in CAN/CGSB-12.20.
- .7 Provide system to accommodate, without damage to components or deterioration of seals:
 - .1 Movement within system.
 - .2 Movement between system and perimeter framing components.
 - .3 Dynamic loading and release of loads.
 - .4 Deflection of structural support framing.
 - .5 Shortening of building concrete structural columns.
 - .6 Creep of concrete structural members.
- .8 Limit air infiltration through assembly to 0.15 L/sm² of wall area, measured at a reference differential pressure across assembly of 300 Pa as measured in accordance with ASTM E283/283M.
- .9 Vapour seal with interior atmospheric pressure of 25 mm sp, 22 degrees C, 40% RH: No failure.
- .10 Water leakage: none, when measured at a test pressure of 750 Pa in accordance with ASTM E331.
- .11 System to provide for expansion and contraction within system components caused by a cycling temperature range of -25 to 70 degrees C over a twelve hour period without causing detrimental affect to system components.
- .12 Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to the exterior by a weep drainage network.

- .13 Maintain continuous air barrier and vapour retarder throughout assembly, primarily in line with inside pane of glass and heel bead of glazing compound. Position thermal insulation on exterior surface of air barrier and vapour retarder.
- .14 Ensure no vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system occur.
- .15 Reinforce curtain wall system to accommodate window washing guide rails. Provide anchors sufficiently rigid to resist loads caused by equipment platform, without damage to wall system.
- .16 Tolerances:
 - .1 Design and install the curtain wall to accommodate tolerances of related work not included in this section. This requirement is in addition to building structure movements and deflections.
 - .2 Fabricate components to provide a plumb, square, level and true installation, and to accommodate allowable tolerances for work of other sections upon which work of this section depends.
 - .3 Erection tolerances for frame assemblies relate to the structural grid of the building, and apply to each individual assembly as follows:
 - .1 vertical position: +3 mm;
 - .2 horizontal position: +3 mm;
 - .3 deviation from plumb: 3 mm maximum each plane;
 - .4 racking of face: 6 mm maximum;
 - .5 racking in elevation: Nil;
 - .6 offset from true alignment between two identical members abutting end to end in line: 0.8 mm;
 - .7 tolerances shall not be accumulative;
 - .8 erection tolerances for operable elements: consistent with smooth operation and weatherproof performance.

2.3 MATERIALS

- .1 Extruded aluminum: Alloy and temper recommended by glazed aluminum curtain wall manufacturer for strength, corrosion resistance, application of required finish and complying with ASTM B221, Aluminum Association (AA) alloy 6063-T5 or 6063-T6.
- .2 Aluminum sheet (exposed): to ASTM B209/B209M, Aluminum Association (AA) alloy 1100, anodizing quality.
- .3 Aluminum sheet (unexposed): utility sheet to CSA HA-Series 6063 alloy, T5 temper.
- .4 Steel Reinforcement: to CSA G40.20/G40.21, 300W hot dipped galvanized after fabrication to ASTM A653/A653M, minimum coating of 600 g/m² shapes to suit mullion sections.
- .5 Aluminum welding: to CSA W59.2.
- .6 Stainless steel: to ASTM A480/A480M, Type 304 or 316; of one type throughout.

- .7 Anchors: adjustable T-anchors located top and/or bottom of mullions. Anchors cannot interfere with membrane to tube face connection.
- .8 Pressure Plate: aluminum plate, fastened to the mullion with stainless steel screws.
- .9 Glass: Clear, as indicated in window schedule, sealed glass units as specified under Section 08 80 50 – Glazing.
- .10 Fasteners: Fasteners: aluminum, non-magnetic stainless steel, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum components of suitable size to sustain imposed loads. Do not use exposed fasteners except where unavoidable for application of hardware. Match finish of adjoining metal.
- .11 Anti-Rotation Channels: non-metallic anti-rotation channel designed to mechanically retain air seal membrane to the face of the tubular back section.
- .12 Anti-Rotation Blocking: 40 psi high density polyurethane foam cut to fit.
- .13 Primer for adhesives: as recommended by the adhesive manufacturer for the materials to be adhered.
- .14 Thermal separators (thermal break): of size to conform to the extruded aluminum members or other locations where required, neoprene, EPDM or polyvinyl chloride and having a minimum tensile strength of (14 MPa) (2000 psi) and Durometer A Hardness of 60, +/- 5.
- .15 Concealed Flashing: Manufacturer's standard corrosion resistant, non-staining, non-bleeding flashing compatible with adjacent materials.
- .16 Gaskets: silicone or manufacturers standard gasket.
- .17 Isolation coating: alkali resistant bituminous paint.
- .18 Insulation for packing into voids and cavities: Lightweight resilient, inorganic fibrous glass having a nominal density of 11 kg/cu.m.
- .19 Waterproofing sheet membrane at coping: as indicated in Section 07 27 13 – Modified Bituminous Air and Vapour Barriers.
- .20 Flexible flashing, flexible air/vapour retarder: silicone sheet
 - .1 Basis-of-Design Materials:
 - .1 Dowsil 123, Dow
- .21 Setting Blocks: silicone to 50-80 durometer A hardness.
- .22 Glazing Tape: continuous polyurethane bond breaker tape compatible with silicone sealant.
 - .1 Basis-of-Design Materials:
 - .1 Thermabond V-2100, Norton.
- .23 Sheet metal air/vapour barrier to be bonded to glazing frame and extended behind mounting frame. Seal to maintain continuity of seal. Install flexible flashing with continuous metal retaining strip to lap to interior wall assembly.

- .1 Sheet metal for metal air/vapour barriers and air seals:
ASTM A653 / A653M, minimum 0.91 mm sheet steel, galvanized,
stretcher-levelled, minimum coating weight 380 g/m². Provide stiffeners
as required.
- .24 Provide insulated interior mullion extensions to fit to interior partitions and
columns.
- .25 Sealants (including primer, joint filler): as specified in section 07 92 00 - Sealants
and as follows:
 - .1 Sealants used in structural joints shall have adequate strength to retain
insulating units to the metal framing under design conditions.
 - .2 Sealants shall be from the same manufacturer for all work of this section.
 - .3 Materials used in the work shall be resistant to rodents, vermin, mildew,
fungus and algae.
 - .4 Components in contact with opacifying coat at spandrel panels:
 - .1 Contact the opacifying coating manufacturer for confirmation of
compatibility of sealant to the coating;
 - .2 Use neutral cure silicone components only in spandrel cavity. Do
not use neoprene gaskets or setting blocks etc;
 - .3 Contact the opacifying coat manufacturer for a list of approved
compatible list of sealants and materials, and tapes and gaskets;

2.4 FRAMING SYSTEM: STICK BUILT

- .1 Exterior Fixed Window Frame: To profiles indicated and as required to fulfill
performance requirements, nominal thickness 2.5 mm, suitable alloy and proper
temper for extruding and adequate structural characteristics; and suitable for
finishing as specified:
 - .1 Back Frame Profile: Nominal 186 mm, mullion depth as indicated.
 - .2 Cap Profile: nominal 19 mm snap cap depth and nominal 63.5 mm high.
 - .3 Total Frame Depth: Mullion depth profile and snap cap depth added to
glazing throat/thermal break width.
- .1 Acceptable Materials:
 - .1 [ThermaWall 2600 Series, Alumatic.](#)
 - .2 [HP3253 Series, triple glazed, CRL/US Aluminum.](#)
 - .3 [7550 Series](#), Kawneer Canada Ltd.

2.5 OPERABLE UNITS

- .1 Provide thermally broken operable windows with screw adjustable opening
restrictors to limit swing of ventilators, set to a maximum 100 mm opening.
 - .1 Acceptable Materials:
 - .1 Alumatic
 - .2 [GLASSvent UT](#), Kawneer Canada Ltd.
 - .3 [7600 Series, CRL/US Aluminum](#)

2.6 GLAZING AND ACCESSORIES

- .1 Triple Pane Insulating Glass Units: Refer to Section 08 80 50 – Glazing.

2.7 INSULATED SPANDREL PANELS

- .1 Spandrel Glass: triple glazed in accordance with Section 08 80 50 - Glazing.
- .2 Back Pan: Galvanized steel in accordance with ASTM A653/A653M, 0.91 mm base metal thickness, formed into a pan shape to fit into glazing throat with back of pan flush with inside face of back section.
- .3 Insulation: Semi-rigid mineral fibre insulation with reinforced foil facing, held in place with manufacturer's standard fixing system to back face of back pan.
 - .1 Basis-of-Design Materials:
 - .1 Curtainrock 80, Rockwool Inc.

2.8 FABRICATION: GENERAL

- .1 Do not start fabrication until samples, shop and erection drawings have been reviewed and have been approved.
- .2 Execute fitting and assembly in the shop, insofar as practical, with the various parts or assemblies ready for erection at the building site.
- .3 Where possible, take field measurements and levels required to verify or supplement those shown on the drawings for the proper layout and installation of the work. Coordinate dimensional tolerances in adjacent building elements and confirm prior to the commencement of the Work.
- .4 Weld aluminum, where required, with inert metal arc equipment. Welders to qualify according to CSA W47.2. Make exposed welds continuous and flush with adjacent surface. Do not mar surface finishes with welds in back of exposed aluminum. Do not deform the exposed metal and finish way by welding.
- .5 Weld steel, where required, to CSA W59. Welded joints to be of adequate strength and durability with jointing tight and flush. Welders to be fully approved by the Canadian Welding Bureau and to comply with CSA W47.1. Where it is necessary to weld components already galvanized, remove galvanizing for 50 mm around weld.
- .6 In locations where curtain wall framing extends up to top of roof parapets, the headrail and glazing cap shall be reinforced to withstand force from window cleaner's suspension chair ropes, which will extend over the top of the parapet and down the face of the building.
- .7 Make provisions in doors and frames to suit requirements of electrically operated hardware and security devices, as applicable, provided under other trades or sections. Blank, drill, reinforce and tap to receive hardware, security and electrical devices. Provide removable plates or knockouts for electrical contacts. Provide fish wires as required.
- .8 Visible manufacturer's identification labels not permitted.

2.9 FABRICATION: FRAMING MEMBERS

- .1 Fabricate members to the profiles shown on the Drawings. Wall thickness of extrusions to be as required to meet the design requirements. Frames that are to receive insulating glass units shall have a continuous thermal break.
- .2 Accurately machine file and fit, and rigidly frame together joints, corners and mitres. Match components carefully to produce perfect continuity of line and design. Make exterior joints weathertight and interior joints airtight in accordance with specified allowances. Metal in contact to have hairline joints. Locations of exposed joints to be subject to the approval of the Consultant.
- .3 Sill Trim: Provide continuous extruded "U" trim to inside of bottom rail at each level with provision for receiving steel base and convector covers, as detailed
- .4 Reinforce frames and assemblies by concealed means as necessary to meet the specified design requirements and as shown. Reinforcing to be hot-rolled mild steel and be securely anchored to horizontal and vertical members by approved positive mechanical means.
- .5 Seal hairline joints at junctions of frame members. Gun-inject sealant from inside ensuring a continuous seal of the joint. Ensure that bead in the glazing space does not impair seating of glazing materials. Remove excess sealant which is forced onto face of frame assembly.
- .6 Location of joints and pressure equalizing drain vents to be subject to consultant's acceptance.
- .7 Provide sheet continuous air/vapour barrier between framing and building structure. Overlap corner joints. Apply barriers and retain with continuous aluminum or galvanized steel plates or bars and non-corrosive mechanical fasteners. Where indicated, fill void between frame and other building components solid with foamed in place polyurethane foam insulation.
- .8 Develop drainage holes with moisture path to exterior.
- .9 Prepare components to receive anchor devices. Fabricate anchorage items.
- .10 Arrange fasteners, attachments, and jointing to ensure concealment from view.
- .11 Cope, notch and drill so as to provide minimum tolerance throughout system and to fit with hairline joints.
- .12 Conceal interconnecting members and fastenings in completed assembly. Provide pressure equalizing holes in members and condensation drains.
- .13 Backup panels, framing members and associated sealing shall combine to form air tight vapour barrier for entire interior skin of curtain wall system. Cooperate and coordinate with other sections to ensure continuous thermal and air barrier seal at interfaces with adjacent materials. Insulate backpans with 75 mm thick semi-rigid mineral wool insulation.
- .14 Provide for vertical expansions and construction joints as necessary and install air cut-offs in continuous vertical members to prevent stack effect of enclosed air columns.
- .15 Jointing and intersections of metals shall be accurately cut, fitted to a tolerance of 0.8 mm, in true planes with adequate concealed beads where required.

- .16 Fabricate expansions joints between mullion sections with formed extruded aluminum internal sleeve sections, secure to permit joint function and maintain true alignment of sections.
- .17 Fabricate sections to accommodate and interface with work of other sub-contractors by means of rabbets, interlocks, miscellaneous angles, trim and filler sections as required.
- .18 Fabricate mullions not less than one storey height with fully fashioned expansion joints adequate for expansion and contraction required. Avoid chimney effect inside mullions by stopping voids at each floor level with packing consisting of rigid insulation.
- .19 Brake form parapet caps and sills out of 3 mm thick aluminum sheet.
- .20 Reinforce mullions with structural steel sections where required with adequate anchorage to structure.
- .21 Provide internal reinforcement in horizontal window mullions to satisfy wind loads and to maintain rigidity.
- .22 Perform fitting and assembly of component parts in shop insofar as practicable. Work that cannot be permanently shop assembled shall be fitted, assembled, marked and disassembled to assure proper fitting in field. Identify shop assembled components on shop drawings for location and erection at site.
- .23 Isolate aluminum in contact with other metals, masonry, concrete, plaster or mortar to prevent corrosion.
- .24 Verify wall openings and adjoining air and vapour seal materials are ready to receive work of this section.
- .25 Beginning installation means acceptance of site conditions.
- .26 Provide airtight vapour seals in curtain wall framing.

2.10 FABRICATION: SPANDREL PANELS/FLASHING/ACCESSORIES

- .1 Refer to Drawings for size type and location of glass spandrel panels.
- .2 Spandrels to have insulated backup panels, complete with 75 mm thick insulation consisting of two layers. Secure insulation to metal liner with adhesive and "spindle" clips with black retainer discs, minimum two per board.
- .3 First layer of insulation to be 50 mm thick impaled on clips and secured with retainer discs. Second layer to be black-faced, secured to first with adhesive, uniformly spread over opposing faces. Align panels symmetrically with joints in line and tight together. Cut off ends of spindles just above discs, It is imperative that joints are tight so that edges do not show, if misaligned, caulk with black sealant. Similarly caulk perimeter edges. Appearance from outside shall be a consistent black colour.
- .4 Provide 3 mm thick aluminium shadow box sheet secured to framing in front of insulation.
- .5 Seal perimeter of liner panels with non-permeable sealant to maintain vapour barrier. Install weatherseal, rain deterrent and vent where detailed and required.
- .6 Reinforce liner panels where necessary to prevent undue deflection.

- .7 Provide sloping sills with high backs, to terminate curtain wall system at bottom. Brake form to detailed profiles.
- .8 Fabricate panels in manner to maintain complete thermal and vapour barrier seal at inner panel, yet to ensure moisture is drained to exterior.
- .9 Form aluminum flashing, parapet coping and cap flashing as detailed and to locations indicated. Prevent damage by window washing equipment, ladders, etc., by reinforcing edges of copings and caps.
- .10 Provide sound baffles within spandrels to reduce noise transmission vertically between floors.

2.11 FINISHES

- .1 Clear Anodized: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class I, AA-M12C22A41, clear anodized matching Kawneer #14.
- .2 Steel exposed to exterior conditions that is on cold-in-winter side of air/vapour barrier, but not exposed to view, shall be blast cleaned and hot dip galvanized in accordance with CSA G164, minimum coating mass 381 g/m². Thread dimensions to be such that nuts will thread over bolts without re-threading or chasing galvanized threads.
- .3 Galvanize after fabrication where possible. Follow standard precautions to avoid making the base metal brittle by over pickling, overheating or during galvanizing.
- .4 Shop and touch-up primer for steel components: SSPC 25 Paint red oxide.
- .5 Touch-up primer for galvanized steel surfaces: SSPC 20 Paint zinc rich.
- .6 Concealed steel items: galvanized in accordance with CSA G164 to 600 gm/m².
- .7 Isolation Coating
 - .1 Isolate aluminum from the following components, by means of isolation coating:
 - .1 Dissimilar metals except stainless steel, zinc, or white bronze.
 - .2 Concrete, mortar and masonry.
 - .3 Wood.

Part 3 Execution

3.1 EXAMINATION

- .1 Inspect Work and conditions affecting the Work of this Section. Proceed only after deficiencies have been corrected.
- .2 Ensure that flashings built-in or integrated with system to divert moisture to exterior.
- .3 Ensure that all anchor blocks or inserts required to receive system are correctly located and installed.
- .4 Ensure that all anchors and setting or installing components provided by this Section for installation are properly located and installed.

- .5 Ensure that building air and vapour retarding membranes can be sealed to window units to maintain system integrity. Coordinate with materials installation specified in Section 07 21 19 – Foam-In-Place Insulation and Section 07 27 13 – Modified Bituminous Air and Vapour Barrier.

3.2 PREPARATION

- .1 Coordinate dimensions, tolerances, and method of attachment with other work.
- .2 Supply anchorage devices and inserts to the appropriate sections where required for building in or casting-in-place and instruct as to proper location and position. Anchors shall have three-way adjustments.
- .3 Remove dust and other loose material from openings.
- .4 Verify that surfaces are ready to receive work and floor to floor dimensions are as indicated on shop drawings.

3.3 INSTALLATION: CURTAIN WALL

- .1 Install curtain wall systems to AAMA CWM, and manufacturer's written instructions, as required to meet or exceed specified performance criteria.
- .2 Use only concealed fasteners, type 304 stainless steel unless otherwise specified.
- .3 Erect all work plumb and true and in proper alignment and relationship to established lines and grades.
- .4 Devices for anchoring the frame assemblies shall have sufficient adjustment to permit correct and accurate alignment. After alignment, positively secure anchorage devices to prevent movement other than those designed for expansion and contraction. Take into consideration climatic conditions prevailing at time of installation.
- .5 Perform welding and drilling of concrete as required to install fixings. Repair, concrete chipped by drilling or fixing operations.
- .6 Group components with shop applied finishes so that those that relate most closely to one another, with regard to colour and appearance, shall be installed adjacent to each other.
- .7 Coordinate work of this section with, and provide connection for, compartmentalization of air spaces provided under other sections.
- .8 Provide thermal insulation and air/vapour barriers compatible and continuous with adjacent thermal and air/vapour barrier systems.
- .9 Apply continuous butyl sealing tape between sheets at lap and between steel and other materials. Screw sheets to each other and metal framing with type 304 stainless steel sheet metal screws, 150 mm o.c. maximum. Continuously seal perimeter of panels with tape and sealant. Place type 304 stainless steel washers over rubber washers under screw heads and cover with sealant to make fastenings air and vapour tight.
- .10 Seal joints of metal, apertures and protrusions of any kind with specified sealant to produce homogeneous air/vapour barrier seal. Joints shall be air, water and weathertight.

- .11 Apply a continuous bead of sealant to all joints and air/vapour barrier junctions with adjacent construction. Liberally butter screw fastenings with sealant.
- .12 Supply and install flexible, continuous gasket air/vapour barrier seals between work of this section and adjacent construction, and at deflection and expansion connections, where required. Prime substrates, apply gaskets to framing and to concrete and masonry with adhesive and retain with continuous aluminum or stainless steel plates or bars and non-corrosive mechanical fasteners. Ensure a continuous permanent seal at joints.
- .13 Provide air tight seals at penetrations in air/vapour barriers.
- .14 Support adhesive-applied clips in place until adhesive has set.
- .15 Isolate metal air/vapour barriers with thermal breaks and spacers.
- .16 Locate vapour barrier on the warm-in-winter side of the insulation.
- .17 Ensure a uniform, continuous thermal and vapour barrier effect. Where adjacent insulation and vapour barriers are to be provided under other sections, coordinate the work such that thermal and vapour barrier continuity is achieved. Ensure compatibility with adjacent thermal and air/vapour barrier systems. Ensure compatibility between tapes, sealants and air/vapour barriers.
- .18 Cut insulation as required and fit snugly to penetrations, obstructions, openings and corners. Butt insulation boards tightly. Cut out back of board insulation as required to accommodate substrate irregularities and build up over cut out areas on the other side as required to ensure thermal barrier uniformity unless otherwise approved.
- .19 Install insulation to thicknesses shown on the Drawings.
- .20 Press insulation boards firmly to barrier or substrate impaling them on clips without bending clips. Butt insulation boards tightly. Install retainers to clips.
- .21 Fill irregular shaped voids within assemblies with fibrous glass packing insulation to maintain continuity of thermal barrier.
- .22 Protect exterior finished surfaces by installing snap-on caps only when building is closed in, and when the possibility of damage due to construction has been minimized, to the approval of the Consultant.
- .23 Secure snap-on caps with concealed stainless steel fasteners, minimum two per cap.
- .24 Install operable windows and related hardware, at locations indicated and ensure weathertight, rattle-free closure when units are in the closed and locked position. Perform drilling required to install stops and other hardware items fixed to adjacent construction.
- .25 Protect exterior finished surfaces by installing snap-on caps when the possibility of damage due to construction has been minimized.
- .26 Provide structural steel framing and supports required to support work of this Section unless indicated to be supplied under other Sections. Provide structural steel support or reinforcement for anchorage of railings.
- .27 Supply and install galvanized formed steel coping supports.

- .28 Supply and install sheet waterproofing membrane at copings and parapets as indicated. Lap, adhere, and seal joints in membrane in accordance with recommendations of the membrane manufacturer to provide a watertight, continuous membrane.

3.4 INSTALLATION GLAZING: FIELD

- .1 Install windows, vents, doors and skylights to AAMA/WDMA/CSA 101/I.S.2/ and CSA A440.
- .2 Install glass and insulating glass units to GANA Glazing Manual recommendations, minimum, and as required to meet or exceed specified performance criteria.
- .3 Provide triple-glass insulating vision lights and spandrel glass panels, as indicated on the drawings, throughout the curtain wall cladding.
- .4 Fabricate units accurately to size allowing 6 mm clearance between frame and glass edge. Butt joints shall be plumb and square, uniformly spaced. Ensure that glass rebates/glazing surfaces are clean and dry before placing glass and glazing gaskets and in place.
- .5 Apply structural glazing tape to faces of back-up mullions and setting blocks to top of horizontal rails, to evenly distribute weight.
- .6 Clean edges of glass units with recommended cleaner and lift them in place. Press into place to assure good contact between glazing gaskets/structural glazing tape and glass, and secure with temporary pressure plates/clamps. Align glass, as necessary; butt joints to be aligned and plumbed and centred on back-up mullion. Vertical joints shall be aligned top to bottom of curtain wall.
- .7 Run a continuous bead of structural sealant into void space between glass and backup mullion filling same completely. Tool/wipe flush with face of mullion. Install insulated back-pans behind spandrel panels. Fit flanges tight to frames and seal junctions.
- .8 Face seal butt joint behind horizontal pressure plates.
- .9 Remove temporary clamps/plates after silicone has set. Apply pressure plates and caps to horizontals to secure glass.
- .10 Excepting corner joints, open faces of vertical joints shall be covered with a snap-in-place, neoprene face seal gasket, colour matched to glass spandrels. Cut and fit ends tight to glazing caps. Corner joints shall be packed and sealed with structural silicone; tool surface and wipe off excess each side of joint.

3.5 SEALANT

- .1 General:
 - .1 Seal joints between frame assemblies and adjacent construction except where specified to be done under other sections, and within glazed assemblies where required to maintain weather tightness and integrity of air/vapour barrier. Seal junctions in sheet metal air/vapour barriers and between air/vapour barriers and adjacent construction.
- .2 Preparation:
 - .1 Ensure that joint conditions are suitable for the materials to be installed.

- .2 Ensure that surfaces to be sealed are sound, dry, free from dirt, water, frost, loose scale, corrosion, or other contaminants which may adversely affect the performance of the sealant materials. Remove protective oil coatings and other oil or grease films.
 - .3 Perform cleaning to the extent required to achieve acceptable joint surfaces.
 - .4 Protect cleaned and primed surfaces from further contamination by oil, dust, rain, condensation and other materials detrimental to sealant bonding strength. Re-clean and re-prime contaminated surfaces.
 - .5 Install joint filler strips as backup for sealant to provide optimum joint profile, but not less than 6 mm depth of sealant bead. Provide bond breaker tapes where required.
 - .6 Mask areas adjacent to the joints to prevent contamination of adjacent surfaces. Remove masking promptly after the joint has been completed.
 - .7 If recommended by the manufacturer of the sealant materials, prime joints to prevent staining, or to assist the bond.
 - .8 Apply primer with a brush which will permit all joint surfaces to be primed. Perform priming immediately before installation of sealant.
- .3 Installation:
- .1 Obtain approval from the sealant manufacturer for the priming, cleaning and application techniques at commencement of the sealant installation.
 - .2 Before sealant installation is commenced, test the sealant for adhesion to substrates.
 - .3 Install materials in compliance with the recommendations of their manufacturers.
 - .4 Do not exceed shelf life and pot life of materials, nor installation times, as stated by the manufacturer. Ensure sealant manufacturer's on-site quality control procedures are maintained.
 - .5 Be familiar with the work life of the sealant to be used. Do not mix multiple component materials until required for use.
 - .6 Mix sealants thoroughly with a mechanical mixer without mixing air into the materials. Continue mixing until the material is a uniform colour and free from streaks of unmixed material.
 - .7 Before any sealing is commenced, test the materials for indications of staining or poor adhesion.
 - .8 Sealants shall be of gun grade or knife grade consistency to suit the joint condition. Use gun nozzles of the proper sizes to suit the joints and the sealant material.
 - .9 Install sealant with pressure operated guns.
 - .10 Use sufficient pressure to fill all voids and joints full. Sealants shall bond to all sides of joint except where filler or bond breaker material is used. Where filler or bond break material is used, sealant shall bond to both sides of joints and shall not adhere to the filler or bond break material.
 - .11 Ensure that the correct sealant depth is maintained. Superficial painting with a skin bead will not be accepted.

- .12 Sealant installations shall be a full bead free from air pockets and embedded impurities and having smooth surfaces, free from ridges, wrinkles and sags.
- .13 After joints have been completely filled, tool them neatly to a slightly concave surface.
- .14 If joints are masked, remove masking immediately after tooling and before sealants begin to cure.
- .15 Install exposed structural silicone sealants at glazing so that top surfaces of the beads are formed to drain water away from the glass.
- .16 Clean excess sealants from glass and framing surfaces immediately after installation.
- .17 Cover all fasteners penetrating the air/vapour barriers with sealant.
- .18 Immediately clean adjacent surfaces which have been soiled and leave work in a neat, clean condition. Remove excess materials and droppings using recommended cleaners and solvents.

3.6 FIELD QUALITY CONTROL

- .1 Inspection will monitor quality of installation and glazing.
- .2 Test to ASTM E1105, and AAMA 501.
- .3 Evaluate installed system by infrared thermographic scan.
- .4 Manufacturer's Field Services:
 - .1 Curtain wall product manufacturers to provide field surveillance of installation of their Products.
 - .2 Monitor and report installation procedures, unacceptable conditions.

3.7 FIELD TESTING REQUIREMENTS

- .1 Conduct window performance testing on 5% of the installed curtain wall windows (minimum of five windows) by a testing agency designated by the Consultant.
- .2 Provide full wall assembly and seals to window opening in area of all tests (for a minimum distance of 1m beyond rough opening). Plywood may be used as a temporary exterior cladding for the tests, otherwise the specified cladding is to be in place at the time of testing.
- .3 Test one (1) curtain wall module at 10%, 25%, 50%, and 75% of aluminum work installation completion Testing selection shall include:
 - .1 Water Penetration: Field testing to be in accordance with AST E1105, by using AAMA 502-02 Test Method B.
 - .2 Field calibrated nozzle testing done to AAMA 501.2-03 standard. (Minimum 100 linear feet of joints interfacing with curtain wall).
 - .3 Chamber Air/Water penetration testing done to ASTM E783 and E1105 standards, respectively
 - .4 Test levels shall be as noted under performance requirements of Clause 1.5.
 - .5 Assemblies which fail to pass the performance requirements, the costs to repair/replace/adjust the assemblies and the costs for subsequent testing to confirm conformance shall be borne by the subcontractor.

- .6 All modifications required to pass field test shall be performed on all other affected or similar windows.
- .7 Test levels shall be as noted under performance requirements of Clause 1.7.
- .8 In the event that wall assemblies fail to pass the performance requirements initially, the costs to repair/replace/adjust the assemblies and the costs for subsequent testing to confirm conformance shall be borne by the Contractor. Location of air barrier imperfections shall be performed in accordance with ASTM E1186-03.

3.8 ADJUSTING

- .1 Replace defective materials and materials damaged due to faulty installation, careless handling or other causes resulting from work of this section.
- .2 Upon completion of the work and just prior to final review, or at a time as directed, inspect units for damage and correct same immediately.
- .3 Test and adjust hardware and replace or repair faulty items.
- .4 Adjust weather-stripping to leave each opening unit in its most weathertight position.
- .5 Test operable elements and ensure easy and smooth operation.

3.9 CLEANING

- .1 Remove protective material from pre-finished aluminum surfaces, interior and exterior.
- .2 Remove, as work progresses, corrosive and foreign materials that may set or become difficult to remove at time of final cleaning or that may damage members. Inspect minimum monthly to ensure cleanliness.
- .3 Wash exposed surfaces with a pre-approved cleaning solution approved by manufacturers of glass and aluminum. Take care to remove dirt from corners. Wipe surfaces clean.
- .4 Select, apply and maintain cleaning and protective methods to ensure finishes will not become uneven or impaired as a result of unequal exposure to light and weathering conditions.
- .5 Perform final cleaning after completion of entire installation when approved by the Consultant. Remove dirt and stains where such does not respond to the washing or cleaning specified in Section 01 74 11 - Cleaning, refer the condition to the Consultant, with recommendations as to the remedial action required; but do not undertake any cleaning procedure of a more severe nature without the written approval.
- .6 Cleaning shall include the interior/exterior surfaces of materials installed under this section.
- .7 Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.
- .8 Upon completion of the work of this section, remove debris, equipment and excess material resulting from the work of this section from the site.

- .9 Provide the Owner with instructions for proper method and materials to be used in maintenance cleaning of finished surfaces.

3.10 PROTECTION

- .1 Protect finished Work from damage.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes conventionally glazed aluminum windows installed as systems consisting of, but not limited to, the following:
 - .1 Fixed, clear, low emissivity (Low E) sealed glass units.
 - .2 Internal weep drainage and compartmentalization in accordance with established design principles for rain screen and pressure equalization in curtain wall systems.
- .2 Drawings contain details that suggest directions for solving some of the major design requirements; these details can be developed further by the Contractor provided that the final installation adheres to aesthetic criteria established by the drawings and specified dimensions with all elements in planes as drawn, maintaining their relationships with all other building elements.
- .3 Related Requirements:
 - .1 Section 06 10 00 – Rough Carpentry
 - .2 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
 - .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barriers
 - .4 Section 07 62 00 – Sheet Metal Flashing and Trim
 - .5 Section 07 92 00 – Sealants
 - .6 Section 08 44 13 – Glazed Aluminum Curtain Walls
 - .7 Section 08 80 50 – Glazing
 - .8 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Aluminum Association (AA):
 - .1 AA ADM-2020, Aluminum Design Manual, 2020 Edition.
 - .2 AA 23, Welding Aluminum: Theory and Practice, Fourth Edition, 2002.
 - .2 American Society for Metals (ASM International):
 - .1 Properties of Aluminum Alloys: Fatigue Data and the Effects of Temperature, Product Form, and Processing, 2008.
 - .3 American Architectural Manufacturers Association (AAMA) / Fenestration and Glazing Industry Alliance (FGIA):
 - .1 AAMA AFPA-1-15, Anodic Finishes/Painted Aluminum.
 - .2 AAMA CW-RS-1-12, The Rain Screen Principle and Pressure Equalized Wall Design.
 - .3 AAMA RPC-00, Rain Penetration Control: Applying Current Knowledge.
 - .4 AAMA/WDMA/CSA 101/I.S.2/A440-2017, North American Fenestration Standard/Specification for Windows, Doors, and Skylights.
 - .5 AAMA 501-15, Methods of Test for Exterior Walls.

- .6 AAMA 501.1-17, Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
- .7 AAMA 502-12, Voluntary Specification for Field Testing of Windows and Sliding Doors.
- .8 AAMA 611-20, Voluntary Standards for Anodized Architectural Aluminum.
- .9 AAMA 1503-09, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
- .10 AAMA 2603-22, Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- .11 AAMA 2604-22, Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- .4 American National Standards Institute (ANSI):
 - .1 ANSI-NFRC-100-2023 (E0A0), Procedure for Determining Fenestration Product U-Factors.
 - .2 ANSI-NFRC-200-2023(E0A0), Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
- .5 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process.
 - .2 ASTM A480/A480M-23b, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - .3 ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .4 ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .5 ASTM B429/B429M-20, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - .6 ASTM C920-18, Standard Specification for Elastomeric Joint Sealants.
 - .7 ASTM E331-00(2023), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference.
 - .8 ASTM F588-17(2023), Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact.
- .6 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .7 Canadian General Standards Board (CGSB):

- .1 CAN/CGSB 1.40-97 (Withdrawn), Anticorrosive Structural Steel Alkyd Primer.
- .2 CAN/CGSB 12.1-2017, Safety Glazing.
- .3 CAN/CGSB 12.3-M91(R2017), Flat, Clear Float Glass.
- .4 CAN/CGSB 12.4-M91(R2017), Heat Absorbing Glass.
- .5 CAN/CGSB 12.8-2017, Insulating Glass Units.
- .6 CAN/CGSB 12.10-M76, Glass, Light and Heat Reflecting (Withdrawn)
- .7 CAN/CGSB 79.1-M91, Insect Screens (Withdrawn).
- .8 Canadian Standards Association (CSA Group):
 - .1 CSA AAMA/WDMA/CSA 101/I.S.2/A440:22, North American Fenestration Standard / Specification for windows, doors, and skylights, Includes Errata (2023).
 - .2 CSA Plus A440H-14, User Guide to AAMA/WDMA/CSA 101/I.S.2/A440 NAFS 2011 - North Fenestration Standard/Specification for Windows, Doors, and Skylights.
 - .3 CSA A440S1-19 (R2022), Canadian Supplement to AAMA/WDMA/CSA 101/I.S.2/A440-17, North American Fenestration Standard/Specification for Windows, Doors, and Skylights.
 - .4 CSA A440.2-22/A440.3-22, Fenestration energy performance/User Guide to CSA A440.2:19, Fenestration energy performance.
 - .5 CSA A440.4:19, Window, Door, and Skylight Installation.
 - .6 CSA-G40.20-13/G40.21-13 (R2023), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel., Includes update No. 1 (2014).
 - .7 CSA G164-18 (R2023) Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No. 1 (2020).
 - .8 CAN/CSA Z91-17(R2022), Health and Safety Code for Suspended Equipment Operations.
- .9 The Society for Protective Coatings (SSPC):
 - .1 SSPC SP COM, Surface Preparation Commentary for Steel and Concrete Substrates.
 - .2 SSPC PS Guide 12.00, Guide to Zinc-Rich Coating Systems.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet.
 - .2 Submit WHMIS SDS - Safety Data Sheets acceptable to Labour Canada, and Health and Welfare Canada. Indicate VOC's for sealant materials.
- .2 Submit copies of test reports to establish that the products assembled by this manufacturer comply with the specified Performance Class, Performance Grade,

Water Test Pressure, and Air Infiltration/Exfiltration Level as tested to NAFS-11 and the Canadian Supplement. Submit complete test reports showing all component drawings.

- .3 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit shop drawings signed and sealed by the Manufacturer's Engineer clearly indicating:
 - .1 Components, materials, finishes, and locations of anchorage.
 - .2 Section details showing all window perimeter conditions.
 - .3 Mullion details and frame corner connections.
 - .4 Sill flashing terminations, in isometric view, including coordination with wall cladding materials.
 - .5 Frame anchorage details.
 - .6 Details showing sealing techniques within and around perimeter of framing and operable sash.
 - .7 Connection to building sheet membrane air and vapour retarder.
 - .8 Required sizes and tolerance of openings.
- .4 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit one representative model of each type window.
 - .2 Include frame, sash, sill, glazing and weatherproofing method, insect screens, surface finish and hardware. Show location of manufacturer's nameplates.
 - .3 Include 150 mm long samples of head, jamb, sill to indicate profile.
- .5 Provide Tests in Accordance with Section 01 45 00 – Quality Control:
 - .1 Static Pressure Air Exfiltration Smoke Test, provide one test.
 - .2 Static Pressure Water Infiltration: ASTM E331 Standard Test Method for Water Penetration by Uniform Static Air Pressure Difference. A minimum 15 minute wait period shall be included after this and each subsequent water penetration test.
 - .3 Dynamic Pressure Water Infiltration: AAMA 501.1 Standard Test Method for Exterior for Water Penetration using Dynamic Pressure. Include two setups.
 - .4 Test and Evaluation Reports:
 - .1 Submit test reports from approved independent testing laboratories, certifying compliance with specifications.
 - .2 All test reports that reference the NAFS must include, on the first page, a summary of the results including, at minimum:
 - .1 The product manufacturer.
 - .2 The type of product.
 - .3 The model number/series number.
 - .4 The primary product designation.
 - .5 The secondary product designation.
 - .1 Positive design pressure.

- .2 Negative design pressure.
 - .3 Water penetration resistance test pressure.
 - .4 Canadian air infiltration and exfiltration levels.
 - .6 The test completion date.
 - .3 The report will also contain the following information:
 - .1 Test dates.
 - .2 Report preparation dates.
 - .3 Test information retention period.
 - .4 Location of testing facilities.
 - .5 Full description of test samples, including:
 - .1 Anodized finish, weathering characteristics.
 - .2 Condensation resistance.
 - .3 Forced entry resistance.
 - .4 Mullion deflection - combination and composite windows.
 - .6 Complete description of amendments, as applicable.
 - .7 Conclusion.
 - .8 Drawings signed by the testing laboratory, if provided.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for windows for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Window fabricator shall have a minimum of five years successful experience in the fabrication and erection of metal windows of similar sizes, shapes and finishes to the units required for this project and shall have ample facilities to produce, furnish and supply the units as required for installation without delay to the Work.
- .2 Retain a professional engineer registered in the Province of the Work experienced in structural design in glass and aluminum window units, connections to door units and connections to building, to ensure the adequacy of the structural aspects of the design, manufacture, and installation of complete assembly. This Engineer is called the "Manufacturer's Engineer" elsewhere in this Section.
- .3 Only fabricators approved by Manufacturer shall fabricate and install products of this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle and store units in accordance with manufacturer's directions.
- .2 Store units at site on raised wood pallets protected from the elements and corrosive materials. Do not remove from crates or other protective covering until ready for installation.

- .3 Store all glass units vertically on end with solid bearing full thickness of insulating units.
- .4 Store pre-fabricated frame assemblies blocked off the ground to prevent warping, twisting, undo strain on assembly or physical abuse and damage.
- .5 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Protect aluminum finishes and glazing during erection against disfiguration, contamination or damage by abuse of harmful materials. Install protective cover where exposure to damage is critical.
- .2 After glass is installed, mark each light with large cross or other symbol to make glass obvious and noticeable to other trades. Use substance which will not stain, mark or "Shadow" glass either by itself or by reaction with sunlight, moisture or the environment. Do not use masking tape.
- .3 Co-ordinate installation of windows with Work specified in other Sections to ensure proper placement and installation of vapour barrier, insulation and flashing in order that air/vapour/thermal barrier of building is intact and moisture will be diverted to the exterior.

1.8 WARRANTY

- .1 Provide manufacturer's written guarantee, signed and issued in the name of Owner, to replace the following items for defective material and workmanship for the time stated from date of Substantial Performance:
 - .1 Framing, panels and glazing: failure of performance requirements specified in Contract Documents; ten years.
 - .2 Sealed glass units: misting, dusting and seal failure; ten years.
 - .3 Sealants, caulking: failure to maintain seal; two years.
 - .4 Aluminum brake shapes: oil-canning and delaminations; two years.
- .2 Anodized Aluminum: Provide 2 year for Class II finishes and 5 years for Class 1 Finishes that metal will not change colour more than 5 DEcmc per AAMA 611 and finished metal will not crack, blister, check, or peel.
- .3 Provide Warranty for aluminum windows to include in maintenance manuals as specified in Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 WINDOW TYPE AND CLASSIFICATION

- .1 Types:
 - .1 Fixed: with removable triple glazing insulating glass.
 - .1 Basis-of-Design Materials:
 - .1 AWS 90 SI+ optimized (PHI cool-temperate certified), Schüco.

- .2 Acceptable Manufacturer:
 - .1 Aluprof
- .2 Tilt and turn: with removable triple glazing insulated glass.
 - .1 Basis-of-Design Materials:
 - .1 AWS 90 SI+ optimized (PHI cool-temperate certified), Schüco.
 - .2 Acceptable Manufacturer:
 - .1 Aluprof
 - .3 Screens: on windows as indicated.
- .2 Classification rating: to AAMA/WDMA/CSA 101/I.S. 2/A440-11 (NAFS-11) AND CSA A440S1-19 CANADIAN SUPPLEMENT TO NAFS-11.
 - .1 Performance Class: AW.
 - .2 Performance Grade: PG60.
 - .3 Air Leakage: Fixed and A3.
 - .4 Water Penetration Test Pressure: minimum 580 Pa.
 - .5 Design Pressure: 2880 Pa.
 - .6 Forced Entry: F2.
 - .7 Insect Screens: S2.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Performance Requirements: Provide assemblies able to withstand positive and negative pressures normal to the plane of window in accordance with Building Code climatic requirements based on one in 30 year criteria in accordance with CSA A440.
- .2 Provide aluminum framed window systems, including anchorage, capable of withstanding, without failure, the effects of the following:
 - .1 Thermal movements.
 - .2 Movements of supporting structure including, but not limited to, deflection from uniformly distributed and concentrated live loads.
 - .3 Dimensional tolerances of building frame and other adjacent construction.
- .3 Provide drainage from all spaces around insulating glass units, including each horizontal space created by setting blocks.
- .4 Provide baffles or other protection at drainage openings to prevent direct entrance of wind-driven rain.

2.3 MATERIALS

- .1 Aluminum: Aluminum Association (AA) alloy 6063-T5 or 6063-T6 for aluminum extrusions and AA 1100, anodizing quality, for aluminum sheet, minimum 3 mm thickness.
- .2 Fasteners: To ASTM A480/A480M, stainless steel, type 304 selected to prevent galvanic action with the components fastened, of suitable size to sustain imposed loads.

- .3 Gaskets: silicone with dimensional tolerances and durometer hardness and of suitable size and shape to meet the requirements of the specifications and their specific application.
- .4 Supporting angles, plates, bars, rods, and other steel accessories: Mild steel CSA G40.20/G40.21, shop painted with zinc chromate primer, thickness as required to sustain imposed loads and in no case less than 5 mm thick.
- .5 Sealant: Including primer, joint filler, as specified in Section 07 92 00 - Sealants.
- .6 Isolation coating: alkali resistant bituminous paint.
- .7 Thermal separator: Polyvinylchloride, 50 Shore A durometer hardness +5.
- .8 Glazing Tape: Refer to Section 08 80 50 - Glazing.
- .9 Metal air seal/vapour barrier (by window supplier) to be bonded to window frame and extend behind mounting frame. Seal all corners to maintain air seal vapour retarder. Install flexible flashing with continuous metal retaining strip to lap to interior wall assembly.
- .10 Exterior Aluminum Frame: Thermally broken frame to profiles indicated and as required to fulfill performance requirements, nominal thickness 3 mm, suitable alloy and proper temper for extruding and adequate structural characteristics; and suitable for finishing as specified, and as follows:
 - .1 Glazing Throat: to suit thickness of sealed glass unit.
 - .2 Back Frame Profile: 50 mm x depth as indicated on Drawings.
 - .3 Cover: Nominal 50 mm x depth as indicated on Drawings.
 - .4 Basis-of-Design Materials:
 - .1 AWS 90 SI, Schüco.

2.4 GLAZING AND ACCESSORIES

- .1 Triple Pane Insulating Glass Units: as specified in Section 08 80 50 – Glazing.
- .2 Clean sealing surfaces at perimeter of glass and sealing surfaces of rabbets and stop beads before applying splines or gaskets. Use solvents and cleaning agents recommended by manufacturer of sealing materials.
- .3 Install glazing gaskets uniformly with accurately formed corners and bevels. Ensure that proper contact is made with glass and rabbet interfaces.
- .4 Support lites of glass thermal units on leveled setting blocks, 4 or 6 mm minimum, spaced as recommended by glass manufacturer. Provide at least one setting block at quarter points from each corner. For casement windows, locate setting blocks closer to corners as recommended by manufacturer.
- .5 Centre glass thermal units in glazing rabbet to maintain 6 mm minimum clearance between edges of glazing and plastic framing at sill or 4 mm minimum clearance between edges of glazing and plastic framing at sill if glazing bite incorporates a drainage channel with a depth of 3 mm minimum.
- .6 Size glass thermal units to ensure exposed face of spacer is in line with glazing stops.
- .7 Use spacers and shims in accordance with glass manufacturer's recommendations.

2.5 FABRICATION

- .1 Fabricate in accordance with CSA A440 supplemented as follows:
- .2 Fabricate units square and true with maximum tolerance of plus or minus 1.5 mm for units with a diagonal measurement of 1800 mm or less and plus or minus 3 mm for units with a diagonal measurement over 1800 mm.
- .3 Face dimensions detailed are maximum permissible sizes.
- .4 Brace frames to maintain squareness and rigidity during shipment and installation.
- .5 Finish steel clips and reinforcement with 380 g/m² zinc coating to CSA G164.

2.6 ALUMINUM FINISHES

- .1 Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
 - .1 Coloured Anodized Finish: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class I, AA-M12C22A44, colour to match anthracite grey as indicated on Drawings.
 - .2 Unexposed aluminum: Mill finish.
- .2 Isolation Coating
 - .1 Isolate aluminum from the following components, by means of isolation coating:
 - .1 Dissimilar metals except stainless steel, zinc, or white bronze.
 - .2 Concrete, mortar and masonry.
 - .3 Wood.

2.7 HARDWARE

- .1 Hardware: Manufacturer's standard sash locks and aluminum handles to provide security and permit easy operation of units.
- .2 Locks: provide operating sash with spring loading locking device, to provide automatic locking in closed position.
- .3 Provide special keyed opening device for windows normally locked.
- .4 Weatherstripping at Operable Sash: neoprene, thermoplastic rubber or EPDM, flexible at minimum design temperature, and as follows:
 - .1 Profiled to mechanically key into window frame and operable sash.
 - .2 Removable without special tools and without dismantling of sash or frame.
 - .3 Designed to maintain pressure contact against sash through design temperature range.
- .5 Where windows latching devices are located in excess of 1900 mm above floor level:
 - .1 Equip tilt and turn units with roto operators with locking handle.
- .6 Force to operate locking devices shall not exceed 20 N.

2.8 AIR BARRIER AND VAPOUR RETARDER

- .1 Equip window frames with site installed air barrier and vapour retarder material for sealing to building air barrier and vapour retarder as indicated in Section 07 27 13 – Modified Bituminous Air and Vapour Barrier.

Part 3 Execution

3.1 EXAMINATION

- .1 Inspect Work and conditions affecting the Work of this Section. Proceed only after deficiencies have been corrected.
- .2 Ensure that flashings are built-in or integrated with system to divert moisture to exterior.
- .3 Ensure that all anchor blocks or inserts required to receive system are correctly located and installed.
- .4 Ensure that all anchors and setting or installing components provided by this Section for installation are properly located and installed.
- .5 Ensure that building air and vapour retarding membranes can be sealed to window units to maintain system integrity. Coordinate with materials installation specified in Section 07 21 19 – Foam-In-Place Insulation and Section 07 27 19 – Sheet Membrane Air and Vapour Barrier.

3.2 PREPARATION

- .1 Obtain all dimensions from the job site.
- .2 Provide data, dimensions and components, anchors and assemblies to be installed in proper time for installation.

3.3 INSTALLATION

- .1 Erect Work in strict accordance with manufacturer's written instructions.
- .2 Conceal all anchors and fitments. Exposed heads of fasteners not permitted. All joints in exposed work to be flush hairline butt joints.
- .3 Use anchors that will permit sufficient adjustment for accurate alignment. Make allowance for deflection of building structure.
- .4 Build in and provide any supplementary reinforcing and bracing required by assembly loads and deflections.
- .5 Secure Work adequately to structure in a manner not restricting thermal and wind movement.
- .6 Correctly locate and install flashings, deflectors and weep holes to ensure proper drainage of moisture to exterior.
- .7 Maintain alignment with adjacent Work.
- .8 Isolate aluminum surfaces from adjacent dissimilar materials and metals with coatings of bituminous paint.

- .9 Fill shim spaces at perimeter of assembly to maintain continuity of thermal barrier with foam-in-place insulation and seal with materials specified in Section 07 92 00 – Sealants.

3.4 GLAZING INSTALLATION

- .1 Ensure all stops, gaskets, splines, seals etc., are aligned and ready to receive glazing and insulated panels as specified herein.
- .2 Install glazing to approved details and instruction, using material specified in accordance with manufacturer's instructions.
- .3 Glazing stops shall be of a continuous length from corner to corner, and be fitted at corners.
- .4 All preformed tapes or gaskets shall be of a continuous length corner to corner and shall be cut over length to prevent stretching. Joints, splices and corners shall be mitred and sealed.
- .5 Clean all contact surfaces of glazing with solvent and wipe dry. Ensure all glazing channels are clean, true to line, and free of dirt or debris and that weep and drainage vents are open.
- .6 Rest glazing on setting blocks at 1/4 points.
- .7 Install shims at sides to align glass units.
- .8 Apply a full heel bead of non-drying non-skinning sealant to the interior perimeter of each glass unit to provide positive air/vapour seal to warm light of glass.

3.5 SEALANTS

- .1 Caulk and seal full perimeter of windows to building air/vapour retarder to provide and maintain the designed air/vapour/thermal barrier integrity and weather tightness.
- .2 Install sealants and back-up materials in strict accordance with manufacturer's written instruction.

3.6 TESTING

- .1 Test one (1) punched window at 10%, 25%, 50%, and 75% of aluminum work installation completion.
- .2 Field calibrated nozzle testing to AAMA 501.2-03 standard. (Minimum 50 linear feet of joints interfacing with punched window).
- .3 Chamber Air/Water penetration testing to ASTM E783 and E1105 standards, respectively.

3.7 CLEANING

- .1 Remove surplus materials, rubbish, tools, and equipment barriers upon completion of installation.

- .2 Remove all protective surface covering film and wrappings at completion of Work. Clean glass, panels and frames using mild soap or other cleaning agent approved by manufacturer.
- .3 Remove excess glazing or joint sealing materials from exposed surfaces. Clean and polish glass.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Door Hardware
 - .2 Fastenings.
- .2 Related Requirements:
 - .1 Section 08 11 13 – Steel Doors and Frames.
 - .2 Section 08 11 16 – Aluminum Doors and Frames
 - .3 Division 26: Electrical wiring for magnetic strikes, electric releases and electric locks.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American National Standards Institute (ANSI)/Builders Hardware Manufacturers Association (BHMA)
 - .1 BHMA Directory, BHMA 2012 Certified Products Directory.
 - .2 BHMA A156 Standards Set, Complete Set of 39 BHMA Standards (A156 Series)
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 Canadian Standards Association (CSA Group):
 - .1 CSA/ASC B651:23, Accessible Design for the Built Environment, Includes Errata 1 (2023)
 - .4 Canadian Steel Door and Frame Manufacturers' Association (CSDFMA):
 - .1 CSDFMA Canadian Metric Conversion Guide for Steel Doors and Frames.
 - .5 Door and Hardware Institute (DHI):
 - .1 DHI TDH-003-20 Sequence and Format for the Hardware Schedule (2019).
 - .2 DHI TDH-007-20, Installation Guide for Doors and Hardware (2020).
 - .3 DHI TDH-009-20, Recommended Location for Architectural Hardware for Standard Steel Frame – Updated 2020.
 - .4 DHI WDHS-3, Recommended Hardware Locations for Wood Flush Doors, 1996.
 - .6 International Code Council (ICC):
 - .1 ICC A117.1-2017, Accessible and Usable Buildings and Facilities.
 - .7 Underwriters Laboratory of Canada (ULC):
 - .1 ULC S133, Standard Method of Tests for Door Closers Intended for Use with Swinging Doors (CAN/ULC-S133:2016).
 - .2 ULC/ORD-C14(e)-M1985 Guide for Hardware for Fire Doors and Emergency Exits.
 - .3 ULC/ORD-C228-1995 Door Closers and Holders.

- .4 ULC C305-M1972 Panic Hardware.
- .5 ULC 132, Tests for Emergency Exit and Emergency Fire Exit Hardware (CAN/ULC-S132-2016).
- .6 ULC 533, Standard for Egress Door Securing and Releasing Devices (CAN/ULC-S533-15).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's warranty requirements.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
- .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Identify each sample by label indicating applicable specification paragraph number, brand name and number, finish and hardware package number.
 - .2 After approval samples will be returned for incorporation in the Work.
- .3 Hardware List:
 - .1 Submit contract hardware list in accordance with Door Hardware Schedule.
 - .2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.
 - .3 Coordinate Division 28 Security Contractor, Division 26 Electrical Contractor and Division 8 Door and Hardware Contractors to jointly prepare, submit, and obtain certified approval from the Consultant shop drawings for work related to door access control systems prior to undertaking the on-site work. The joint submission will clarify and assign responsibility between these Divisions for labour and materials associated with the supply and installation of electronic and physical components for doors and access control. An individual drawing shall be submitted in Cadd format for each door within the project scope depicting both public and secure side of door and arrangement of access control and security components, conduit, and cabling.
- .4 Keying Schedule:
 - .1 Submit keying schedule prepared by or under the supervision of qualified Architectural Hardware Consultant (AHC), detailing Owner's final keying instructions for locks, including schematic keying diagram and index each key set to unique door designations.

- .5 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for door closers, locksets, door holders electrified hardware and fire exit hardware for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Supply two sets of wrenches for door closers, locksets, and fire exit hardware.

1.7 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Hardware for doors in fire separations and exit doors certified by a Canadian Certification Organization accredited by Standards Council of Canada.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, Shipping, Handling and Unloading:
 - .1 Deliver, store, handle and protect materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Package each item of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- .2 Storage and Protection:
 - .1 Store finishing hardware in locked, clean and dry area.
- .3 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.9 WARRANTY

- .1 Provide written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

- .2 Failures include, but are not limited to, the following:
 - .1 Structural failures including excessive deflection, cracking, or breakage.
 - .2 Faulty operation of operators and door hardware.
 - .3 Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- .3 Warranty Period: From date of Substantial Performance, and as follows:

Hardware Type	Warranty Term
Locks, latches and cylinders	Two years
Closers	25 years
Hinges	One year
Panics	Three years
Miscellaneous	One year
Electrical Hardware:	Five years

Part 2 Products

2.1 HARDWARE -GENERAL

- .1 Use one manufacturer's products only for similar items.

2.2 DOOR HARDWARE

- .1 Door Hardware as per attached schedule.

2.3 AUTOMATIC SWING DOOR OPERATORS

- .1 Coordinate the work of all trades, including glass and glazing, masonry, and electrical requirements covered in manufacturer's details and appropriate sections of the specifications.
- .2 The electrical contractor shall provide 117 volt, 60 cycle, single phase 15 ampere service for one-two operators, 30 ampere service for three-four operators, and as follows:
 - .1 Coordinate with electrical contractor for provision of service to each operator from junction box for multiple operators.
 - .2 Coordinate with electrical contractor shall provide electrical conduit and wiring from specified controls to operators as outlined on manufacturer's drawings.
- .3 Finish hardware supplier shall provide and install surface mounted electro-mechanical swing door operator, consisting of electro-mechanical swinging door operator and electronic control, aluminum header, connecting hardware, and power on/off switch and actuator switches.
- .4 Automatic entrance equipment: comply with BHMA A156.10 or A156.19.
- .5 Aluminium header extrusions: minimum nominal 4 mm wall thickness with finish anodized AA-M12-C22-A31 clear.
- .6 Equipment must operate between -35°C and +55°C in all climate conditions.

- .7 Operator: Electro-mechanical system installed in a header to resist dust, dirt and corrosion; entire operator shall be removable from the header as a unit.
- .8 Bearings: Fully lubricated and sealed to minimize wear and friction.
- .9 Operator shall open the door with a 1/8 HP motor through reduction gears, door arm, and linkage assembly, and as follows:
- .10 Low energy operator:
 - .1 Door opening time: not less than four seconds.
 - .2 Door closing time: not less than four and a half seconds.
- .11 The drive train shall have a positive, constant engagement. The operator shall stop the door in the open position by electrically reducing the motor voltage and stalling against a 90° stop.
- .12 Close the door by spring energy; controlled by employing the motor as a dynamic brake.
- .13 Pre-load closing spring for positive closing action at a low material stress level for long spring life.
- .14 The operator shall function as a manual door closer in the direction of swing with or without electrical power.
- .15 The door forces and speeds generated during power opening, and manual opening in both directions of swing, and spring closing in both directions of swing shall conform to the requirements of BHMA A156.10 or A156.19.
- .16 Verify that no defects or errors are present in completed phases of the work that would result in poor application or installation, or cause latent defects of the automatic door equipment.
- .17 Installation and warranty adjustments shall be performed by authorized distributors factory trained technician.

2.4 FASTENINGS

- .1 Use only fasteners provided by manufacturer. Failure to comply may void warranties and applicable licensed labels.
- .2 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.
- .3 Exposed fastening devices to match finish of hardware.
- .4 Where pull is scheduled on one side of door and push plate on other side, supply fastening devices, and install so pull can be secured through door from reverse side. Install push plate to cover fasteners.
- .5 Use fasteners compatible with material through which they pass.

2.5 KEYING

- .1 Doors, padlocks and cabinet locks to be keyed as directed. Prepare detailed keying schedule in conjunction with Consultant.
- .2 Provide keys in duplicate for every lock in this Contract.
- .3 Stamp keying code numbers on keys and cylinders.

- .4 Provide construction keying.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Furnish metal door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- .3 Furnish manufacturers' instructions for proper installation of each hardware component.

3.2 HARDWARE

- .1 Install hardware to standard hardware location dimensions in accordance with Canadian Metric Conversion Guide for Steel Doors and Frames (Modular Construction) prepared by Canadian Steel Door and Frame Manufacturers' Association.
- .2 Where door stop contacts door pulls, mount stop to strike bottom of pull.
- .3 Install key control cabinet.
- .4 Use only manufacturer's supplied fasteners. Failure to comply may void manufacturer's warranties and applicable licensed labels. Use of quick type fasteners, unless specifically supplied by manufacturer, is unacceptable.
- .5 Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - .1 Standard Steel Doors and Frames: DHI TDH-009 Recommended Locations for Architectural Hardware for Standard Steel Frame.
 - .2 Wood Doors: DHI WDHS.3, Recommended Locations for Architectural Hardware for Wood Flush Doors.
 - .3 Where indicated to comply with accessibility requirements, comply with ICC A117.1 Accessible and Usable Buildings and Facilities.
 - .4 Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- .6 Remove construction cores when directed by Owner, install permanent cores and check operation of locks.

3.3 INSTALLATION: AUTOMATIC SWING DOOR OPERATOR

- .1 Install components as indicated on drawings and as scheduled to manufacturer's recommendations.
- .2 Install door holders to limit doors to opening swing specified.
- .3 Install operators on interior side of exterior entrances.
- .4 Install rubber dampening devices to sound isolate operators from door frames.

- .5 Isolate aluminum surfaces from contact with cementitious materials, using thick coating of bituminous paint. Let paint dry before installation of aluminum component.
- .6 Conceal wiring between activating devices, electric locking system, and operators.
- .7 Coordinate and confirm mechanical systems are balanced to ensure proper closing of doors.

3.4 ADJUSTING

- .1 Adjust door hardware, operators, closures and controls for optimum, smooth operating condition, safety and for weather tight closure.
- .2 Lubricate hardware, operating equipment and other moving parts.
- .3 Adjust door hardware to provide tight fit at contact points with frames.

3.5 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacture's instructions.
- .3 Remove protective material from hardware items where present.
- .4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.6 CLOSEOUT ACTIVITIES

- .1 Demonstration:
 - .1 Keying System Setup and Cabinet:
 - .2 Set up key control system with file key tags, duplicate key tags, numerical index, alphabetical index and key change index, label shields, control book and key receipt cards.
 - .3 Place file keys and duplicate keys in key cabinet on their respective hooks.
 - .4 Lock key cabinet and turn over key to Owner.
- .2 Maintenance Staff Briefing:
 - .1 Brief maintenance staff regarding:
 - .1 Proper care, cleaning, and general maintenance of projects complete hardware.
 - .2 Description, use, handling, and storage of keys.
 - .3 Use, application and storage of wrenches for door closers, locksets, and fire exit hardware.
- .3 Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.7 SCHEDULE

- .1 As per attached Door Hardware Schedule.

END OF SECTION

DOOR HARDWARE

08 71 00

PROJECT:



York Region North Roads Operation Centre

ARCHITECT:



Prepared By: Chad Connors

Date: May 21, 2024

Revised: June 10, 2024

July 12, 2024

Architectural Hardware Finishes

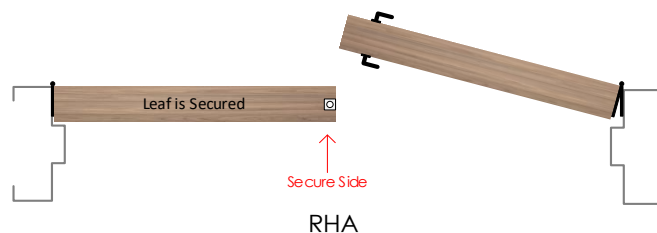
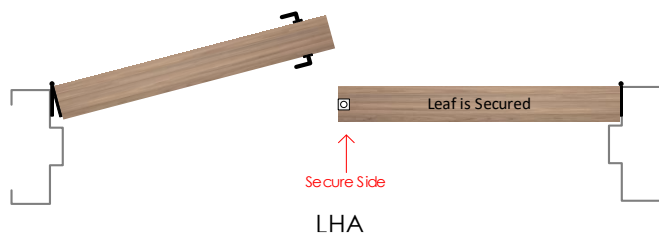
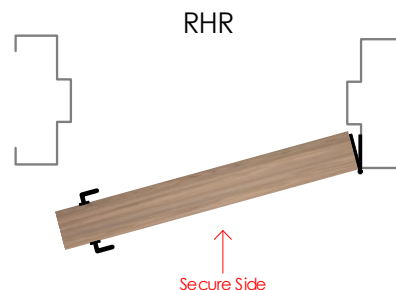
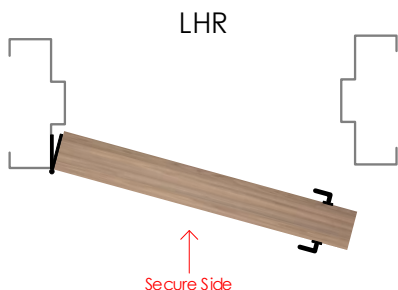
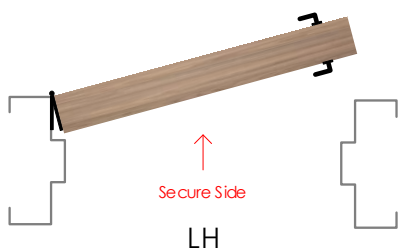
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Clear Anodized				628	689	US28
Satin Nickel	646		619	670		US15
Polished Nickel	645		618	669		US14
Satin Stainless Steel		630				US32D
Polished Stainless Steel		629				US32
Satin Chrome	652		626	702		US26D
Polished Chrome	651		625	672		US26
Satin Brass	633		606	667	678	US4
Polished Brass	632		605	666	677	US5
Satin Bronze	639		612	668	680	US10
Oil Rubbed Bronze	640		613	703	695	US10B
Flat Black / Anodized Black	631		622	671	693	US19

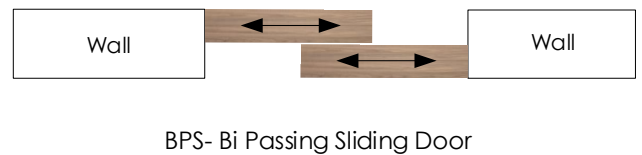
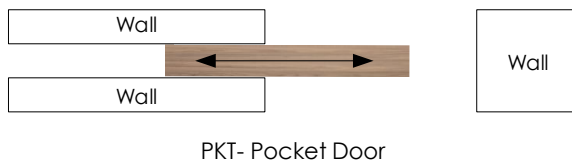
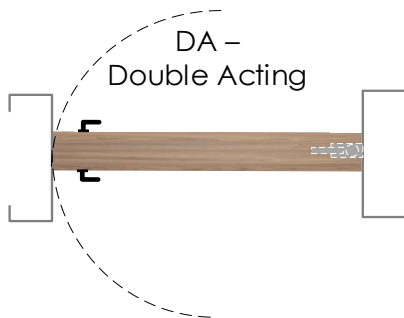
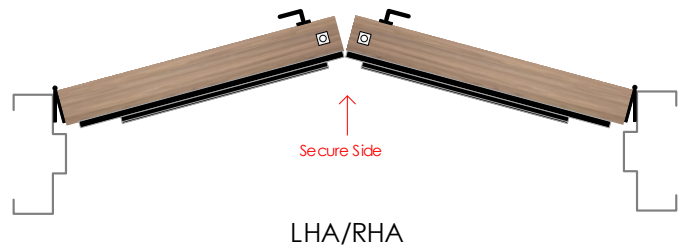
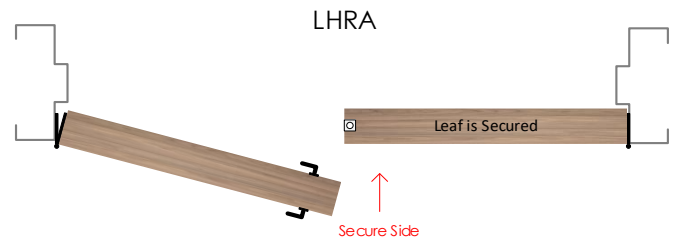
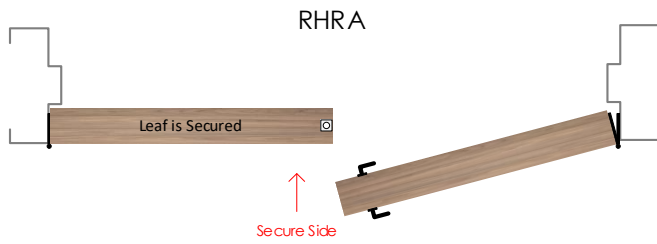
Door Handing's

Abbreviations

RH = Right Hand	RHA = Right Hand Active	SS = Single Slider
LH = Left Hand	LHA = Left Hand Active	BP = Bi-Parting Slider
RHR = Right Hand Reverse	RHA/LHA = Right & Left Hands Active	BF = Bi-Folding Slider
LHR = Left Hand Reverse	RHRA/LHRA = Right & Left Hand Reverse Active	TS = Telescopic Slider
RHRA = Right Hand Reverse Active	DA = Double Acting	PKT = Pocket Slider
LHRA = Left Hand Reverse Active	DE = Double Egress	

NOTE: The handing of a swing door is determined by placing yourself on the secured or keyed side of the door.





Products & Alternatives

NOTE: Only those products / brands listed here are acceptable and should be used to form a bid price. No unsolicited products will be considered. If acceptable alternates are listed here those too can be used to form a bid price provided, they are exactly the same as the specified item. If using an alternate product to form a price it is the bidder's responsibility to ensure that product is identical in every way to the specified item. If no alternates are listed, no alternate products are acceptable.

Product Type	Product#	Manufacturer	Alternate Manufacturer 1	Alternate Manufacturer 2
Butt Hinge	TA386 / TA786	McKinney		
Cont. Hinge	661HD	Best		
Exit Device	PE8000 series	Sargent		
Lockset	8200 series	Sargent		
Electric Strike	1500C / 9600	HES		
Coordinator	F7600	Standard Metal		
Power Transfer	CEPT	Securitron		
Flush Bolt	F65UL	Standard Metal		
Dust Proof Strike	F68	Standard Metal		
Overhead Stop	690 series	Sargent		
Door Closer	351 series	Sargent		
Latch Guard	150	HES		
Push / Pull Set	2012-2 x K11A-5	Standard Metal		
Auto Door Operator	ED100	Dormakaba		
Touchless Actuator	CM-325	Camden		
Touchless Restroom Control Kit	CX-WC16	Camden		
Emergency Call System	CX-WEC10K2	Camden		
Relay	CX-33	Camden		
Kick Plate	K10A	Standard Metal		
Threshold	CT-74	KN Crowder		
Weatherstrip	W-23	KN Crowder		
Door Sweep	W24-S	KN Crowder		
Smoke / Sound Seal	W-66	KN Crowder		

Symbols



- Door has a fire rating and all associated hardware must have a fire label to suit. Must comply with local requirements.



- Door is automatic and is equipped with an auto operator. Door must meet local barrier free codes



- Door has an electrical requirement and requires power to be brought to the appropriate location above the door or to the latch, for either security or barrier free applications. Refer to security & electrical drawings for further information.



- Door requires security card access. Refer to security / electrical drawings for further information.

Abbreviations

Door:

HMD = Hollow Metal Door
IHMD = Insulated Hollow Metal Door
ALD = Aluminum Door
SSD = Stainless Steel Door
ISSD = Insulated Stainless Steel Frame
STL = Steel Door
IC-ALD = Insulated Clad Aluminum Door
SCWD = Solid Core Wood Door
HCWD = Hollow Core Wood Door
FGD = Frameless Glass Door
FRP = Fiberglass Reinforced Plastic Door
OHD = Overhead Door

Frame:

HMF = Hollow Metal Frame
ALF = Aluminum Frame
Cased Open HMF = Cased Open Hollow Metal Frame
SSF = Stainless Steel Frame
STL = Steel Frame
WDF = Wood Frame
Cased Open WDF = Cased Open Wood Frame
Cased Open Drywall = Cased Open Drywall

Fire Ratings:

0 HR – Zero Hour Fire Rating / Smoke Barrier
20 MIN – 20 Minute Fire Rating
¾ HR – 45 Minute Fire rating
1 ½ HR – 90 Minute Fire Rating
2 HR – 120 Minute Fire Rating
3 HR – 180 Minute Fire Rating

Disclaimer

Weblinks:

Weblinks do change from time to time as manufacturers move around their websites, please inform us if you have a none functioning weblink.

HARDWARE SCHEDULE



Heading# 1

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 45	STC Rating	None
Door Material:	IHMD	Frame Material:	HMF	Fire Rating	None

5	Total Openings							
1	Door#	100.1	Location:	Exterior	From	Wash Bay 100	Handing:	RHR
1	Door#	100.2	Location:	Exterior	From	Wash Bay 100	Handing:	LHR
1	Door#	101.7	Location:	Exterior	From	Garage 101	Handing:	RHR
1	Door#	101.8	Location:	Exterior	From	Garage 101	Handing:	RHR
1	Door#	111.3	Location:	Exterior	From	Sign Garage 111	Handing:	LHR

Web Link
Site Verified

By Hardware Supplier					
15	Heavy Weight Butt Hinge	TA386 114 x 102 x NRP	630 / US32D / Satin Stainless Steel	McKinney	<input type="checkbox"/>
5	Storeroom Exit Device	PE8806J x ETL CMK	630 / US32D / Satin Stainless Steel	Sargent	<input type="checkbox"/>
5	Electric Strike	9600	630 / US32D / Satin Stainless Steel	HES	<input type="checkbox"/>
5	Strike Latch Guard	150	626 / US26D / Satin Chrome	HES	<input type="checkbox"/>
5	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent	<input type="checkbox"/>
5	Door Closer	351-P9	689 / US28 / Painted Aluminum	Sargent	<input type="checkbox"/>
5	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal	<input type="checkbox"/>
5	Threshold	CT-74 x 965	719 Milled Aluminum	KN Crowder	<input type="checkbox"/>
5	Weatherstrip	W-23 1/965 x 2/2135	628 / US28 / Clear Anodized	KN Crowder	<input type="checkbox"/>
5	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	<input type="checkbox"/>
By Security Supplier					
5	Card Reader	By Security Provider	Black		<input type="checkbox"/>
5	Request to Exit	By Security Provider			<input type="checkbox"/>
5	Door Contact	By Security Provider			<input type="checkbox"/>
5	Power Supply	By Security Provider			<input type="checkbox"/>

5	Access Controller	By Security Provider				<input type="checkbox"/>
By Owner						
5	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome			<input type="checkbox"/>

Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Exit device push pad allows egress, while the request to exit sensor alerts security of an authorized exit.

.....End of Heading.....



Heading# 2

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	3/4 HR

1	Total Openings							
1	Door#	100.5	Location:	Garage 101	To	Wash Bay 100	Handing:	RH

Web Link

Site Verified

By Hardware Supplier

3	Heavy Weight Butt Hinge	TA386 114 x 102 x NRP	630 / US32D / Satin Stainless Steel	McKinney		<input type="checkbox"/>
1	Classroom Lockset	8237 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
1	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
1	Door Closer	351-P9	689 / US28 / Painted Aluminum	Sargent		<input type="checkbox"/>
1	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5235	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Owner

1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome		<input type="checkbox"/>
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.....End of Heading.....

Heading# 3

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	100A.1	Location:	Wash Bay 100	To	Equipment Room 100A	Handing:	RH

Web Link
Site Verified

By Hardware Supplier					
3	Heavy Weight Butt Hinge	TA386 114 x 102	630 / US32D / Satin Stainless Steel	McKinney	 <input type="checkbox"/>
1	Storeroom Lockset	8204 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent	 <input type="checkbox"/>
1	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent	 <input type="checkbox"/>
1	Door Closer	351-O	689 / US28 / Painted Aluminum	Sargent	 <input type="checkbox"/>
1	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal	 <input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5235	628 / US28 / Clear Anodized	KN Crowder	 <input type="checkbox"/>
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	 <input type="checkbox"/>
By Owner					
1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome		 <input type="checkbox"/>

.....End of Heading.....



Heading#

4

Opening Information					
Opening Type:	Pair	Opening Size:	2 - 915 x 2150 x 44	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	3/4 HR

1	Total Openings							
1	Door#	101.9	Location:	Garage 101	To	Multipurpose Tool / Parts Room 101A	Handing:	RHA

Web Link

Site Verified

By Hardware Supplier

6	Heavy Weight Butt Hinge	TA786 114 x 102	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
1	Power Transfer	CEPT	630 / US32D / Satin Stainless Steel	Securitron		<input type="checkbox"/>
2	Flush Bolt	F65UL	626 / US26D / Satin Chrome	Standard Metal		<input type="checkbox"/>
1	Dust Proof Strike	F68	626 / US26D / Satin Chrome	Standard Metal		<input type="checkbox"/>
1	Storeroom Lockset	8204 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
1	Electric Strike	1500C	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
1	Coordinator / Filler Bar	F7672	600 / USP / Primed	Standard Metal		<input type="checkbox"/>
2	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
2	Door Closer	351-O	689 / US28 / Painted Aluminum	Sargent		<input type="checkbox"/>
2	Kick Plate	K10A 204 x 877	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 6130	Black	KN Crowder		<input type="checkbox"/>
2	Door Sweep	W-24S x 915	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>
1	Astragal	Welded Z Astragal by Door Supplier	600 / USP / Primed			<input type="checkbox"/>

By Security Supplier

1	Card Reader	By Security Provider	Black			<input type="checkbox"/>
1	Request to Exit	By Security Provider				<input type="checkbox"/>
2	Door Contact	By Security Provider				<input type="checkbox"/>
1	Power Supply	By Security Provider				<input type="checkbox"/>
1	Access Controller	By Security Provider				<input type="checkbox"/>

By Owner					
1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome		 

Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Rotate lever for egress, the request to exit sensor alerts security of an authorized exit.

.....End of Heading.....



Heading#

5

Opening Information					
Opening Type:	Single	Opening Size:	1016 x 2135 x 57	STC Rating	None
Door Material:	IC-ALD	Frame Material:	ALF	Fire Rating	None

2	Total Openings							
1	Door#	101A.1	Location:	Exterior	From	Multipurpose Tool / Parts Room 101A	Handing:	RHR
1	Door#	101A.4	Location:	Exterior	From	Multipurpose Tool / Parts Room 101A	Handing:	LHR

Web Link

Site Verified

By Hardware Supplier

2	Continuous Hinge	661HD x 2105	628 / US28 / Clear Anodized	Best		<input type="checkbox"/>
2	Storeroom Exit Device	31-AD-PE8506J x ETL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
2	Electric Strike	9600	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
2	Strike Latch Guard	150	626 / US26D / Satin Chrome	HES		<input type="checkbox"/>
2	Overhead Stop	699S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
2	Door Closer	351-P9	689 / US28 / Painted Aluminum	Sargent		<input type="checkbox"/>
2	Threshold	CT-74 x 1016	719 Milled Aluminum	KN Crowder		<input type="checkbox"/>
2	Weatherstrip	By Door Supplier				<input type="checkbox"/>
2	Door Sweep	By Door Supplier				<input type="checkbox"/>

By Security Supplier

2	Card Reader	By Security Provider	Black			<input type="checkbox"/>
2	Request to Exit	By Security Provider				<input type="checkbox"/>
2	Door Contact	By Security Provider				<input type="checkbox"/>
2	Power Supply	By Security Provider				<input type="checkbox"/>
2	Access Controller	By Security Provider				<input type="checkbox"/>

By Owner

2	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome			<input type="checkbox"/>
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Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Exit device push pad allows manual egress, while the request to exit sensor alerts security of an authorized exit.

.....End of Heading.....



Heading#

6

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 44	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	1 1/2 HR

2	Total Openings							
1	Door#	101A.2	Location:	Multipurpose Tool / Parts Room 101A	From	Corridor	Handing:	RHR

Web Link

Site Verified

By Hardware Supplier

3	Heavy Weight Butt Hinge	TA786 114 x 102 x NRP	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
1	Storeroom Lockset	8204 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
1	Electric Strike	1500C	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
1	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
1	Door Closer	351-O	689 / US28 / Painted Aluminum	Sargent		<input type="checkbox"/>
1	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5235	Black	KN Crowder		<input type="checkbox"/>
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Security Supplier

1	Card Reader	By Security Provider	Black			<input type="checkbox"/>
1	Request to Exit	By Security Provider				<input type="checkbox"/>
1	Door Contact	By Security Provider				<input type="checkbox"/>
1	Power Supply	By Security Provider				<input type="checkbox"/>
1	Access Controller	By Security Provider				<input type="checkbox"/>

By Owner

1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome			<input type="checkbox"/>
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Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Rotate lever for egress, the request to exit sensor alerts security of an authorized exit.

.....End of Heading.....



Heading#

7

Opening Information					
Opening Type:	Single	Opening Size:	1016 x 2135 x 44	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	1 1/2 HR

1	Total Openings							
1	Door#	101A.3	Location:	Multipurpose Tool / Parts Room 101A	From	Corridor	Handing:	LHR

Web Link

Site Verified

By Hardware Supplier

3	Heavy Weight Butt Hinge	TA786 127 x 114 x NRP	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
1	Storeroom Lockset	8204 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
1	Electric Strike	1500C	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
1	Overhead Stop	699S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
1	Door Closer	351-O	689 / US28 / Painted Aluminum	Sargent		<input type="checkbox"/>
1	Kick Plate	K10A 204 x 978	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5286	Black	KN Crowder		<input type="checkbox"/>
1	Door Sweep	W-24S x 1016	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Security Supplier

1	Card Reader	By Security Provider	Black			<input type="checkbox"/>
1	Request to Exit	By Security Provider				<input type="checkbox"/>
1	Door Contact	By Security Provider				<input type="checkbox"/>
1	Power Supply	By Security Provider				<input type="checkbox"/>
1	Access Controller	By Security Provider				<input type="checkbox"/>

By Owner

1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome			<input type="checkbox"/>
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Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Rotate lever for egress, the request to exit sensor alerts security of an authorized exit.

.....End of Heading.....



Heading#

8

Opening Information					
Opening Type:	Single	Opening Size:	1016 x 2135 x 44	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	3/4 HR

2	Total Openings							
1	Door#	103.1	Location:	Corridor	From	Mechanical 103	Handing:	RHR
1	Door#	105.1	Location:	Corridor	From	Electrical 105	Handing:	RHR

Web Link

Site Verified

By Hardware Supplier

6	Heavy Weight Butt Hinge	TA786 127 x 114 x NRP	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
2	Storeroom Lockset	8204 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
2	Overhead Stop	699S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
2	Door Closer	351-P9	689 / US28 / Painted Aluminum	Sargent		<input type="checkbox"/>
2	Kick Plate	K10A 204 x 978	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
2	Smoke / Sound Seal	W-66 x 5286	Black	KN Crowder		<input type="checkbox"/>
2	Door Sweep	W-24S x 1016	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Owner

2	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome		<input type="checkbox"/>
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-----End of Heading-----



Heading#

9

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 44	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

2	Total Openings							
1	Door#	104.1	Location:	Corridor	To	IT 104	Handing:	RH
1	Door#	111.1	Location:	Sign Garage 111	From	Corridor	Handing:	LHR

Web Link

Site Verified

By Hardware Supplier

6	Heavy Weight Butt Hinge	TA786 114 x 102	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
2	Storeroom Lockset	8204 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
2	Electric Strike	1500C	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
2	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
2	Door Closer	351-O	689 / US28 / Painted Aluminum	Sargent		<input type="checkbox"/>
2	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
2	Smoke / Sound Seal	W-66 x 5235	Black	KN Crowder		<input type="checkbox"/>
2	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Security Supplier

2	Card Reader	By Security Provider	Black			<input type="checkbox"/>
2	Request to Exit	By Security Provider				<input type="checkbox"/>
2	Door Contact	By Security Provider				<input type="checkbox"/>
2	Power Supply	By Security Provider				<input type="checkbox"/>
2	Access Controller	By Security Provider				<input type="checkbox"/>

By Owner

2	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome			<input type="checkbox"/>
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Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Rotate lever for egress, the request to exit sensor alerts security of an authorized exit.

-----End of Heading-----



Heading#

10

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	106.1	Location:	Lunch Room 10050	To	Female Change Room 106	Handing:	LH
1	Door#	107.1	Location:	Lunch Room 10050	To	Male Change Room 107	Handing:	LH

Web Link

Site Verified

By Hardware Supplier

6	Heavy Weight Butt Hinge	TA786 114 x 102	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
2	Push / Pull Set	2012-2 x K11A-5	626 / US26D / Satin Chrome	Standard Metal		<input type="checkbox"/>
2	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
2	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
2	Smoke / Sound Seal	W-66 x 5235	Black	KN Crowder		<input type="checkbox"/>
2	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Automatics Supplier

2	Auto Door Operator	ED100-FC SGL-PULL-NH-CL 38-19 (fine cover)	628 / US28 / Clear Anodized	Dormakaba		<input type="checkbox"/>
4	Wave Actuator	CM-325	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>

Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

.....End of Heading.....



Heading#

11

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 44	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	3/4 HR

1	Total Openings							
1	Door#	108.1	Location:	Corridor	To	Janitor 108	Handing:	LH

Web Link

Site Verified

By Hardware Supplier

3	Heavy Weight Butt Hinge	TA786 114 x 101	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
1	Storeroom Lockset	8204 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
1	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
1	Door Closer	351-O	689 / US28 / Painted Aluminum	Sargent		<input type="checkbox"/>
1	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5235	Black	KN Crowder		<input type="checkbox"/>
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Owner

1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome		<input type="checkbox"/>
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.....End of Heading.....



Heading# 12

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 44	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	109.1	Location:	Corridor	To	Universal WC 109	Handing:	RH

Web Link

Site Verified

By Hardware Supplier

3	Heavy Weight Butt Hinge	TA786 114 x 101	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
1	Storeroom Lockset	8204 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
1	Electric Strike	1500C (fail safe)	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
1	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
1	Kick Plate	K10A 203 x 927	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5235	Black	KN Crowder		<input type="checkbox"/>
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Automatics Supplier

1	Auto Door Operator	ED100-FC SGL-PULL-NH-CL 38-19 (fine cover)	628 / US28 / Clear Anodized	Dormakaba		<input type="checkbox"/>
1	Touchless Restroom Control Kit	CX-WC16	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>
1	Emergency Call System	CX-WEC10K2	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>

By Owner

1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome			<input type="checkbox"/>
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Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

Method of Operation:

Ingress: Push door for manual entry. Alternatively, the actuator can engage the auto door operator. Once inside the washroom, the 'wave to lock' actuator locks the outside actuator and engages the electric strike. The outside actuator changes colour to indicate the washroom is in use. In the event of an emergency, push the emergency button and audible / visual signals will activate and the door will unlock for access.

Egress: Rotate lever for manual egress, alternatively the actuator can engage the auto door operator.









-----End of Heading-----

Heading# 13

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	110.1	Location:	Corridor	To	First Aid Room 110	Handing:	LH

Web Link
Site Verified

By Hardware Supplier					
3	Heavy Weight Butt Hinge	TA786 114 x 102	652 / US26D / Satin Chrome	McKinney	 <input type="checkbox"/>
1	Classroom Lockset	8237 LNL CMK	630 / US32D / Satin Stainless Steel	Sargent	 <input type="checkbox"/>
1	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent	 <input type="checkbox"/>
1	Door Closer	351-O	689 / US28 / Painted Aluminum	Sargent	 <input type="checkbox"/>
1	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal	 <input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5235	628 / US28 / Clear Anodized	KN Crowder	 <input type="checkbox"/>
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	 <input type="checkbox"/>
By Owner					
1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome		 <input type="checkbox"/>

.....End of Heading.....

Heading# 14

Opening Information					
Opening Type:	Single	Opening Size:	1016 x 2135 x 45	STC Rating	None
Door Material:	ALD	Frame Material:	ALF	Fire Rating	None

3	Total Openings							
1	Door#	10010.1	Location:	Office 10000	To	Shared Office 10010	Handing:	LH
1	Door#	10020.1	Location:	Office 10000	To	District Manager Office 10020	Handing:	LH
1	Door#	10070.1	Location:	Office 10000	To	Enclave 10070	Handing:	RH

Web Link
Site Verified

By Hardware Supplier					
		Door Hardware by Door Supplier			 <input type="checkbox"/>
By Owner					
2	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome		 <input type="checkbox"/>

Note: Door 10070.1 to be non-locking.

-----End of Heading-----



Heading#

15

Opening Information









Opening Type:	Single	Opening Size:	1016 x 2135 x 57	STC Rating	None
Door Material:	IC-ALD	Frame Material:	ALF	Fire Rating	None

3	Total Openings							
1	Door#	10030.1	Location:	Exterior	From	Main Vestibule 10030	Handing:	RHR
1	Door#	10060.1	Location:	Exterior	From	Vestibule 10060	Handing:	LHR
1	Door#	10080.1	Location:	Exterior	From	Lunch Room 10050	Handing:	RHR



Web Link

Site Verified




By Hardware Supplier

3	Continuous Hinge	661HD x 2105	628 / US28 / Clear Anodized	Best		<input type="checkbox"/>
3	Storeroom Exit Device	31-AD-PE8506J x ETL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
3	Electric Strike	9600	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
3	Strike Latch Guard	150	626 / US26D / Satin Chrome	HES		<input type="checkbox"/>
3	Overhead Stop	699S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
3	Threshold	CT-74 x 1016	719 Milled Aluminum	KN Crowder		<input type="checkbox"/>
3	Weatherstrip	By Door Supplier				<input type="checkbox"/>
3	Door Sweep	By Door Supplier				<input type="checkbox"/>

By Security Supplier

3	Card Reader	By Security Provider	Black			<input type="checkbox"/>
3	Request to Exit	By Security Provider				<input type="checkbox"/>
3	Door Contact	By Security Provider				<input type="checkbox"/>
3	Power Supply	By Security Provider				<input type="checkbox"/>
3	Access Controller	By Security Provider				<input type="checkbox"/>

By Automatics Supplier

3	Auto Door Operator	ED100-FC SGL-PUSH-NH-CL 40-19 (fine cover)	628 / US28 / Clear Anodized	Dormakaba		<input type="checkbox"/>
6	Wave Actuator	CM-325	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>
3	Relay	CX-33		Camden		<input type="checkbox"/>

By Owner

3	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome			<input type="checkbox"/>
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Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress. Alternatively, the actuator can engage the auto door operator after valid card authorization has released the electric strike.

Egress: Exit device push pad allows manual egress, while the request to exit sensor alerts security of an authorized exit. Alternatively, the actuator can engage the auto door operator.

.....End of Heading.....



Heading#

16

Opening Information					
Opening Type:	Single	Opening Size:	1016 x 2135 x 45	STC Rating	None
Door Material:	ALD	Frame Material:	ALF	Fire Rating	None

1	Total Openings							
1	Door#	10030.2	Location:	Main Vestibule 10030	From	Office 10000	Handing:	RHR

Web Link

Site Verified

By Hardware Supplier

1	Continuous Hinge	661HD x 2105	628 / US28 / Clear Anodized	Best		<input type="checkbox"/>
1	Storeroom Exit Device	AD-PE8506J x ETL CMK	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
1	Electric Strike	9600	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
1	Overhead Stop	699S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>

By Security Supplier

1	Card Reader	By Security Provider	Black			<input type="checkbox"/>
1	Request to Exit	By Security Provider				<input type="checkbox"/>
1	Door Contact	By Security Provider				<input type="checkbox"/>
1	Power Supply	By Security Provider				<input type="checkbox"/>
1	Access Controller	By Security Provider				<input type="checkbox"/>

By Automatics Supplier

1	Auto Door Operator	ED100-FC SGL-PUSH-NH-CL 40-19 (fine cover)	628 / US28 / Clear Anodized	Dormakaba		<input type="checkbox"/>
2	Wave Actuator	CM-325	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>
1	Relay	CX-33		Camden		<input type="checkbox"/>

By Owner

1	Medeco M3 Logic Cylinder	By York Region Corporate Security	626 / US26D / Satin Chrome			<input type="checkbox"/>
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Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

Method of Operation:

SPYDER SC

Ingress: Valid card authorization releases the electric strike allowing ingress. Alternatively, the actuator can engage the auto door operator after valid card authorization has released the electric strike.

Egress: Exit device push pad allows manual egress, while the request to exit sensor alerts security of an authorized exit. Alternatively, the actuator can engage the auto door operator.

.....End of Heading.....

Heading# 17

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	10040.1	Location:	Corridor	To	Meeting Room10040	Handing:	LH

Web Link

Site Verified

By Hardware Supplier					
3	Heavy Weight Butt Hinge	TA386 114 x 102	630 / US32D / Satin Stainless Steel	McKinney	 <input type="checkbox"/>
1	Passage Set	8215 LNL	630 / US32D / Satin Stainless Steel	Sargent	 <input type="checkbox"/>
1	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal	 <input type="checkbox"/>
1	Wall Stop	S120	626 / US26D / Satin Chrome	Standard Metal	 <input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5235	628 / US28 / Clear Anodized	KN Crowder	 <input type="checkbox"/>
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	 <input type="checkbox"/>

.....End of Heading.....



Heading#

18

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	10090.1	Location:	Corridor	From	Lunch Room 10050	Handing:	RHR

Web Link

Site Verified

By Hardware Supplier

3	Heavy Weight Butt Hinge	TA786 114 x 102	652 / US26D / Satin Chrome	McKinney		<input type="checkbox"/>
1	Push / Pull Set	2012-2 x K11A-5	626 / US26D / Satin Chrome	Standard Metal		<input type="checkbox"/>
1	Overhead Stop	698S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
1	Kick Plate	K10A 204 x 927	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5235	Black	KN Crowder		<input type="checkbox"/>
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>

By Automatics Supplier

1	Auto Door Operator	ED100-FC SGL-PUSH-NH-CL 38-19 (fine cover)	628 / US28 / Clear Anodized	Dormakaba		<input type="checkbox"/>
2	Wave Actuator	CM-325	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>

Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

.....End of Heading.....



Heading#

19

Opening Information					
Opening Type:	Single	Opening Size:	1016 x 2135 x 45	STC Rating	None
Door Material:	ALD	Frame Material:	ALF	Fire Rating	None

2	Total Openings							
1	Door#	10060.2	Location:	Vestibule 10060	From	Office 10000	Handing:	LHR
1	Door#	10080.2	Location:	Vestibule 10080	From	Lunch Room 10050	Handing:	RHR

Web Link

Site Verified

By Hardware Supplier

2	Continuous Hinge	661HD x 2105	628 / US28 / Clear Anodized	Best		<input type="checkbox"/>
2	Passage Exit Device	AD-PE8515J x ETL	630 / US32D / Satin Stainless Steel	Sargent		<input type="checkbox"/>
2	Electric Strike	9600	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
2	Overhead Stop	699S	626 / US26D / Satin Chrome	Sargent		<input type="checkbox"/>
2	Door Contact	DPS-M	Black	Securitron		<input type="checkbox"/>

By Automatics Supplier

2	Auto Door Operator	ED100-FC SGL-PUSH-NH-CL 40-19 (fine cover)	628 / US28 / Clear Anodized	Dormakaba		<input type="checkbox"/>
4	Wave Actuator	CM-325	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>
2	Relay	CX-33		Camden		<input type="checkbox"/>

Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

-----End of Heading-----

End of Door Hardware Schedule

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Tempered safety glass.
 - .2 Laminated safety glass.
 - .3 Spandrel glass.
 - .4 Fire rated glass.
 - .5 Low emissivity (low e) glass.
 - .6 Sealed insulating glass.
 - .7 Accessories.: Sealant, setting blocks, spacer shims, Glazing tape, glazing compound for fire rated glazing materials, glazing splines, glazing clips, Screws, bolts, fasteners, Lock-strip gaskets and accessories:
- .2 Related Requirements:
 - .1 Section 07 92 00 – Sealants
 - .2 Section 08 11 13 – Steel Doors and Frames
 - .3 Section 08 11 16 – Aluminum Doors and Frames
 - .4 Section 08 44 13 – Glazed Aluminum Curtain Walls
 - .5 Section 08 50 13 – Aluminum Windows
 - .6 Section 08 87 53 – Glazing Film

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American National Standards Institute (ANSI):
 - .1 ANSI Z97.1-2015 (R2020), Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C542-05 (2017), Specification for Lock-Strip Gaskets.
 - .2 ASTM C1172-19, Standard Specification for Laminated Architectural Flat Glass.
 - .3 ASTM D790-17, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - .4 ASTM D2240-15(2021), Standard Test Method for Rubber Property - Durometer Hardness.
 - .5 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .6 ASTM E330/E330M-14(2021), Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - .7 ASTM F1233-08(2019), Standard Test Method for Security Glazing Materials and Systems.
 - .3 Canada Green Building Council (CaGBC):

- .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-12.1-2017, Safety Glazing.
 - .2 CAN/CGSB-12.2-M91(R2017), Flat, Clear Sheet Glass.
 - .3 CAN/CGSB-12.3-M91(R2017), Flat, Clear Float Glass.
 - .4 CAN/CGSB-12.4-M91(R2017), Heat Absorbing Glass.
 - .5 CAN/CGSB-12.8-2017, Insulating Glass Units.
 - .6 CAN/CGSB-12.9-M91, Spandrel Glass. (Withdrawn)
 - .7 CAN/CGSB-12.10-M76, Glass, Light and Heat Reflecting. (Withdrawn)
 - .8 CAN/CGSB 12.20-M89, Structural Design of Glass for Buildings. (Withdrawn)
- .5 Canadian Standards Association (CSA Group):
 - .1 CSA A440.2:22/A440.3:22, Fenestration energy performance/User guide to CSA A440.2-19, Fenestration energy performance.
 - .2 CSA Certification Program for Windows, Doors, and Skylights.
- .6 Fenestration and Glazing Industry Alliance (FGIA):
- .7 Glazing Association of North America (GANA):
 - .1 GANA Glazing Manual – IYOG Edition 2022.
- .8 Insulating Glass Manufacturers Alliance (IGMA).
- .9 National Fire Protection Association (NFPA):
 - .1 NFPA (Fire) 80, Standard for Fire Doors and Other Opening Protectives, 2022 Edition.
 - .2 NFPA (Fire) 252, Fire Tests of Door Assemblies, 2022 Edition.
 - .3 NFPA (Fire) 257, Fire Test for Window and Glass Block Assemblies, 2022 Edition.
- .10 Underwriters Laboratories ECOLOGO Certification Program (UL):
 - .1 UL 2761, Sealants and Caulking Compounds (formerly CCD-045) 2011.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meetings: one week prior to beginning work of this Section.
 - .1 Verify project requirements.
 - .2 Review installation conditions.
 - .3 Co-ordinate with other building subtrades.
 - .4 Review manufacturer's instructions and warranty requirements.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.

- .2 Submit product data that provides performance data of IGU assemblies, including CoG U-value, SHGC, STC etc.
- .3 Submit electronic copy of WHMIS SDS - Safety Data Sheets. Indicate VOC's:
 - .1 For glazing sealant materials during application and curing.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Delegated Design: Submit shop drawings, signed and sealed by the delegated design engineer, detailing fabrication and assembly of glazed aluminum curtain wall systems clearly indicating all construction details including; but not limited to, the following:
 - .1 Fully dimensioned layouts for positioning of secondary support members and anchorage of tie-back devices to structures;
 - .2 Large scale details of members and materials, of brackets and anchorage devices and of connection and jointing details;
 - .3 Include thermal values and weathertightness rating data.
 - .4 Fully dimensioned layouts for positioning of brackets and anchorage devices to structures;
 - .5 Dimensions, gauges, thicknesses;
 - .6 Type, size and spacing of fastening devices;
 - .7 Glazing details;
 - .8 Air/vapour barrier details, acoustic control details, aluminum alloy and temper designations, metal finishing specifications and other pertinent data and information;
 - .9 Internal drainage;
 - .10 Show details of perimeter and interface connecting work of this section with work of adjacent sections.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit 300 mm x 300 mm size of each glazing type. Consultant reserves the right to change type and colour of glass after review of submitted samples.
- .4 Certificates: Submit proof of FGIA (formerly IGMAC) certification for insulating glass units, including component codes.
- .5 Manufacturer's Instructions: Submit manufacturer's installation instructions.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data including cleaning instructions for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Manufacturer's technical recommendations:

- .1 Perform glazing work in accordance with written recommendations from the glass manufacturer or glass fabricator.
- .2 Certify glass compatibility with glazing materials (i.e. insulating glass sealants, structural sealants and silicones, gaskets, setting blocks, etc.).
- .3 Designs to be analyzed for thermal stress and wind/snow loads.
- .4 Provide shop inspection for glass.
- .2 Window fabricator qualifications: shall be a member in good standing of the Ontario Glass And Metal Association (OGMA) and adhere to the rules and regulations for workmanship, training and personnel as set forth by the association.
- .3 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
 - .1 Provide testing and analysis of glass under provisions of Section 01 45 00 - Quality Control.
 - .2 Provide shop inspection and testing for glass.
- .4 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .5 Glass panels in doors, lites and windows shall have a permanent label located in the lower right-hand side of the glass unit in accordance with CAN/CGSB-12.1
- .6 Glazing for Fire-Rated Door and Window Assemblies: Glass tested per NFPA (Fire) 252 and NFPA (Fire) 257, as applicable, for assemblies complying with NFPA 80 and listed and labelled per requirements of authorities having jurisdiction.
- .7 Tempered glass shall be heat soaked in accordance with EN 14179-1 and EN 14179-2 for the following applications: railings, balustrades, exposed overhead locations, exterior exposures one or more storeys above pedestrian areas, heavy tempered glass, fabricated glass with cut outs, notches, holes or countersinks. Provide manufacturer's factory label on each unit confirming tempered glass has been heat soaked.

1.7 SITE CONDITIONS

- .1 Install glazing when ambient temperature is 4 degrees C minimum. Maintain ventilated environment for 24 hours after application.
- .2 Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Section 01 61 00 - Common Product Requirements.
- .2 Coordinate Work of this Section with Work of other Sections so as not to delay construction schedule.
- .3 Deliver, store and handle all components to prevent damage.
- .4 Provide secure, temporary, dry enclosed structure for storage of glass units.
- .5 All individual cases of glass to be secured, blocked and braced to prevent falls.

- .6 Replace any broken, scratched, or damaged materials at Contractor's expense.
- .7 Protect all exposed surfaces from stain, discolouration, corrosion, and other abuse.
- .8 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.9 WARRANTY

- .1 Provide manufacturers guarantee for the following types of glass listed, against defects in materials and workmanship for the period indicated, commencing from the date of Substantial Performance of Work.
 - .1 Sealed Glass Units: Replace units that exhibit failure of hermetic seal under normal use evidenced by the obstruction of vision by dust, moisture, or film on interior surface of glass: Ten Years.
 - .2 Coated- Glass: Replace units that display peeling, cracking, and other deterioration in metallic coating under normal use: Ten Years.
 - .3 Laminated Glass: Replace units that display edge separation, delamination, and blemishes exceeding those allowed by ASTM C1172: 5 Years.
 - .4 Provide warranty for glazing to include in maintenance manuals as specified in Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 MANUFACTURERS

- .1 Basis of Design products are named in this Section; additional manufacturers offering similar setting systems may be incorporated into the work provided they meet the performance requirements established by the named products.
- .2 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Vision Glass:
 - .1 AGC Flat Glass North America (formerly AFG or AFGD).
 - .2 AHC Glass (formerly Visteon).
 - .3 Cardinal Glass Industries Inc.
 - .4 Guardian Glass.
 - .5 Hartung Glass Industries
 - .6 Pilkington Glass of Canada.
 - .7 Prelco Inc.
 - .8 Vitro Architectural Glass (formerly PPG Industries).
 - .9 Schott Glass AG.

2.2 PERFORMANCE / DESIGN CRITERIA

- .1 Provide continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:

- .1 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.
- .2 Size glass to withstand wind loads, dead loads and positive and negative live loads as measured in accordance with ANSI/ASTM E330/E330M and in accordance with CAN/CGSB-12.20.
- .3 Limit center-of-glass deflection to the smallest of:
 - .1 Displacement associated with the structural capacity of the glazing unit.
 - .2 $L/100$, where L is the shortest side dimension of the unit measured in inches.
 - .3 Or 19 mm.

2.3 MATERIALS

- .1 Tempered Safety Glass: to CAN/CGSB-12.1, transparent, 6 mm minimum thickness.
 - .1 Type: 2-tempered.
 - .2 Class: B-float.
 - .3 Category: II – 540 J impact resistance.
- .2 Laminated Safety Glass: to CAN/CGSB-12.1, transparent, thickness as directed.
 - .1 Type: 1-laminated, tempered.
 - .2 Class: B-float.
 - .3 Category: II – 540 J impact resistance.
 - .4 Laminating Film:
 - .1 Material: Polyvinyl Butyral (PVB)
 - .2 Minimum film thickness: 1.14 mm
 - .3 Colour: Clear as indicated on Drawings.
- .3 Spandrel glass: to CAN/CGSB-12.9, minimum 6 mm thick.
 - .1 Type: 1-Tempered
 - .2 Class: A-Float
 - .3 Style: 3-Organic – applied silicone elastomeric coated.
 - .4 Form: I-Insulating glass unit
 - .5 Colour: as indicated on Drawings.
 - .6 Acceptable Materials:
 - .1 Opaci-Coat 300, ICD.
 - .2 Span-Kote.
- .4 Fire Rated Glass: Comprised of multiple layers of tempered glass ceramic, laminated with transparent intumescent materials, providing distortion free viewing through pane and as follows:
 - .1 Thickness: As required by manufacturer to meet structural requirements for performance range specified.
 - .2 Impact Safety Rating: Category I, 665 J/m in accordance with ANSI Z97.1.
 - .3 Temperature Rise Rating: Not required.

- .4 Fire Rating: As indicated in door and frame schedule.
- .5 Labelled: Permanent logo listing name of product, manufacturer, testing laboratory, fire rating period and safety requirements.
- .6 Acceptable Manufacturers:
 - .1 InterEdge Technologies.
 - .2 SAFTI Fire and Safety Rated Glass.
 - .3 Saint-Gobain Glass Solutions.
 - .4 Technical Glass Products.
- .5 Frit Glass Coating: In accordance with CAN/CGSB-12.13 and as follows:
 - .1 Tempered glass unit with Duranar DTG 2-coat system, on second surface, pattern and colour as indicated on Drawings with high opacity white frit factory applied oven baked Fluoropolymer finish as supplied by PPG Canada Inc.
 - .2 Acceptable Applicators:
 - .1 Durapaints Inc.
 - .2 Goldray Corporation.
 - .3 Garibaldi Glass Industries Inc.
- .6 Low Emissivity (Low E) Glass: to CAN/CGSB-12.10, thickness as indicated and as follows:
 - .1 Metallic coating: soft, sputtered.
 - .2 Basis-of-Design Materials:
 - .1 Planitherm XN II, Saint-Gobain Glass.

2.4 MATERIALS: SEALED INSULATING GLASS

- .1 Drawings and Specifications for insulated glass units are intended to show design concept, configuration, components and arrangement; they are not intended to identify nor solve completely the problems from thermal stress. Insulating glass units shall withstand thermal stresses created by shadowing of exterior components or assembly and elevated interstitial space temperatures. Glass thermal stress analysis shall be provided by Contractor.
- .2 Triple Pane Insulating Glass Units: meet or exceed requirements of CAN/CGSB-12.8. Units shall be certified by the Fenestration and Glazing Industry Alliance (FGIA), (formerly Insulated Glass Manufacturers Alliance (IGMA)). Overall unit thickness shall be 54 mm using 6 mm glass thickness for individual panes. Use two stage seal method of manufacture, as follows:
 - .1 Primary Seal: polyisobutylene sealing compound between glass and metal spacer/separator, super spacer bar or TDSE Intercept.
 - .2 Secondary Seal: silicone base sealant, completely filling gap between the two lites of glass at the edge up to the spacer/separator and primary seal.
- .3 Spacer/separator to provide continuous vapour barrier between interior of sealed unit and secondary seal.
- .4 Clear Float Glass: to CAN/CGSB-12.3, glazing quality, for inner lite and exterior lite above 2133 mm a.f.f. and as indicated on Drawings.

- .5 Clear Safety Glass: to CAN/CGSB-12.1 for outer lite below 2133 mm above floor finish, as indicated on Drawings and as follows:
 - .1 Type: Two-tempered.
 - .2 Class: B-float.
- .6 Provide low-E coating on No.2 and No.5 surfaces of triple glazed insulating glass units.
- .7 Gas: 95% Argon filled.
- .8 Other Glazing Accessories: setting blocks to CAN/CSA-A440.

2.5 ACCESSORIES

- .1 Sealant: in accordance with Section 07 92 00 – Sealants.
- .2 Setting blocks: Neoprene, EPDM, or Silicone, 80-90 Shore A durometer hardness to ASTM D2240, to suit glazing method, glass light weight and area.
- .3 Spacer shims: Neoprene or Silicone, 50-60 Shore A durometer hardness to ASTM D2240, 75 mm long x one half height of glazing stop x thickness to suit application. Self adhesive on one face.
- .4 Glazing tape:
 - .1 Preformed butyl compound with integral resilient tube spacing device, ten-fifteen Shore A durometer hardness to ASTM D2240; coiled on release paper; black colour.
 - .2 Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume 2%, designed for compression of 25%, to effect an air and vapour seal.
- .5 Glazing compound for fire rated glazing materials:
 - .1 Glazing Tape: Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2%, designed for compression of 25% to effect an air and vapour seal.
 - .2 Silicone Sealant: One-part neutral curing silicone, medium modulus sealant, Type S; Grade NS; Class 25 with additional movement capability of 50% in both extension and compression (total 100%); Use (Exposure) NT; Uses (Substrates) G, A, and O as applicable.
 - .1 Acceptable materials:
 - .1 Dow Corning 795, Dow Corning Corp.
 - .2 Silglaze-II 2800, General Electric Co.
 - .3 Spectrum 2, Tremco Inc.
 - .3 Setting Blocks: Hardwood, glass width by 100 mm x 5 mm thick.
 - .4 Spacers: Neoprene or other resilient blocks of 40 to 50 Shore A durometer hardness, adhesive-backed on one face only, tested for compatibility with specified glazing compound.
 - .5 Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.
- .6 Glazing splines: resilient polyvinyl chloride or silicone, extruded shape to suit glazing channel retaining slot, black colour.

- .7 Glazing clips: manufacturer's standard type.
- .8 Screws, bolts and fasteners: Type 304 stainless steel.
- .9 Glass presence markers: easily removable, non-residue depositing.
- .10 Lock-strip gaskets: to ASTM C542.

2.6 FABRICATION

- .1 Verify glazing dimensions on Site.
- .2 Clearly label each glass light with maker's name, weight, quality, type and certification number. Do not remove labels until after work has been reviewed by Engineer.
- .3 Accurately size glass to fit openings allowing the clearances shown on the following tables:

.1 Minimum glass clearances:

	Thickness	Edge Clearance	Face Clearance
(1)	2 mm	3 mm (a)	1.5 mm
(2)	3 mm	3 mm (a)	3 mm
(3)	4 mm	3 mm (a)	3 mm
(4)	5 mm	3 mm (a)	3 mm
(5)	6 mm	5 mm	3 mm
(6)	6 mm	6 mm	3 mm
(7)	over 6 mm	6 mm or 3/4 times the glass thickness, whichever is greater	

(a) where any dimension of glass exceeds 760 mm increase minimum edge clearance by 1.5 mm.

- .4 Bite of glass edge on stop:
 - .1 Up to 1270 mm united size: 6 mm minimum.
 - .2 1270 mm to 2540 mm united size: 10 mm minimum.
 - .3 Over 2540 mm united size: 13 mm minimum.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that openings for glazing are correctly sized and within tolerance.
- .2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

3.2 PREPARATION

- .1 Ensure all wood backing rebates and stops properly primed and finished, coordinate with Section 06 40 00 – Architectural Woodwork.
- .2 Ensure all glazing rebates smooth and true, free of projections nails, screws, fastenings properly set to prevent contact with glass.

- .3 Ensure all stops, splines, glazing accessories provided are accurately cut to length and proper size and type for specific glazing.
- .4 Clean contact surfaces with solvent and wipe dry.
- .5 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .6 Prime surfaces scheduled to receive sealant.

3.3 GENERAL INSTALLATION

- .1 Install work in accordance with the Quality Management provisions specified in this section and manufacturer's written instructions.
- .2 Size glass to Code requirements and verify glass for openings are correctly sized and are within allowable tolerances. Install glass with full contact and adhesion at perimeter. Maintain edge clearance recommended by glass manufacturer.
- .3 Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .4 Remove and replace glazing stops in original locations, using original fasteners, securely set and undamaged.
- .5 Use setting blocks, spacers and, for wet glazing, shims, as required to properly support the glass, centred in place in the glazing space independent of the glazing materials and to uniformly distribute its load.
- .6 Use a minimum of two setting blocks, located at the quarter points. Locate spacers at jamb edges of glass, uniformly spaced at 600 mm o.c. maximum, and 300 mm maximum from top to bottom.
- .7 Handle and install heat absorbing glass in accordance with manufacturer's directions.
- .8 Prevent nicks, abrasion and other damage likely to develop stress on edges.
- .9 Set glass properly centred with uniform bite and face and edge clearance, free from twist, warp or other distortion likely to develop stress.
- .10 Trim tape protruding more than 2 mm above stop.
- .11 Leave labels on glass until it has been set and inspected and accepted. Leave glass whole and without cracks, scratches or other defects and with settings in perfect condition at completion. Remove rejected, broken or damaged glass due to defective materials or improper setting and replace with acceptable materials. Units producing distorted vision shall be rejected and replaced at no cost to the Owner.
- .12 Remove, dispose of, and replace broken, cut and abraded glass.
- .13 Install glass presence markers in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

3.4 EXTERIOR

- .1 Arrange for installed glass to have labels facing the interior. Ensure that sufficient space is left within the glazing space to allow thermal movement of glass without imposing stress on the glass.

- .2 Install curtain wall glazing to Section 08 44 13 - Glazed Aluminum Curtain Walls, and as follows:
 - .1 Perform work in accordance with GANA Glazing Manual.
 - .2 Cut glazing spline to length; install on glazing light. Seal corners by butting spline and sealing junctions with sealant.
 - .3 Place setting blocks at one third points, with edge block maximum 150 mm from corners.
 - .4 Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
 - .5 Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
 - .6 Trim protruding tape edge.
- .3 Install pressed steel frame and hollow steel door glazing as follows:
 - .1 Perform work in accordance GANA Glazing Manual.
 - .2 Cut glazing tape to length and set against permanent stops, 6 mm below sight line. Seal corners by butting tape and dabbing with sealant.
 - .3 Apply heel bead of sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete continuity of air and vapour seal.
 - .4 Place setting blocks at one third points, with edge block maximum 150 mm from corners.
 - .5 Rest glazing on setting blocks and push against tape and heel head of sealant with sufficient pressure to attain full contact at perimeter of light or glass unit.
 - .6 Install removable stops with spacer strips inserted between glazing and applied stops, 6 mm below sight line.
 - .7 Fill gap between glazing and stop with sealant to depth equal to bite of frame on glazing, maximum 9 mm below sight line.
 - .8 Apply cap head of sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.5 INTERIOR

- .1 Glazing materials and installation to meet Ontario Building Code requirements for fire rated separations where required; refer to drawings for locations of fire-rated separations.
- .2 Arrange for installed glass to have labels facing the interior. Ensure that sufficient space is left within the glazing space to allow thermal movement of glass without imposing stress on the glass.
- .3 Provide insulating glass units in sound attenuated partitions.
- .4 Unless otherwise specified or indicated, interior glazing shall be dry glazing.
- .5 Install extruded resilient channel gasket around entire perimeter of glass. Make tight butt joint at corners of lights. Place setting blocks at sill and spacers at both jambs as required to centre the unit in the frame. Place the unit into the frames and apply the stops against the gaskets. Tighten the screws or clips to obtain positive uniform pressure avoiding excessive pressure.

- .6 Ensure rattle free cushioning.
- .7 Install spacer shims at 600 mm o.c. to centre balustrade glazing in rebate space. Install shims 6 mm below sight line. Apply cap bead of glazing sealant to uniform line, flush with rebate sightline and tool to smooth appearance, both sides.
- .8 Install two-sided frameless structural butt joint glass assemblies where indicated using tempered safety glass with slightly wet grinded kerf and polished butt-joint edges for aesthetics. Ensure precise levelling of sill member achieved and provision made at head to accommodate deflection of structure. For glazing at head and sill use wet, dry, or wet/dry glazing systems. Position glazing so vertical edges spaced slightly apart and seal with clear, colourless, or coloured silicone sealant. At framing or rebate locations, provide silicone sealant in clear, colourless, or colour selected by Consultant. Ensure sealant flush with and does not protrude above glazing stop or rebate.
- .9 Install wet glazing materials to obtain complete contact and adhesion over the full bite area of the unit and to be free from gaps, air bubbles and embedded foreign matter. Use primers where recommended by the glazing material manufacturer. Use sufficient bedding compound so that when glass is pressed into place, excess compound is forced well out around entire margin. Use shims to ensure maintenance of uniform face clearance. Where required on both sides of a unit, make shims coincident.
- .10 Install glazing tape to ensure complete contact and adhesion over the full bite area of the unit. Make joints only at corners of the unit. Use preshimmed glazing tape at glass installed with pressure plates. Fit tape accurately with tight joints, free from tension, gaps and cracks. After installation of the glass, the glazing tape shall not extend more than 3 mm above the line of the fixed stop. Remove and reglaze units where the glazing tape exceeds this tolerance.
- .11 Gun in a heel bead of glazing compound ensuring a continuous seal between glazed element and frame.
- .12 Finish gunned bead surfaces uniformly smooth and straight, to slope away from glass.

3.6 INSTALLATION - FIRE RATED GLASS

- .1 Comply with GANA standards and instructions of manufacturers of glass, glazing sealants, and glazing compounds.
- .2 Protect glass from edge damage during handling and installation. Inspect glass during installation and discard pieces with edge damage that could affect glass performance.
- .3 Place hardwood setting blocks located at quarter points of glass with edge block no more than 150 mm from corners.
- .4 Glaze vertically into labelled fire rated steel frames or partition walls with same fire rating as glass and push against tape for full contact at perimeter of pane or unit.
- .5 Place glazing tape on free perimeter of glazing in same manner described above.
- .6 Do not remove protective edge tape.
- .7 Install removable stop and secure without displacement of tape.

- .8 Do not pressure glaze.
- .9 Knife trim protruding tape.
- .10 Provide minimum 5 mm edge clearance.
- .11 Install vision panels in fire rated doors to requirements of NFPA (Fire) 80.
- .12 Install so that appropriate fire rating labels and markings remain permanently visible.

3.7 CLEANING

- .1 At completion of Work, remove and dispose of all protections, clean down all exposed aluminum surfaces, replace all damaged members, including members with damaged finishes.
- .2 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .3 Remove traces of primer, caulking.
- .4 Remove glazing materials from finish surfaces.
- .5 Remove labels after work is complete.
- .6 Clean glass using approved non-abrasive cleaner in accordance with manufacture's instructions.
- .7 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.8 PROTECTION OF FINISHED WORK

- .1 After installation, mark light with an "X" by using removable plastic tape or paste. Do not mark heat absorbing or reflective glass units.

3.9 SCHEDULE

- .1 Aluminum Windows:
 - .1 GL-2 (54 mm):
 - .1 Exterior Lite: 6 mm Planiclear Tempered: Planitherm XN II (#2)
 - .2 Airspace: 18 mm Black Swisspacer Ultimate, with 90% Argon gas
 - .3 Middle Lite: 6 mm Parsol Grey Tempered
 - .4 Airspace: 18 mm Black Swisspacer Ultimate, with 90% Argon gas
 - .5 Interior Lite: 6 mm Planiclear Tempered: Planitherm XN II (#5).
 - .2 Spandrel: triple glazed same as above, grey back painted #5 glass, with mineral fibre in aluminum backpan.
- .2 Aluminum Doors:
 - .1 GL-1 (61 mm):
 - .1 Exterior Lite: 6 mm Planiclear Laminated Tempered: 4Bird Etch (4BE01) Planitherm XN II (#1) /PVB/ Planiclear Tempered: Planitherm XN II (#4).
 - .2 Airspace: 18 mm Black Swisspacer Ultimate, with 90% Argon gas
 - .3 Middle Lite: 6 mm Parsol Grey Tempered

- .4 Airspace: 18 mm Black Swisspacer Ultimate, with 90% Argon gas
- .5 Interior Lite: 6 mm Planiclear Tempered: Planitherm XN II (#7)
- .3 Hollow Steel Doors and Borrowed Lights:
 - .1 Interior Doors:
 - .1 Single pane 6 mm tempered safety glazing.
 - .2 Single 6 mm clear fire rated glazed light, as indicated.
 - .4 Borrowed Light in Pressed Steel Frames:
 - .1 Single 6 mm clear tempered safety glazed units.
 - .2 Single 6 mm clear fire rated glazed light, as indicated.
 - .5 Other glass types as indicated on Drawings.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Translucent glazing film.
 - .2 Glazing film accessories.
- .2 Related Requirements:
 - .1 Section 08 80 50 – Glazing
 - .2 Section 10 22 23 – Moveable Partition System

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American National Standards Institute (ANSI):
 - .1 ANSI Z97.1-2015 (R2020), Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM D1004-21, Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
 - .2 ASTM D3330/D3330M-04(2018), Standard Test Method for Peel Adhesion of Pressure-Sensitive Tape.
 - .3 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .4 Consumer Product Safety Commission Publications (CPSC)/Code of Federal Regulations (CFR):
 - .1 CPSC, 16 CFR 1201 CAT I and CAT II, Safety Standard for Architectural Glazing Materials.
 - .5 U.S. General Services Administration (GSA):
 - .1 GSA-TS01-03, Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings.
 - .6 International Window Film Association (IWFA):
 - .1 IWFA Architectural Visual Inspection Standard Window Film.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit one 500 x 500 mm sample of glazing film of each product colour specified.

- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 - LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit Closeout Submittals in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Provide operation and maintenance data for window film for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Follow manufacturers written instructions for care and maintenance of security and safety film.
 - .3 Use only cleaning solution recommended by manufacturer for regularly scheduled cleaning of security film.

1.5 QUALITY ASSURANCE

- .1 Film installation Subcontractor to be factory approved and have a minimum of three years documented experience on not less than five similar installations.
- .2 Comply with requirements of the International Window Film Association (IWFA).
- .3 Use adequate numbers of skilled workmen, thoroughly trained and experienced in the installation of this film system.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with section 01 61 01 - LEED Product Requirements.
- .2 Provide and maintain dry, off-ground weatherproof storage.
- .3 Store rolls of film flat on cross supports. Do not stand rolls of film on end.
- .4 Remove from storage, in quantities required for same day use.
- .5 Store materials in accordance with manufacturers written instructions.
- .6 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 WARRANTY

- .1 Contractor hereby warrants that Security and Safety Film will stay in place without delaminating, peeling or blistering in accordance with the Contract, but for ten years.
- .2 Ensure warranty includes items as follows:
 - .1 Maintaining adhesion properties without blistering, bubbling or delaminating from glass surface.
 - .2 Maintaining appearance without discolouration.
 - .3 Removing, replace and reapply defective materials.

Part 2 Products

2.1 MATERIALS

- .1 Translucent Glazing Film (WF1): Vinyl film, adhered to face of glass, computer generated and cut:
 - .1 Flammability: Surface burning characteristics when tested in accordance ASTM E84, demonstrating film applied to glass rated Class A for Interior Use:
 - .1 Flame Spread Index: no greater than 25.
 - .2 Smoke Developed Index: no greater than 55.
 - .2 Pattern and Colour: as indicated in Section 09 99 99 – Material List.
 - .3 Basis-of-Design Manufacturer: as indicated in Section 09 99 99 – Material List.

2.2 GLAZING FILM ACCESSORIES

- .1 Adhesive: pressure sensitive acrylic adhesive system.
- .2 Cleaners, primers and sealers: types as recommended by glazing film manufacturer.

Part 3 Execution

3.1 PREPARATION

- .1 Clean glass before beginning installation using neutral cleaning solution.
- .2 Ensure no deleterious material adheres to glass by scraping surface of glass using industrial razors.
- .3 Ensure dust, grease, and chemical residue are removed from surface of glass before installation of film.
- .4 Examine glass under natural daylight and identify cracks, blisters, bubbles, discolouration, edge defects or other anomalies that may cause film to delaminate or cause vision transparency or distortion problems. Report findings to Consultant.
- .5 Before beginning Work, place absorbent material on window sill or at sash frame to absorb moisture accumulation generated by film application.

3.2 INSTALLATION

- .1 Comply with glazing film manufacturer's written installation instructions.
- .2 Cut film edges straight and square.
- .3 Cut edges 3 mm maximum from edge of glass sealing device in accordance with manufacturers written instructions.
- .4 Apply and attach film to glass in accordance with manufacturer's written instructions.
- .5 Splicing:
 - .1 Splice film only when glass is greater in width than film.

- .2 Splice film only after receipt of written approval from Consultant.
- .3 Use butt factory edges only.
- .4 Install with no gaps or overlaps.
- .6 Use only water and film slip solution on glass to facilitate positioning of film.
- .7 Ensure removal of excess water from between film and glass.
- .8 Remove left over material from work area and return work area to original condition.

3.3 SITE QUALITY CONTROL

- .1 Installer's Inspection: Visual Inspection: in accordance with IWFA – Architectural Visual Inspection Standard Window Film.
- .2 Remove and replace film that continues to show blisters, bubbles, tears, scratches, edge defects or vision distortion in film when viewed under natural daylight from 2 m minimum after 30 day period.

3.4 CLEANING

- .1 Follow manufacturer's recommendations and instructions for all cleaning procedures.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Interior gypsum wallboard of all types.
 - .2 Exterior gypsum board panels for ceilings and soffits. Metal furring runners
 - .4 Drywall furring channels
 - .5 Resilient clips
 - .6 Mineral fiber acoustical insulation
 - .7 Fibrous Glass Acoustical Insulation
 - .8 Ceiling/wall access doors
 - .9 Accessories such as nails, screws, adhesives, casing beads, caps, mouldings, sealants, trims, gaskets and joint treatments.
- .2 Related Requirements:
 - .1 Section 06 10 00 – Rough Carpentry
 - .2 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
 - .3 Section 07 84 00 – Firestopping and Smoke seals
 - .4 Section 07 92 00 – Sealants
 - .5 Section 09 22 00 – Non-Structural Metal Framing
 - .6 Section 09 30 13 – Tiling
 - .7 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Aluminum Association (AA):
 - .1 AA DAF-45-2003(R2009), Designation System for Aluminum Finishes.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C423-23, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .3 ASTM C475/C475M-17(2022), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .4 ASTM C514-04(2020), Specification for Nails for the Application of Gypsum Board.
 - .5 ASTM C557-03(2017), Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
 - .6 ASTM C612-14(2019), Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

- .7 ASTM C635/C365M-22, Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- .8 ASTM C645-18, Standard Specification for Nonstructural Steel Framing Members.
- .9 ASTM C665-23, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- .10 ASTM C840-23, Standard Specification for Application and Finishing of Gypsum Board.
- .11 ASTM C919-22, Standard Practice for Use of Sealants in Acoustical Applications.
- .12 ASTM C954-22, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm to 0.112 in. (2.84 mm) in Thickness.
- .13 ASTM C1002-22, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- .14 ASTM C1047-19, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
- .15 ASTM C1177/C1177M-17, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- .16 ASTM C1178/C1178M-18, Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.
- .17 ASTM C1278/C1278M-17 Standard Specification for Fiber-Reinforced Gypsum Panel.
- .18 ASTM C1280-18(2023), Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.
- .19 ASTM C1325-22e1, Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units.
- .20 ASTM C1396/C1396M-17, Standard Specification for Gypsum Board.
- .21 ASTM C1658/C1658M-19, Standard Specification for Glass Mat Gypsum Panels.
- .22 ASTM D3273-21, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- .23 ASTM D4977/D4977M-20, Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion.
- .24 ASTM D5420-21, Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).
- .25 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.

- .26 ASTM E90-23, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .27 ASTM E413-22, Classification for Rating Sound Insulation.
- .28 ASTM E695-22, Standard Test Method of Measuring Relative Resistance of Wall, Floor and Roof Construction to Impact Loading.
- .29 ASTM F1267-18(2023), Standard Specification for Metal, Expanded, Steel.
- .3 Association of the Wall and Ceiling Industry (AWCI).
- .4 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .5 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-71.25-M88, Adhesives, for Bonding Drywall to Wood Framing and Metal Studs. (Withdrawn)
 - .2 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction. (Withdrawn)
- .6 Gypsum Association (GA):
 - .1 GA-214-2021 Levels of Finish for Gypsum Panel Products.
- .7 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1168-22, Adhesives and Sealants Applications.
- .8 Underwriters' Laboratories of Canada (ULC):
 - .1 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies. (ULC S102)
 - .2 ULC 114, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
 - .3 ULC 702.1, Standard for Thermal Insulation Mineral Fibre for Buildings, Part 1: Material Specification (ULC S702.1).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for each product specified.
- .2 LEED Submittals: provide submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials in original packages, containers or bundles bearing manufacturers brand name and identification.
- .2 Store materials inside, level, under cover. Keep dry. Protect from weather, other elements and damage from construction operations and other causes.
- .3 Handle gypsum boards to prevent damage to edges, ends or surfaces. Protect metal accessories and trim from being bent or damaged.

- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.5 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Maintain temperature minimum 10 degrees C, maximum 21 degrees C for 48 hours prior to and during application of gypsum boards and joint treatment, and for at least 48 hours after completion of joint treatment.
 - .2 Apply board and joint treatment to dry, frost free surfaces.
 - .3 Ventilation: Ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers:
 - .1 Cabot Gypsum Company
 - .2 CertainTeed Gypsum Canada Inc.
 - .3 CGC Inc.
 - .4 Georgia-Pacific Canada, Inc.

2.2 GYPSUM MATERIALS

- .1 Standard board: to ASTM C1396/C1396M and as follows:
 - .1 Type: regular and fire resistant.
 - .2 Size: 1220 mm x maximum practical length.
 - .3 Thickness: as indicated on Drawings.
 - .4 Ends: square cut.
 - .5 Edges: tapered
 - .6 Acceptable Materials:
 - .1 Wallboard (Type X), CertainTeed.
 - .2 Sheetrock (Firecode), CGC Inc.
 - .3 Toughrock Gypsum Wallboard (Fireguard), Georgia-Pacific Canada, Inc.
- .2 Lightweight Fire Resistant board: to ASTM C1396/C1396M and as follows:
 - .1 Type: fire resistant.
 - .2 Size: 1220 mm x maximum practical length.
 - .3 Thickness: as indicated on Drawings.
 - .4 Ends: square cut.
 - .5 Edges: tapered.
 - .6 Basis-of-Design Materials:

- .1 Ultralight Panels Firecode X, CGC Sheetrock.
- .3 Sag Resistant Gypsum Board: to ASTM C1396/C1396M and as follows:
 - .1 Type: regular.
 - .2 Thickness: as indicated on Drawings.
 - .3 Acceptable Materials:
 - .1 Interior Ceiling Board, CertainTeed.
 - .2 Sheetrock Interior Ceiling Board, CGC Inc.
 - .3 CD Ceiling Board, Georgia-Pacific Canada, Inc.
 - .4 Cementitious backer board: to ASTM C1325 and as follows:
 - .1 Size: 1220 mm x maximum practical length.
 - .2 Thickness: as indicated on Drawings.
 - .3 Acceptable Materials:
 - .1 Durock, CGC Inc.
 - .2 Wonderboard, Custom Building Products Ltd.

2.3 FRAMING MATERIALS

- .1 Studs and Tracks: as indicated in Section 09 22 00 - Non-Structural Metal Framing.
- .2 Metal furring runners, hangers, tie wires, inserts, anchors.
- .3 Drywall furring channels: 0.75 mm core thickness galvanized steel channels for screw attachment of gypsum board.
- .4 Resilient drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.

2.4 INSULATION MATERIALS

- .1 Mineral Fiber Insulation for Fire and Smoke Rated Assemblies: Un-faced preformed GreenGuard™ or formaldehyde free binder stone wool insulation meeting the requirements of ULC 702.1; having maximum flame spread and smoke developed of 0/0 in accordance with ULC 102 and ASTM E84 and being non-combustible in accordance with ULC 114 and as follows:
 - .1 Type: 1 to ASTM C665.
 - .2 Width: to friction fit in stud spaces.
 - .3 Thickness: to fill a minimum of 90% of the cavity thickness.
 - .4 STC Ratings: as indicated on Drawings.
 - .5 Acceptable Materials:
 - .1 Thermafiber SAFB, Owens-Corning Canada Inc.,
 - .2 AFB Acoustical Fire Batt, Rockwool Inc.
- .2 Fibrous Glass Acoustical Insulation for Non-rated Assemblies: Un-faced, preformed GreenGuard™ or formaldehyde free binder fibrous insulation meeting the requirements of ASTM C423, ASTM E90, ASTM E413 and ULC 702.1 and as follows:
 - .1 Type: One.

- .2 Width: to friction fit in stud spaces.
- .3 Thickness: to fill a minimum of 90% of the cavity thickness.
- .4 Acceptable Materials:
 - .1 NoiseReducer, Sound Control Fibre Glass Batts, CertainTeed.
 - .2 Sound Shield Glass Fibre Batts, Johns Manville.
 - .3 Quietzone Acoustic Insulation, Owen-Corning Canada Inc.

2.5 CEILING/WALL ACCESS DOORS

- .1 Architectural, flush mounting access panels for gypsum board installation, thickness and fire rating to match wall assembly, manufacturer's standard sizes selected to suit access requirements, complete with extruded aluminum frame, concealed hinge and a removable door panel, air tight gasket and screwdriver slot latch mechanism. Confirm proposed location and number of access doors with Consultant prior to installation.
 - .1 Non-Rated Access Doors and Frames:
 - .1 Concealed Flange Access Panel: Flush design frame with a drywall bead taping flange, specifically for use with gypsum board.
 - .1 Frame: 1.90 mm (14 gauge) galvanized steel.
 - .2 Door Panel: 1.52 mm (16 gauge) galvanized steel.
 - .3 Hinge: Fully concealed pin type hinge with 175 degree opening.
 - .4 Latch: Screwdriver operated cam latch.
 - .2 Exterior Flange Stainless Steel Access Panel: Surface mounted with exposed flange frame design. No. 4 polished finish 304 stainless steel.
 - .1 Frame: 1.21 mm (18 gauge) stainless steel.
 - .2 Door Panel: 1.52 mm (16 gauge) stainless steel.
 - .3 Hinge: Fully concealed pin type hinge with 175 degree opening.
 - .4 Latch: Screwdriver operated cam latch.
 - .2 Fire-Rated Access Doors and Frames:
 - .1 Concealed Flange Fire-Rated Wall Access Panel: Flush design frame with a drywall bead taping flange, specifically for use with gypsum board.
 - .1 Frame: 1.61 mm (14 gauge) galvanized steel.
 - .2 Door Panel: 1.99 mm (16 gauge) galvanized steel, uninsulated.
 - .3 Hinge: Fully concealed pin type hinge with 90 degree opening, self-closing device. Latch: Allen key operated latch with interior latch release.
 - .4 Rating: as indicated.
 - .2 Concealed Flange Fire-Rated Ceiling Access Panel: Flush design frame with a drywall bead taping flange, specifically for use with gypsum board.
 - .1 Frame: 1.99 mm (16 gauge) galvanized steel.
 - .2 Door Panel: 1.31 mm (18 gauge) galvanized steel, with high temperature insulation and 0.85 mm (22 gauge) metal liner.

- .3 Hinge: Fully concealed pin type hinge with 90 degree opening, self-closing device.
- .4 Latch: Allen key operated latch with interior latch release.
- .5 Rating: as indicated.
- .3 Acceptable Manufacturers:
 - .1 Access Panel Solutions.
 - .2 Acudor Products, Inc.
 - .3 Bauco Access Panel Solutions
 - .4 Chicago Metallic/Rockfon Corporation.
 - .5 Nystrom Building Products Co.

2.6 FINISHES

- .1 Paint: in accordance with Section 09 91 00 – Painting.
- .2 Tiling: in accordance with Section 09 30 13 – Tiling.

2.7 ACCESSORIES

- .1 Nails: to ASTM C514.
- .2 Steel drill screws: to ASTM C1002.
- .3 Laminating compound: as recommended by manufacturer, asbestos-free.
- .4 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, 0.5 mm base thickness galvanized metal to ASTM A653, perforated flanges, one piece length per location.
- .5 Strippable Edge Trim: Extruded PVC with pre-masked L-shaped tape on trim with tear away protective serrated strip for removal after compound and paint is applied, for use at areas where gypsum butts aluminum frames and where gypsum butts concrete or concrete block.
- .6 Sealants: in accordance with Section 07 92 00 - Sealants.
- .7 Acoustic sealant: in accordance with Section 07 92 00 – Sealants.
- .8 Firestopping: refer to Section 07 84 00 - Firestopping and Smoke seals for project as required for all new and existing surfaces, penetrations, irregular connections, and locations as described in Section 07 84 00 - Firestopping and Smoke seals.
- .9 Insulating strip (sill gasket): rubberized, moisture resistant 3 mm thick cork or foam strip, width to suit, with self sticking adhesive on one face, lengths as required.
- .10 Joint Treatment Materials: Provide joint compound and accessory materials in accordance with ASTM C475/C475M and as follows:
 - .1 Joint Tape:
 - .1 Interior Gypsum Board: Paper.
 - .2 Tile Backing Panels: As recommended by panel manufacturer.
 - .2 Joint Compound for Interior Gypsum Board: Vinyl based, non-asbestos, low dusting type compatible with other compounds applied on previous or for successive coats, and as follows:
 - .1 Pre-filling: Setting type taping compound.

- .2 Embedding and First Coat: Drying type compound.
- .3 Fill Coat: Drying type compound.
- .4 Finish Coat: Drying type, sandable topping compound.
- .5 Skim Coat: Drying type, sandable topping compound.
- .6 Acceptable Materials:
 - .1 CertainTeed Dust Away.
 - .2 CGC Dust Control.
- .3 Joint Compound for Tile Backing Panels:
 - .1 Gypsum based tile backing board: Use setting type taping and setting type, sandable topping compounds.

Part 3 Execution

3.1 ACOUSTIC ASSEMBLIES

- .1 Maintain continuity of acoustic rated assemblies, including at junction with dissimilar adjacent materials and components such as beams, slabs, columns above ceilings and the like.

3.2 ERECTION

- .1 Perform application and finishing of gypsum board in accordance with ASTM C840 except where specified otherwise.
- .2 Do not install gypsum based products where there will be direct exposure to water or continuous high humidity conditions.
- .3 Erect hangers and runner channels for suspended gypsum board ceilings in accordance with ASTM C840 except where specified otherwise.
- .4 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .5 Install work level to tolerance of 1:1200.
- .6 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles.
- .7 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.
- .8 Furr gypsum board faced vertical bulkheads within and at termination of ceilings.
- .9 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.
- .10 Install gypsum 19 mm above finished floor at base of walls and seal joint for acoustic partitions to achieve STC rating as indicated.
- .11 Seal fire rated partitions with fire caulking as indicated in Section 07 84 00 - Firestopping and Smoke seals and authority having jurisdiction.
- .12 Install wall furring for gypsum board wall finishes in accordance with ASTM C840, except where specified otherwise.

- .13 Furr openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .14 Furr duct shafts, beams, columns, pipes and exposed services where indicated.
- .15 Erect drywall resilient furring transversely across studs and joists spaced maximum 600 mm on centre and not more than 150 mm from ceiling/wall juncture. Secure to each support with 25 mm drywall screw.
- .16 Install 150 mm continuous strip of gypsum board along base of partitions where resilient furring installed.

3.3 APPLICATION

- .1 Do not apply gypsum board until bucks, anchors, blocking, sound attenuation, electrical and mechanical work are approved.
- .2 Apply single or double layer gypsum board to metal furring or framing using screw fasteners for first layer, screw fasteners for second layer. Maximum spacing of screws 300 mm on centre.
 - .1 Single-Layer Application:
 - .1 Apply gypsum board on ceilings prior to application of walls in accordance with ASTM C840.
 - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
 - .2 Double-Layer Application:
 - .1 Install gypsum board for base layer and exposed gypsum board for face layer.
 - .2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.
 - .3 Apply base layers at right angles to supports unless otherwise indicated.
 - .4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250 mm with base layer joints.
- .3 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components in accordance with ASTM C919. Seal full perimeter of cut-outs around electrical boxes, ducts, in partitions where perimeter sealed with acoustic sealant.
- .4 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.
- .5 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .6 Install gypsum board with face side out.
- .7 Do not install damaged or damp boards.

- .8 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre or using contact adhesive for full length.
- .2 Install casing beads where ceilings abut dissimilar materials.
- .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .5 Install shadow mould at gypsum board/ceiling juncture as indicated. Minimize joints; use corner pieces and splicers.
- .6 Construct control joints of preformed units or two back-to-back casing beads set in gypsum board facing and supported independently on both sides of joint.
- .7 Provide continuous polyethylene dust barrier behind and across control joints.
- .8 Locate control joints where indicated and at changes in substrate construction at approximate 10 m spacing on long corridor runs at approximate 15 m spacing on ceilings.
- .9 Install control joints straight and true.
- .10 Construct expansion joints at building expansion and construction joints. Provide continuous dust barrier.
- .11 Install expansion joint straight and true.
- .12 Splice corners and intersections together and secure to each member with three screws.
- .13 Install access doors to electrical and mechanical fixtures specified in respective sections.
 - .1 Rigidly secure frames to furring or framing systems.
- .14 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .15 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with GA-214:
 - .1 Levels of finish (at locations below or as indicated on drawings)
 - .1 Level 0: No taping, finishing or accessories required for areas of temporary construction.
 - .2 Level One: Embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable. Use at plenum areas above ceilings, in attics, or in concealed spaces.

- .3 Level Two: Embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable. Use when gypsum is used as a substrate for tile.
- .4 Level Three: Embed tape for joints and interior angles in joint compound and apply two separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges and where areas are to receive a heavy coating of textured material.
- .5 Level Four: Embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges and where light textures or wall coverings are to be applied.
- .16 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .17 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.
- .18 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .19 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.
- .20 Mix joint compound slightly thinner than for joint taping.
- .21 Apply thin coat to entire surface using trowel or drywall broadknife to fill surface texture differences, variations or tool marks.
- .22 Remove ridges by light sanding or wiping with damp cloth.
- .23 Provide protection that ensures gypsum drywall work will remain without damage or deterioration at time of Substantial Performance.

3.5 NON-CONFORMING WORK

- .1 Touch-up minor damage to finishes in accordance with manufacturer's instructions; remove and replace ceiling components that cannot be successfully cleaned and repaired.

3.6 CLEANING

- .1 Clean exposed surfaces of panels, including trim, edge mouldings, and suspension system members in accordance with manufacturer's instructions.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Non-load bearing channel stud framing.
 - .2 Runners.
 - .3 Metal channel stiffener.
 - .4 Sheet metal backing.
 - .5 Acoustical sealant.
 - .6 Insulating strip (sill gasket).
 - .7 Fasteners.
- .2 Related Requirements:
 - .1 Section 09 21 16 - Gypsum Board Assemblies.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Iron and Steel Institute (AISI):
 - .1 AISI S220-15, North American Standard for Cold-Formed Steel Framing, Nonstructural Members
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C645-18, Standard Specification for Nonstructural Steel Framing Members.
 - .3 ASTM C754-20, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - .4 ASTM C919-22, Standard Practice for Use of Sealants in Acoustical Applications.
 - .3 Association of the Wall and Ceiling Industry (AWCI).
 - .4 Canadian Standards Association (CSA Group):
 - .1 CSA S136-16, North American specification for the design of cold-formed steel structural members.
 - .2 CSA S304-14 (R2019), Design of Masonry Structures, Includes Update No. 1 (2015).
 - .5 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.40-97, Anticorrosive Structural Steel Alkyd Primer (Withdrawn).
 - .6 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .7 Canadian Sheet Steel Building Institute (CSSBI):

- .1 CSSBI 51-06, Lightweight Steel Framing Design Manual – 2nd Edition.
- .2 CSSBI SSF 03-17, Care and Maintenance of Prefinished Sheet Steel Building Products.
- .3 CSSBI Technical Bulletin, Vol. 7, No 1, Maximum Height Tables for Interior Non-Loadbearing Partitions.
- .8 Underwriters Laboratories ECOLOGO Certification Program (UL):
 - .1 UL 2760, Sustainability for Surface Coatings: Recycled Water-Borne.
 - .2 UL 2768 Architectural Surface Coatings (formerly CCD-047).

1.3 ADMINSTRATIVE REQUIREMENTS

- .1 Convene pre-installation meetings one week prior to beginning work of this Section in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation conditions.
 - .3 Co-ordinate with other building subtrades.
 - .4 Review manufacturer's instructions.

1.4 ACTION SUBMITTALS / INFORMATIONALSUBMITTALS

- .1 Delegated Design:
 - .1 Professional engineers sealed and signed shop drawings and design submittals requiring structural engineering.
 - .2 Provide delegated design for the studs where heights or loads exceed manufacturers standard designs.
- .2 Evaluation Reports: Submit steel manufacturer evaluation reports certified under an independent third-party inspection program reviewed to the local building code.
- .3 Submit signed and sealed drawings stamped by a Professional Engineer registered in the Province of the work and as indicated in Section 01 35 00 – Delegated Design.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .2 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .3 Retain a professional engineer, registered in the province of the Work, to design fabrication and erection of the Work of this Section in accordance with applicable Building Code and Contract Document requirements including, but not limited to, the following:

- .1 Submittals.
- .2 Site review and certification of installed components.
- .3 Completion of Letters or Commitment and Supervision specified in Section 01 35 00 – Delegated Design.
- .4 Verify stud thickness based on maximum deflections and loads from cladding on exterior walls.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

Part 2 Products

2.1 PERFORMANCE REQUIREMENTS

- .1 System Design: Design and size components in accordance with CSA S136, to withstand dead loads, and live loads caused by wind loads acting normal to plane of wall as calculated in accordance with applicable code.
 - .1 Wind Loads: In accordance with Local Building Code with importance factors indicated on structural drawings.
- .2 Maximum deflections under specified wind loads shall conform to the following:
 - .1 Wall studs supporting masonry veneer shall meet the requirements of CSA S304, with veneer deflections limited to L/600 or with stud deflections limited to L/720.
 - .2 Wall studs supporting other finishes = L/360.
- .3 Design to provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges. Design wind bearing stud end connections to accommodate floor/roof deflections such that the studs are not loaded axially.
- .4 Conform to the requirements of specified fire rated and sound rated assemblies.
- .5 Provide bridging to prevent member rotation and member translation perpendicular to the minor axis. Provide for secondary stress effects due to torsion between lines of bridging. Do not rely on sheathing to resist torsion or minor axis buckling.
- .6 Design assembly to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
- .7 Design door support assemblies to accommodate suspended loads, deflection of building structural members, and clearances of intended sliding door openings.
- .8 Connections between lightweight steel framing members shall be bolts, welding or sheet metal screws.
- .9 Resistances for sheet metal screws shall be based on the manufacturer's lower bound test values multiplied by the appropriate resistance factor given in CSA S136.

2.2 MATERIALS

- .1 Non-load bearing channel stud framing: to ASTM C645, stud sizes as indicated on Drawings, roll formed from 0.45 mm thickness hot dipped galvanized steel sheet complying with ASTM A653/A653M, Z120; or coating with equivalent corrosion resistance, for screw attachment of gypsum board. Use 0.75 mm heavy weight framing to support fire rated door frames. Knock-out service holes at 460 mm centres.
 - .1 Coating shall demonstrate equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.
- .2 Runners: Width, gauge and galvanizing to match steel studs, and as follows:
 - .1 Double Runner Deflection Track: Outside runner using 50 mm flanges; inner runner 33 mm; maintaining 25 mm minimum deflection space.
 - .2 Deep Leg Deflection Track: Top runner having 50 mm down standing legs; maintaining 13 mm minimum deflection space.
 - .3 Slotted Deflection Track for Fire Separations: Premanufactured slotted top runner with 63 mm down standing legs and having 6 mm wide x 38 mm high slots spaced at 25 mm o/c along length of runner; tested and certified for use in fire rated wall construction:
 - .1 Acceptable Materials:
 - .1 Bailey Metal Products Ltd.
 - .2 SliptrackSystems, Brady Innovations LLC.
 - .3 BlazeFrame DSL Slotted Deflection Track, ClarkDietrich.
 - .2 Base Runner: Bottom track with 33 mm upstanding legs.
- .3 Metal channel stiffener: sizes as required, 1.4 mm thick cold rolled steel, coated with rust inhibitive coating.
- .4 Provide 20 gauge x 200 mm high sheet metal backing at all locations to support equipment, furniture, architectural woodwork, or casework.
- .5 Acoustical sealant: to Section 07 92 00 - Sealants.
- .6 Insulating strip (sill gasket): rubberized, moisture resistant 3 mm thick cork or foam strip, width to suit, with self sticking adhesive on one face, lengths as required.
- .7 Fasteners for Metal Framing: Type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

Part 3 Execution

3.1 ERECTION

- .1 Align partition tracks at floor and ceiling and secure at 600 mm on centre maximum.
- .2 Install damp proof course under stud shoe tracks of partitions on slabs on grade.
- .3 Place studs vertically at 400 mm on centre and not more than 50 mm from abutting walls, and at each side of openings and corners. Position studs in tracks

at floor and ceiling. Cross brace steel studs as required to provide rigid installation to manufacturer's instructions.

- .4 Erect metal studding to tolerance of 1:1000.
- .5 Attach studs to bottom or ceiling track using screws, crimp method, or pop rivets.
- .6 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.
- .7 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .8 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified. Secure studs together, 50 mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.
- .9 Install heavy gauge (1.52 mm thick) single jamb studs at openings if required.
- .10 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs. Secure track to studs at each end, in accordance with manufacturer's instructions. Install intermediate studs above and below openings in same manner and spacing as wall studs.
- .11 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .12 Provide 40 mm stud or furring channel secured between studs for attachment of fixtures behind lavatory basins, toilet and bathroom accessories, and other fixtures including grab bars and towel rails, attached to steel stud partitions.
- .13 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .14 Extend partitions to underside of roof except where noted otherwise on drawings.
- .15 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs. Use 50 mm leg ceiling tracks. Use double track slip joint as indicated.
- .16 Install continuous insulating strips to isolate studs from uninsulated surfaces.
- .17 Install two continuous beads of acoustical sealant or continuous insulating strip under studs and tracks around perimeter of sound control partitions in accordance with ASTM C919.

3.2 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.3 STEEL STUD HEIGHT SCHEDULE

- .1 Table below is a standard non-load bearing steel stud height table, provide delegated design as indicated in Section 01 35 00 – Delegated Design for anything not indicated below.

Maximum Stud Height (mm) based on lateral pressure of 240 Pa with deflection limit of L/240

Stud Spacing O.C.	300	400	600	300	400	600
Stud Depth (mm)	0.45 mm Steel Design Thickness			0.80 mm Steel Design Thickness		
64	3630	3430	3230	4240	3910	3530
92	4670	4370	4090	5440	5000	4500
102	5000	4670	4320	6070	5590	5000
152	6730	6020	5110	8150	7470	6580

Maximum Hard Board Stud Height (mm) based on lateral pressure of 240 Pa with deflection limit of L/240

Stud Spacing O.C.	305	406	610	305	406	610
Stud Depth (mm)	362S150-B18			600S150-B18		
5PSF						
L/120	7213	6553	5359	9779	8458	6908
L/240	5944	5385	4724	8407	7645	6680
L/360	5131	4674	4064	7290	6604	5766
10 PSF						
L/120	5359	4648	3785	6909	5994	4877
L/240	4724	4293	3734	6680	5994	4877
L/360	4064	3708	3150	5766	5258	4572

Based upon tests with 13 mm gypsum board both sides with screw fasteners spaced at 300 mm o.c. Heights also apply to greater gypsum board thickness and multiple gypsum board layers.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Wall tile.
 - .2 Grout.
 - .3 Membranes.
 - .4 Patching and levelling compound.
 - .5 Accessories including edge strips and tile sealer.
 - .6 Cleaning compounds.
- .2 Related Requirements:
 - .1 Section 06 10 00 – Rough Carpentry
 - .2 Section 07 92 00 – Sealants
 - .3 Section 09 21 16 – Gypsum Board Assemblies
 - .4 Section 09 99 99 – Materials List

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American National Standards Institute (ANSI):
 - .1 ANSI/TCNA A108-A118-A136.1, American National Standard for the Installation of Ceramic Tile.
 - .2 ANSI/TCNA A137.1-2022, Ceramic Tile Specifications.
 - .3 ANSI A326.3-2021, American National Standard Test Method for Dynamic Coefficient of Friction of Hard Surface Materials.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C136/C136M-19, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .2 ASTM C144-18, Standard Specification for Aggregate for Masonry Mortar.
 - .3 ASTM C150/C150M-22, Standard Specification for Portland Cement
 - .4 ASTM C207-18, Standard Specification for Hydrated Lime for Masonry Purposes.
 - .5 ASTM C373-18(2023), Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products.
 - .6 ASTM C979/C979M-16, Standard Specification for Pigments for Integrally Coloured Concrete.
 - .7 ASTM D226/D226M-17(2023), Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 - .8 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.

- .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 75.1-M88, Tile, Ceramic. (Withdrawn)
- .5 Canadian Standards Association (CSA Group):
 - .1 CSA-A3000-18, Cementitious materials compendium, Includes Update No. 1 and Errata (2021).
- .6 International Organization for Standardization (ISO):
 - .1 ISO 13007: Part 1-6, Ceramic Tiles- Grouts and Adhesives.
- .7 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1168-22, Adhesives and Sealants Applications.
- .8 Terrazzo Tile and Marble Association of Canada (TTMAC):
 - .1 2019-2021 Specification Guide 09 30 00 Tile Installation Manual.
 - .2 Hard Surface Maintenance Guide.
- .9 Tile Council of North America (TCNA):
 - .1 2022 TCNA Handbook for Ceramic, Glass, and Stone Tile Installation.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Preconstruction Meeting: Arrange a preconstruction meeting in accordance with Section 01 31 19 – Project Meetings attended by Contractor, Consultant, tile installer, tile supplier, and mortar and grout representative to discuss the following:
 - .1 Substrate and backing surfaces flatness requirements.
 - .2 Installation techniques associated with specified materials.
 - .3 Compatibility between specified materials and between adjacent materials.
 - .4 Concerns arising from site conditions.
 - .5 Concerns of installers or suppliers arising from as-constructed conditions.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Include manufacturer's information on:
 - .1 Ceramic tile, marked to show each type, size, and shape required.
 - .2 Chemical resistant mortar and grout (Epoxy and Furan).
 - .3 Cementitious backer unit.
 - .4 Dry-set cement mortar and grout.
 - .5 Divider strip.
 - .6 Elastomeric membrane and bond coat.
 - .7 Reinforcing tape.
 - .8 Levelling compound.
 - .9 Latex cement mortar and grout.

- .10 Commercial cement grout.
 - .11 Fasteners.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate tile layout, patterns, colour arrangement, perimeter conditions, junctions with dissimilar materials, thresholds, and setting details.
 - .2 Locate and detail movement joints.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Tile: Submit actual tile samples illustrating colour, texture, size and pattern for each type of tile specified.
 - .2 Grout: Submit manufacturer's full range of colours available for each type of grout specified.
 - .3 Trim shapes, bullnose cap and cove including bullnose cap and base pieces at internal and external corners of vertical surfaces, each type, colour, and size.
 - .4 Adhere tile samples to 11 mm thick plywood and grout joints to represent project installation.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide minimum 2% of each type and colour of tile required for project for maintenance use. Store where directed.
 - .3 Maintenance material same production run as installed material.

1.6 QUALITY ASSURANCE

- .1 Installer Qualifications: Specializing in tile work having minimum of five years successful documented experience with work comparable to that required for this project. Installer must be registered as a member in good standing with the Terrazzo, Tile and Marble Association of Canada.
- .2 Conform to requirements of Terrazzo, Tile and Marble Association of Canada (TTMAC) 2019-2021 Specification Guide 09 30 00 Tile Installation Manual.
- .3 Obtain each type of tile material required from single source. For colour consistency, ensure the supplier has capacity to provide products from the same production run, dye lot, calibre and batch number.
- .4 Obtain setting and grouting materials from one manufacturer to ensure compatibility.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials in containers with labels legible and intact and grade-seals unbroken.

- .2 Store materials to prevent damage or contamination.
- .3 Store materials in a dry area, protected from freezing, staining and damage.
- .4 Store cementitious materials on a dry surface.
- .5 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Maintain air temperature and structural base temperature at ceramic tile installation area above 12 degrees C for 48 hours before, during, and 48 hours after, installation. Tile and setting material stored at same conditions 48 hours before and seven days after application.
 - .2 Do not install tiles at temperatures less than 12 degrees C or above 38 degrees C.
 - .3 Do not apply epoxy mortar and grouts at temperatures below 15 degrees C or above 25 degrees C.

Part 2 Products

2.1 MATERIALS

- .1 Factory blend tile that exhibits colour variations within the ranges selected and package, therefore tile units taken from one package show the same range in colours as those taken from other packages.
- .2 Provide tile products manufactured in accordance with CAN/CGSB 75.1 or ANSI A108.1 as appropriate to the Basis-of-Design Materials.
 - .1 Provide Products used in exits having a flame spread rating of 25 or less when tested in accordance with ASTM E84 or ULC 102.2.

2.2 WALL TILE

- .1 Ceramic mosaic tile: to CAN/CGSB-75.1, and as follows:
 - .1 Type: 1
 - .2 Size: as indicated in Section 09 99 99 – Materials List
 - .3 Colour: as indicated in Section 09 99 99 – Materials List

2.3 MORTAR, GROUT, AND ADHESIVE MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements herein, provide products from one of the following manufacturers:
 - .1 Ardex Americas.
 - .2 Custom Building Products Ltd.
 - .3 Flextile Ltd.
 - .4 Laticrete International Inc.
 - .5 MAPEI Inc.

2.4 MORTAR AND ADHESIVE MATERIALS

- .1 Mortar to be of the following properties unless otherwise specified:
 - .1 Cement: Grey meeting requirements of CSA A3000.
 - .2 Sand: to ASTM C144, passing 16 mesh.
 - .3 Hydrated lime: to ASTM C207, Type N
 - .4 Latex additive: formulated for use in cement mortar and thin set bond coat.
 - .5 Water: potable and free of minerals and chemicals which are detrimental to mortar and grout mixes.
 - .6 Mortars and Adhesives:
 - .1 Maximum VOC limit 65 g/L to SCAQMD Rule 1168.
- .2 Thin Set Mortar: modified, non-sagging, dry-set lightweight cement mortar with polymer and complying with ANSI A118.4, A118.11 and ISO 13007 C2TES1P1.
 - .1 Acceptable Materials:
 - .1 ProLite Premium Blend LFT Mortar, Custom Building Products.
 - .2 66 FlexLite Mortar, Flextile Ltd.
 - .3 255 Multimax, Laticrete International Inc.
 - .4 Ultralite Mortar, MAPEI Inc.

2.5 GROUT

- .1 Colouring Pigments:
 - .1 Pure mineral pigments, limeproof and nonfading, complying with ASTM C979.
 - .2 Colouring pigments to be added to grout by manufacturer.
 - .3 Job coloured grout are not acceptable.
 - .4 Use in Commercial Cement Grout, Dry-Set Grout, and Latex Cement Grout.
- .2 Epoxy Grout: Multi-component, factory prepared, 100 percent epoxy resin and hardener with sand or mineral filler material; comply with ANSI A118.3 and ISO 13007 Classification R2/RG/ Classification RD for industrial grade.
 - .1 Colour: as indicated in Section 09 99 99 – Materials List
 - .2 Acceptable Materials:
 - .1 CEG-Lite, CEG-IG 100% Solid Commercial Epoxy Grout, Custom Building Products.
 - .2 FlexEpoxy 100 – 100% Solids 2-Component Epoxy Grout, Flextile Ltd.
 - .3 Latapoxy SpectraLOCK Pro Premium, Laticrete International Inc.
 - .4 SpectraLOCK 2000 IG, Laticrete International Inc.
 - .5 Kerapoxy CQ, Premium Epoxy Mortar and Grout, MAPEI Inc.

2.6 MEMBRANES

- .1 Waterproofing Membrane: Liquid rubber with fabric reinforcing.

- .1 Acceptable Materials:
 - .1 Custom 9240 Waterproofing and Crack Prevention Membrane, Custom Building Products.
 - .2 WP900 or WP980 WP/Crack Isolation Membrane, Flextile Ltd.
 - .3 9235 Waterproofing Membrane, Laticrete International Inc.
 - .4 Mapelastic AquaDefense, MAPEI Inc.

2.7 ACCESSORIES

- .1 Trim shapes (TS2):
 - .1 Conform to applicable requirements of adjoining wall tile.
 - .2 Use trim shapes sizes conforming to size of adjoining field wall tile, including existing spaces, unless specified otherwise.
 - .3 Internal and External Corners: provide trim shapes as follows where indicated.
 - .1 Material: brushed stainless steel
 - .2 Profile: Rounded reveal surface for edges and outside corners of tile surfaces.
 - .3 Basis of Design Materials:
 - .1 RONDEC, Schlüter
- .2 Sealant: in accordance with Section 07 92 00 - Sealants.
 - .1 Sealants: maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .3 Tile sealer and protective coating: to CAN/CGSB-25.20, Type one or two to tile and grout manufacturers recommendations.

2.8 CLEANING COMPOUNDS

- .1 Specifically designed for cleaning masonry and concrete and which will not prevent bond of subsequent tile setting materials including patching and leveling compounds and elastomeric waterproofing membrane and coat.
- .2 Materials containing acid or caustic material are not acceptable.

Part 3 Execution

3.1 EXAMINATION

- .1 Surfaces for tile installation must be clean, dimensionally stable, cured, level, plumb and free of contaminants such as oil, sealers and curing compounds.

3.2 PREPARATION

- .1 Protect surrounding work from damage or disfiguration arising from work of this Section.
- .2 Surfaces: Thoroughly clean substrate surfaces receiving tile finishes to remove grease, oil or dust films, and other contaminants affecting bond of materials within bonding systems and as follows:

- .1 Clean back of each tile before installation to remove surface contaminants and cutting residue, firing release dust and other debris detrimental to bond and final surface appearance.
- .3 Surface Levelling: apply self levelling compound to make backing surfaces flat and true to tolerances in plane listed in performance requirements above and as required by TTMAC.

3.3 INSTALLATION

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Do tile work in accordance with TTMAC Tile Installation Manual except where specified otherwise.
- .3 Apply tile or backing coats to clean and sound surfaces.
- .4 Back Buttering: Obtain minimum 95% mortar coverage in accordance with applicable requirements for back buttering of tile in referenced TTMAC and ANSI A108 series of tile installation standards for the following applications:
 - .1 Tile having tiles 380 mm or larger in any direction.
 - .2 Tile installed with chemical resistant mortars and grouts.
 - .3 Tile having raised or textured backs.
 - .4 Tile having tile installation rated for Heavy or Extra Heavy Duty.
 - .5 All porcelain tiles with more than 20% of the tile backs covered with "white firing release" shall be "back buttered" so that 100% of the back is covered with adhesive mortar rated for C627, Extra Heavy Duty rating.
- .5 Fit tile around corners, fitments, fixtures, drains and other built-in objects. Maintain uniform joint appearance. Cut edges smooth and even. Do not split tiles.
- .6 Maximum surface tolerance 1:800.
- .7 Make joints between tile uniform, plumb, straight, true, even and flush with adjacent tile. Confirm joint width with Consultant. Ensure sheet layout not visible after installation. Align patterns.
- .8 Lay out tiles as indicated on drawings so perimeter tiles are minimum 1/2 size.
- .9 Sound tiles after setting and replace hollow-sounding units to obtain full bond.
- .10 Install divider strips at junction of dissimilar materials.
- .11 Allow minimum 24 hours after installation of tiles, before grouting.
- .12 Clean installed tile surfaces after installation and grouting cured.
- .13 Locate expansion, control, contraction, and isolation joints, as indicated in the TTMAC Installation manual to suit installation.

3.4 WATERPROOFING MEMBRANE INSTALLATION

- .1 Install waterproofing membrane in accordance with manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate.

3.5 WALL TILE

- .1 Install tile on concrete walls to TTMAC details 302W.
- .2 Install tile on gypsum board to TTMAC details 305W.

3.6 TILE SEALER AND PROTECTIVE COATING

- .1 Apply manufacturer's recommended sealer in strict accordance with manufacturer's written instructions for the specific tile type being sealed.
- .2 Apply sealer to tiles before grouting in cases of absorbent biscuit tiles and again after completion and cleaning of grouting process.

3.7 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.8 CLEANING

- .1 On completion of placement and grouting, clean all tile surfaces so they are free of foreign matter using Job Site Cleaner listed above:
 - .1 Remove grout residue from tile as soon as possible.
 - .2 Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's written instructions, but no sooner than ten days after installation.
 - .3 Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning.
 - .4 Flush surface with clean water before and after cleaning.

3.9 PROTECTION

- .1 Leave finished installation clean and free of cracked, chipped, broken, unbonded, or other tile deficiencies:
 - .1 Protect finished areas from traffic until setting materials have sufficiently cured in accordance with TTMAC requirements.
- .2 Provide protective covering until Substantial Performance of the Work.
- .3 Protect wall tiles and bases from impact, vibration, heavy hammering on adjacent and opposite walls for a minimum of 14 days after installation.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Non-Woven layered and formed Polyester felt fiber ceiling panels.
 - .2 Wire hangers, fasteners, main runners, cross tees, wall angle moldings and accessories.
- .2 Related Requirements:
 - .1 Section 09 21 16 – Gypsum Board Assemblies
 - .2 Section 09 51 13 – Acoustical Panel Ceilings
 - .3 Section 09 51 53 – Direct-Attached Acoustical Ceilings
 - .4 Section 09 22 00 – Non-Structural Metal Framing
 - .5 Section 09 99 99 – Materials List

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C423-22, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM D3273-21, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - .3 ASTM D3574-17, Standard Test Methods for Flexible Cellular Materials – Slab Bonded, and Molded Urethane Foams.
 - .4 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .5 ASTM F793/F793M-20, Standard Classification of Wall Covering by Use Characteristics.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 Underwriters Laboratories (UL):
 - .1 UL 181, Factory-Made Air Ducts and Connectors.
 - .4 Underwriters' Laboratories of Canada (ULC):
 - .1 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies. (ULC S102)

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures:
 - .1 Product Data: Submit manufacturer's technical data for each type of panel and baffle including fire-resistive characteristics, finishes, details of installation, and the following:
 - .1 Manufacturer's installation instructions.

- .2 Certified test reports indicating compliance with Performance Requirements specified herein.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Layout of work.
 - .2 Sizes and details of components.
 - .3 Anchorage methods.
- .3 Submit samples in accordance with Section 01 33 00 - Submittal Procedures:
 - .1 Submit two full size samples of baffles to Consultant in specified colour selection for final approval prior to ordering.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Closeout Submittals: Submit cleaning and maintenance instructions for incorporation into Operations and Maintenance Manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials
 - .1 Provide extra materials of acoustic units in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide baffles amounting to 5% of that installed in each pattern and type required for project.
 - .3 Ensure extra materials are from same production run as installed materials.
 - .4 Clearly identify each type of baffle, including colour and texture.
 - .5 Deliver to Consultant, upon completion of the work of this Section.

1.6 QUALITY ASSURANCE

- .1 Single Source Responsibility: Obtain baffles from a single manufacturer.
- .2 Installer: Use installers having a minimum of five years experience in successful application of acoustic baffles for projects of similar scope and complexity.
- .3 Mock-Ups:
 - .1 Construct mock-up 7 m² minimum of each type acoustical baffle including hangers.
 - .2 Verify spacing is adequate and as per design intent.
 - .3 Construct mock-up where directed.
 - .4 Allow 24 hours for inspection of mock-up by Consultant before proceeding with ceiling work.
 - .5 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of the finished work.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's instructions.
- .2 Deliver and store materials in manufacturer's original unopened containers with brands, names, and production lot numbers clearly marked on these containers.
- .3 Store products in a cool, dry place out of direct sunlight.
- .4 Protect from elements and from damage.
- .5 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 WARRANTY

- .1 Provide manufacturer's standard warranty in name of owner and include in Operations and Maintenance Manuals.

Part 2 Products

2.1 MANUFACTURERS

- .1 Basis-of-Design Materials:
 - .1 As indicated in Section 09 99 99 – Materials List.

2.2 MATERIALS

- .1 Baffles (C3): Prefabricated, sound absorptive, suspended ceiling blades.
 - .1 Material: Non-woven layered and formed Polyester felt (PET) fibre.
 - .2 Panel Size and Thickness: as indicated in Section 09 99 99 – Materials List.
 - .3 Colour: as indicated in Section 09 99 99 – Materials List.
 - .4 Edge Profile: Square.
 - .5 Fire Resistance: Class A in accordance with ASTM E84 and as follows:
 - .1 Flame Spread: 25 or less.
 - .2 Smoke Developed: 450 or less.
- .2 Suspension System: Manufacturer's recommended suspension system including connectors, cables and blade hanging assemblies.
 - .1 Basis-of-Design Materials:
 - .1 Aluminum Suspension System, Armstrong World Industries, Inc.

2.3 ACCESSORIES

- .1 1.6 mm steel cable to suit application as recommended by manufacturer.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper and or timely completion.
- .2 Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's written instructions and recommendations.
- .2 Acoustical Baffles: Do not fasten anchors of any type to steel deck without written approval from structural engineer of record.
 - .1 Install mounting cable by attaching to bottom chord of trusses or joists.
 - .2 Attach bottom end of cable directly to baffle's integral web strapping or grommets directly or with "S" type hooks.
 - .3 Install baffle in configuration and elevations indicated, true to lines and plane indicated.
 - .4 Do not install baffles more than 3000 mm below ceiling or roof structure from which it is hanging. This may cause excessive swaying of baffles by air movement.

3.3 NON-CONFORMING WORK

- .1 Remove damaged or discoloured material, or material that cannot be properly cleaned, and install new material.

3.4 CLEANING

- .1 Clean adjacent surfaces and remove unused product and debris from site.
- .2 Clean soiled surfaces of materials after installation is complete.
- .3 Remove and reinstall improperly installed material.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Acoustic panels.
- .2 Acoustical suspension system.
- .3 Accessories including sealants and expansion joints.

.2 Related Requirements:

- .1 Section 09 21 16 – Gypsum Board Assemblies
- .2 Section 09 51 53 – Direct-Attached Acoustical Ceilings
- .3 Section 09 99 99 – Materials List.
- .4 Division 23 – HVAC
- .5 Division 26 – Electrical

1.2 REFERENCES

.1 Reference Standards:

- .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C423-23, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C635/C635M-22, Standard Specifications for Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
 - .3 ASTM C636/C636M-19, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - .4 ASTM E580/E580M-22, Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.
 - .5 ASTM E795-23, Standard Practices for Mounting Test Specimens During Sound Absorption Tests
 - .6 ASTM E1264-23, Standard Classification for Acoustical Ceiling Products.
 - .7 ASTM E1477-98a (2022), Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
 - .8 ASTM F1667/F1667M-21a, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- .2 Association of the Wall and Ceiling Industry (AWCI).
- .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian General Standards Board (CGSB):

- .1 CAN/CGSB-92.1-M89, Sound Absorptive Prefabricated Acoustical Units. (Withdrawn)
- .5 Department of Justice Canada (Jus):
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .2 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .6 Underwriter's Laboratories of Canada (ULC):
 - .1 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies (ULC S102).

1.3 ADMINISTRATIVE REQUIREMENTS.

- .1 Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for each product specified.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling mounted items indicating the following:
 - .1 Ceiling suspension system members.
 - .2 Method of attaching suspension system hangers to building structure.
 - .3 Ceiling mounted items including light fixtures; air outlets and inlets; speakers; sprinklers; and special mouldings at walls, column penetrations, and other junctures of acoustic ceilings with adjoining construction.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit duplicate full size samples of each type of acoustical unit.
 - .2 Include accessories and mitered interior and exterior corners of wall mouldings.
- .4 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets acceptable to Labour Canada and Health and Welfare Canada.
- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials
 - .1 Provide extra materials of acoustic units in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide acoustical units amounting to 5% of gross ceiling area for each pattern and type required for project.
 - .3 Ensure extra materials are from same production run as installed materials.
 - .4 Clearly identify each type of acoustic unit, including colour and texture.
 - .5 Deliver to Consultant, upon completion of the work of this Section.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Fire-resistance rated floor/ceiling and roof/ceiling assembly: certified by Canadian Certification Organization accredited by Standards Council of Canada.
- .2 Single-Source Responsibility: Provide perimeter trim components, panels and grid components by a single manufacturer.
- .3 Ensure seismic restraint work including anchoring devices are designed and certified by a Professional Engineer registered in BC, who shall carry out periodic site reviews of the work of this Section during construction and at completion, and submit reports and Letters of Assurance in the Forms established by BC Building Code.
- .4 Mock-Ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct mock-up 10 m² minimum of each type of acoustical panel ceiling including one inside corner and one outside corner.
 - .3 Construct mock-up where directed.
 - .4 Allow 24 hours for inspection of mock-up by Consultant before proceeding with ceiling work.
 - .5 When accepted, mock-up will demonstrate minimum standard for this work. Reviewed mock-up may remain as part of the finished work.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 01 - LEED Product Requirements and as follows:
 - .1 Protect on site stored or installed absorptive material from moisture damage.
 - .2 Store extra materials required for maintenance, where directed by Consultant.
- .2 Packaging Waste Management

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 SITE CONDITIONS

- .1 Permit wet work to dry before beginning to install.
- .2 Maintain uniform minimum temperature of 15 degrees C and humidity of 20-40% before and during installation.
- .3 Store materials in work area 48 hours prior to installation.

1.9 WARRANTY

- .1 Provide manufacturers 30 year ceiling system warranty for failures including:
 - .1 Sagging and warping on panels.
 - .2 Growth of mould and mildew on panels.
 - .3 Rusting and manufacturers defects on grid system.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 Acoustic Panels:
 - .1 Armstrong World Industries Canada Ltd.
 - .2 CertainTeed.
 - .3 CGC Interiors, A USG Company.
 - .4 Rockfon.
 - .2 Suspension Systems:
 - .1 Armstrong World Industries Canada Ltd.
 - .2 CertainTeed.
 - .3 CGC Interiors, A USG Company.
 - .4 Chicago Metallic / Rockfon.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Maximum deflection: 1/360th of span to ASTM C635/C635M deflection test.

2.3 MATERIALS

- .1 Acoustic Panels (C4): conforming to ASTM E1264 as indicated in Section 09 99 99 – Materials List.
 - .1 Flame Spread: Class A.

2.4 ACOUSTICAL SUSPENSION SYSTEM

- .1 Intermediate duty system to ASTM C635/C635M.
- .2 Basic materials for suspension system: commercial quality cold rolled steel.
- .3 Suspension system: non fire rated, exposed tee bar grid width as appropriate for materials specified.
- .4 Acceptable Materials: materials to match products specified, use only materials from same manufacturers of panel products and as follows:
 - .1 Prelude XL 15/16" Exposed Tee, Armstrong.
 - .2 15/16" Classic, CertainTeed.
 - .3 DX/DXL, CGC, A USG Company.
 - .4 Chicago Metallic 1200, Rockfon.
- .5 Exposed tee bar grid components: shop painted satin sheen, white colour. Components die cut. Main tee with double web, rectangular bulb and 25 mm rolled cap on exposed face. Cross tee with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection.
- .6 Hanger wire: galvanized soft annealed steel wire:
 - .1 3.6 mm diameter for access tile ceilings.
 - .2 To ULC design requirements for fire rated assemblies.
 - .3 To suit seismic requirements and ceiling flatness requirements.
 - .4 2.78 mm diameter for other ceilings.
- .7 Hanger inserts: purpose made.
- .8 Accessories: splices, clips, wire ties, retainers and wall moulding flush, to complement suspension system components, as recommended by system manufacturer.
- .9 Edge Mouldings and Trim: Sheet metal edge mouldings and trim selected from manufacturer's standard mouldings for edges and penetrations that fit specified acoustic panel edge and suspension system, and as follows:
 - .1 Provide stepped edge moulding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member for lay in panels with tegular edged materials.
 - .2 Provide edge mouldings fabricated to diameter required to fit circular penetrations exactly.
 - .3 Provide edge mouldings and trims that match width and configuration of exposed runners including the following configurations:
 - .1 Sheet Metal Fillers: Light zinc coated sheet steel finished to match T-bar.
 - .2 Wall Mould: Channel or angle shape with a 25 mm or 22 mm exposed face.

.10 System Accessories:

- .1 Sealant: Acrylic type as specified in Section 07 92 00 - Sealants for use in exposed locations, colour to match ceiling grid.
- .2 Expansion Joint: 50% movement santoprene with mill finish aluminum base, colour from manufacturers standard range, confirm colour with Consultant.
 - .1 Basis-of-Design Material:
 - .1 ACWW-3, Balco.

Part 3 Execution

3.1 EXAMINATION

- .1 Do not install acoustical panels and tiles until work above ceiling has been reviewed by Consultant.

3.2 PREPARATION

- .1 Store materials in work area 48 hours prior to installation.

3.3 INSTALLATION OF SUSPENSION SYSTEM

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Installation: in accordance with ASTM C636/C636M except where specified otherwise.
- .3 Install suspension system to manufacturer's instructions and Certification Organizations tested design requirements.
- .4 Conform to building code for seismic restraints of ceiling grid and as follows:
 - .1 Minimum 50 mm wall molding.
 - .2 Attach suspension system to two adjacent walls, opposite walls must have a 19 mm clearance.
 - .3 Use heavy duty suspension system.
 - .4 Ceiling areas over 93 m2 must have horizontal restraint wire or rigid bracing.
 - .5 Ceiling areas over 232 m2 must have seismic separation joints or full height partitions.
 - .6 Ceilings without rigid bracing must have 50 mm oversized trim rings for sprinklers and other penetrations.
 - .7 Changes in ceiling plane must have positive bracing.
 - .8 Cable trays and electrical conduits must be independently supported and braced.
 - .9 Suspended ceilings are subject to special inspection.
 - .10 Provide perimeter support wires within 200 mm.

- .5 Do not erect ceiling suspension system until all mechanical and electrical work above ceiling has been inspected by Consultant.
- .6 Secure hangers to overhead structure using attachment methods acceptable to Consultant.
- .7 Install hangers spaced at maximum 1200 mm centres and within 150 mm from ends of main tees.
- .8 Lay out system according to reflected ceiling plan.
- .9 Ensure suspension system is co-ordinated with location of related components.
- .10 Install wall moulding to provide correct ceiling height.
- .11 Completed suspension system to support super-imposed loads, such as lighting fixtures, diffusers grilles and speakers.
- .12 Support at light fixtures and diffusers with additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .13 Interlock cross member to main runner to provide rigid assembly.
- .14 Finished ceiling system to be square with adjoining walls and level within 1:1000.
- .15 Expansion joints:
 - .1 Erect two main runners parallel, 25 mm apart, on building expansion joint line. Lay in strip of acoustic tile/board, painted colour as directed, 25% narrower than space between 2 'T' bars.
 - .2 Supply and install "Z" shaped metal trim pieces at each side of expansion joint. Design to accommodate plus or minus 25 mm movement and maintain visual closure. Finish metal components to match adjacent exposed metal trim. Provide backing plates behind butt joints.

3.4 INSTALLATION OF ACOUSTIC PANELS

- .1 Install acoustic panels and tiles in ceiling suspension system.

3.5 APPLICATION

- .1 Refer to reflected ceiling plan.
- .2 Scribe acoustic units to fit adjacent work. Butt joints tight, terminate edges with moulding.
- .3 Paint cut panel edges remaining exposed after installation; match colour of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.6 SYSTEM INTEGRATION

- .1 Co-ordinate ceiling work to accommodate components of other Sections, such as light fixtures, diffusers, speakers, sprinkler heads, to be built into acoustical ceiling components.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Non-Woven layered and formed Polyester felt fiber ceiling and wall panels.
 - .2 Wire hangers, fasteners, main runners, cross tees, and accessories.
- .2 Related Requirements:
 - .1 Section 09 21 16 – Gypsum Board Assemblies
 - .2 Section 09 22 00 – Non-Structural Metal Framing
 - .3 Section 09 48 33 – Acoustic Baffles
 - .4 Section 09 51 13 – Acoustical Panel Ceilings
 - .5 Section 09 99 99 – Materials List
 - .6 Division 23 Mechanical: HVAC
 - .7 Division 26 Electrical: Lighting

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A1008/A1008M-23e1, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - .2 ASTM A641/A641M-19, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .3 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .4 ASTM C423-23, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .5 ASTM C635/C635M-22, Standard Specifications for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
 - .6 ASTM C636/C636M-19, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - .7 ASTM D3273-21, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - .8 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .9 ASTM E580/E580M-22, Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.

- .10 ASTM E1264-23, Standard Classification for Acoustical Ceiling Products.
- .11 ASTM E1414/E1414M-21a, Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 National Fire Protection Agency (NFPA):
 - .1 NFPA (Fire) 70, National Electrical Code, 2020 Edition.
- .4 Underwriter's Laboratories of Canada (ULC):
 - .1 ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies. (ULC S102)

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination of Work: Coordinate Work of this Section with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for each product specified.
 - .2 Certifications: submit manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, products must be tested to the A, D-20, C-20, or C-40 method.
- .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit minimum 152 mm x 152 mm samples of direct-attached acoustical ceiling panels.
- .3 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit layout and details of direct-attached ceiling panels showing locations of items that are to be coordinated with the installation.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 EXTRA MATERIALS SUBMITTALS

- .1 Provide extra materials of acoustic units in accordance with Section 01 78 00 – Closeout Submittals.
- .2 Extra Materials: Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.

- .1 Direct-Attached Ceiling Panels: Furnish quality of full-size units equal to five percent of amount installed.

- .3 Deliver to Consultant, upon completion of the work of this Section.

1.6 QUALITY ASSURANCE

- .1 Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.
- .2 Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
 - .1 Surface Burning Characteristics: tested in accordance with ASTM E84 and complying with ASTM E1264 Classification.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 01 – LEED Product Requirements.
- .2 Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- .3 Provide labels indicating brand name, style, size and thickness.
- .4 Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.
- .5 Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.
- .6 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 SITE CONDITIONS

- .1 Do not install ceiling panels until building is closed in and HVAC system is operational.
- .2 Locate materials onsite at least 24 hours before beginning installation to allow materials to reach temperature and moisture content equilibrium.
- .3 Ambient Conditions: Maintain the following conditions in areas where acoustical materials are to be installed 24 hours before, during and after installation:
 - .1 Relative Humidity: 65 - 75%.
 - .2 Uniform Temperature: 13 - 21 degrees C.

1.9 WARRANTY

- .1 Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:
 - .1 Sagging and warping.

- .2 Direct-attached ceiling panels one source manufacturer is thirty years from date of Substantial Performance.

Part 2 Products

2.1 PERFORMANCE/DESIGN CRITERIA

- .1 Maximum deflection: 1/360th of span to ASTM C635/C635M deflection test.

2.2 MATERIALS

- .1 Direct-Attached Acoustic Panels (C1):
 - .1 Material: Non-woven layered and formed Polyester felt (PET) fibre.
 - .2 NRC: 0.85
 - .3 Size: as indicated on Drawings.
 - .4 Edge Profile: Bevelled.
 - .5 Fire Resistance: Class A in accordance with ASTM E84 and as follows:
 - .1 Flame Spread: 25 or less.
 - .2 Smoke Developed: 450 or less.
 - .6 Basis-of-Design Materials:
 - .1 As indicated in Section 09 99 99 – Materials List.

2.3 ACCESSORIES

- .1 Main beams and cross tees: commercial quality hot-dipped galvanized steel.
- .2 Main Beams: manufactured main beam 38 mm knurled face with reverse hem by 43 mm high by 3658 mm long with factory punched cross tee routs and hanger wire holes and main beam clip. Heavy-duty performance per ASTM C635/C635M.
- .3 Cross Tee: manufactured cross tee 38 mm knurled face with reverse hem by 38 mm high by length to suit with factory punched cross tee routs and hanger wire holes and XL stake on clip.

Part 3 Execution

3.1 EXAMINATION

- .1 Do not proceed with installation until all wet work such as concrete, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

3.2 PREPARATION

- .1 Locate materials onsite at least 24 hours before beginning installation to allow materials to reach temperature and moisture content equilibrium.
- .2 Measure each ceiling area and establish layout of units. Coordinate panel layout with mechanical and electrical fixtures.

- .3 Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other Sections.
- .4 Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.3 INSTALLATION

- .1 Install direct-attached ceiling panels in accordance with manufacturer's installation instructions.
- .2 Replace damaged and broken units.

3.4 CLEANING

- .1 Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any units that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Vinyl composition tile.
- .2 Resilient base.
- .3 Accessories:
 - .1 Metal edge strips.
 - .2 Sub-floor filler and leveller.
 - .3 Primers and adhesives.
 - .4 Sealer and wax.

.2 Related Requirements:

- .1 Section 03 35 00 – Concrete Finishing
- .2 Section 06 10 00 – Rough Carpentry
- .3 Section 07 92 00 – Sealants
- .4 Section 09 99 99 – Materials List

1.2 REFERENCES

.1 Reference Standards:

- .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM F150-06(2018), Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
 - .2 ASTM F710-22, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 - .3 ASTM F1066-23, Standard Specification for Vinyl Composition Floor Tile.
 - .4 ASTM F1516-23, Standard Practice for Sealing Seams of Resilient Flooring Products by the Heat Weld Method (when Recommended).
 - .5 ASTM F1861-21, Standard Specification for Resilient Wall Base.
 - .6 ASTM F1869-23, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - .7 ASTM F2170-19a, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .3 National Floor Covering Association (NFCA):
 - .1 NFCA Floor Covering Reference Manual of Canada.
 - .2 NFCA Quality Assurance Program (QAP).
 - .3 NFCA Accredited Quality Assurance (AQA) Provider.
- .4 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.

- .2 SCAQMD Rule 1168-22, Adhesives and Sealants Applications.
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 ULC 102.2, Standard Method of Test for Surface Burning Characteristics of Floor Coverings and Miscellaneous Materials and Assemblies (ULV S102.2).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit one copy of product data for each type of product specified.
 - .2 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets for flooring adhesive and seam welding. Indicate VOC content.
 - .3 Provide seaming diagram prior to laying flooring.
- .2 Provide samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit duplicate 300 x 300 mm sample pieces of sheet material, 300 mm long base.
- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide manufacturer's printed recommendations for general maintenance, including cleaning instructions and guidelines for use of waxes and other protective coatings and appearance enhancers in accordance with Section 01 78 00 – Closeout Submittals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials
 - .1 Provide extra materials of resilient sheet flooring and adhesives in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide 5 % of each colour, pattern and type flooring material required for project for maintenance use.
 - .3 Extra materials from same production run as installed materials.
 - .4 Clearly identify each roll of sheet flooring and each container of adhesive.
 - .5 Deliver to Owner upon completion of the work of this Section.
 - .6 Store where directed by Consultant.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: Provide products that meet requirements of ULC 102.2 as applicable for required flame spread ratings; labelled and listed by Underwriters Laboratories of Canada (ULC), or another testing and inspecting agency acceptable to authorities having jurisdiction.
- .2 Provide preparation, materials and workmanship in strict accordance with NFCA requirements as detailed in the latest (online) edition of the NFCA Floor Covering Reference Manual of Canada, (www.floorcoveringreferencemanual.com) and the

material manufacturer's written recommendations for conditions of work and guarantee periods stated.

- .3 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Installer shall be Trade Qualified for their specific flooring products by the National Floor Covering Association.
 - .2 Resilient Flooring Installer: Use an installer who is competent in heat welding and have a minimum of five years documented experience in the installation of resilient sheet flooring and seams in accordance with manufacturer's training or certification program:
 - .3 Source Limitations: Obtain each type, colour, and pattern of flooring or accessories specified from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
- .4 Mock-Up:
 - .1 Construct mock-ups as directed by Consultant to verify selections made under sample Submittals and to demonstrate aesthetic effects, patterns, and qualities of materials, and execution before installing flooring materials and accessories in accordance with requirements in Section 01 45 00 – Quality Control.
 - .2 Install in a representative room designated by the Consultant, a sample flooring installation of at least 10 m² in area showing pattern as directed by Consultant, colour matching, and longitudinal and transverse joints for the Consultants' review and acceptance.
 - .3 The mock-up room shall represent the minimum acceptable standard for the Work when identified modifications to the mock-up are completed, reviewed, and accepted by the Consultant.
 - .4 Accepted mock-up room installation can remain as part of the Work.

1.7 NFCA QUALITY ASSURANCE PROGRAM

- .1 All Work described in this Section is included under the Quality Assurance Program (QAP) of NFCA (National Floor Covering Association), as detailed in the latest (online) edition of the Floor Covering Reference Manual of Canada (www.floorcoveringreferencemanual.com) and will be reviewed in accordance with QAP requirements therein by a third party Inspection Agency assigned by the Accredited Quality Assurance (AQA) Provider. Include the cost of this program in the Contract Price.
- .2 Replace preparation, materials, and workmanship that do not meet NFCA requirements in accordance with Quality Assurance requirements without any additional cost to the Owner.
- .3 Provide a two-year NFCA Maintenance Bond.
- .4 Request a QA Review Form (Part A04A) from NFCA and submit prior to ordering materials.
- .5 Meet the requirements detailed in PART A05 Trade Qualifications in the latest edition of the NFCA Floor covering Reference Manual.

- .6 Installer Qualifications: be a member in good standing of the National Floor Covering Association (NFCA) and referenced on the NFCA website (www.nfca.ca).

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials in good conditions to the jobsite in the manufacturer's original unopened containers that bear the name and brand of the manufacturer, project identification, and shipping and handling instructions.
- .3 Store materials in a clean, dry, enclosed space off the ground, and protect from the weather and from extremes of heat and cold. Protect adhesive from freezing. Store flooring, adhesives and accessories in the spaces where they will be installed for at least 48 hours before beginning installation.
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.9 SITE CONDITIONS

- .1 Ambient Conditions: Maintain air temperature and structural base temperature at flooring installation area above 20 degrees for 48 hours before, during and 48 hours after installation.

1.10 WARRANTY

- .1 Provide Manufacturer's Warranty for product to be free from manufacturer's defects for a period of five years from date of substantial performance.
- .2 Provide a two-year NFCA Maintenance Bond as indicated above.

Part 2 Products

2.1 MATERIALS

- .1 Basis-of-Design Materials: Materials and colours listed below form the Basis-of-Design materials for this project.
- .2 Materials other than named products Basis-of-Design materials may be acceptable to the Consultant; submit information in accordance with Section 01 62 00 – Product Options and Substitutions no later than seven days prior to bid closing date and as follows:
 - .1 Proposed alternates shall match colour range, texture and performance characteristics of named products, and shall not require a change to colour board for Project.
 - .2 Proposed alternates found acceptable by Consultant will be listed in an Addendum.
 - .3 The Consultant is not obliged to accept any materials presented for their review and does not need to provide reasons for rejection of proposed alternates.

2.2 TILE FLOORING

- .1 Vinyl composition tile (VCT1, VCT2): to ASTM F1066, and as follows:
 - .1 Class: One – solid colour tile
 - .2 Pattern: plain.
 - .3 Wearing surface: smooth
 - .4 Thickness: 3.17 mm.
 - .5 Size: as indicated.
 - .6 Colour: as indicated in Section 09 99 99 – Materials List

2.3 RESILIENT BASE

- .1 Resilient Base (RB1): to ASTM F1861, and as indicated in Section 09 99 99 – Materials List.
 - .1 Type: TP – rubber, thermoplastic
 - .2 Group: One – solid
 - .3 Style: B – Cove
 - .4 Thickness: 3.17 mm.
 - .5 Height: 101 mm.
 - .6 Length: 36.5 meter rolls.
 - .7 End Stops and External Corners: premoulded.
 - .8 Colour: as indicated in Section 09 99 99 – Materials List

2.4 ACCESSORIES

- .1 Metal edge strips (TS1):
 - .1 Extruded, smooth, mill finish stainless steel with lip to extend under floor finish, shoulder flush with top of adjacent floor finish.
 - .2 Finish and Profile: as indicated in Section 09 99 99 – Materials List.
- .2 Sub-floor filler and leveller: white premix latex requiring water only to produce cementitious paste or Two part latex-type filler requiring no water as recommended by flooring manufacturer for use with their product.
- .3 Primers and adhesives: of types recommended by resilient flooring manufacturer for specific material on applicable substrate, above, on or below grade.
 - .1 VCT adhesives:
 - .1 SBR Emulsion polymer, wet-lay moisture resistant adhesive with maximum VOC limit 50 g/L to SCAQMD Rule 1168.
 - .2 Basis-of-Design Materials:
 - .1 Ultrabond ECO 711, MAPEI Inc.
 - .2 Resilient base adhesives:
 - .1 Acrylic polymer, vertical surface impact resistant adhesive with maximum VOC limit 50 g/L to SCAQMD Rule 1168.
 - .2 Basis-of-Design Materials:
 - .1 Ultrabond ECO 575, MAPEI Inc.

- .4 Sealer and wax: type recommended by resilient flooring material manufacturer for material type and location that does not affect the warranty or the slip resistance.
 - .1 Sealer: maximum VOC limit 100 g/L to SCAQMD Rule 1113.

Part 3 Execution

3.1 EXAMINATION

- .1 Install flooring and accessories after the other finishing operations, including painting, have been completed. Close spaces to traffic during the installation of the flooring. Do not install flooring over concrete slabs until they are sufficiently dry to achieve a bond with the adhesive, in accordance with the manufacturer's recommended bond and moisture tests.
- .2 Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring substrate.
- .3 Ensure concrete floors have maximum 2.5% moisture content, exhibit normal alkalinity and no carbonization or dusting.
- .4 Ensure concrete floors are clean, smooth, and flat to plus or minus 3 mm over 3 meters.

3.2 PREPARATION

- .1 Remove existing resilient flooring.
- .2 Remove or treat old adhesives to prevent residual, old flooring adhesives from bleeding through to new flooring and/or interfering with the bonding of new adhesives.
- .3 Clean floor and apply filler; trowel and float to leave smooth, flat hard surface. Prohibit traffic until filler cured and dry.
- .4 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .5 Prohibit traffic until filler is cured
- .6 Clean substrates of contaminants.
- .7 Alkalinity and Adhesion Testing: perform tests recommended by manufacturer. Proceed with installation after substrates pass testing.
- .8 Moisture Testing: perform tests recommended by manufacturer and as follows:
 - .1 Perform anhydrous calcium chloride test ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapour-emission rate of 3 lb of water/1000 sq. ft in 24 hours.
 - .2 Perform relative humidity test using in situ probes, ASTM F2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.
 - .3 Proceed with installation after substrates pass testing.

- .9 Prime or seal concrete slab or plywood sub-floor to resilient flooring manufacturer's printed instructions.

3.3 INSTALLATION: GENERAL

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Provide high ventilation rate, with maximum outside air, during installation, and for 48 to 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through district or whole building air distribution system. Maintain extra ventilation for at least one month following building occupation.
- .3 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturer's instructions. Do not spread more adhesive than can be covered by flooring before initial set takes place.
- .4 Cut flooring around fixed objects.
- .5 Install feature strips and floor markings where indicated. Fit joints tightly.
- .6 Install flooring in pan type floor access covers. Maintain floor pattern.
- .7 Continue flooring over areas which will be under built-in furniture.
- .8 Continue flooring through areas to receive movable type partitions without interrupting floor pattern.
- .9 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .10 Install metal edge strips at unprotected or exposed edges where flooring terminates.

3.4 INSTALLATION: FLOOR TILE

- .1 Lay flooring with joints parallel to building lines to produce symmetrical tile pattern. Border tiles minimum half tile width.
- .2 Install flooring to pattern as directed.
- .3 As installation progresses and after installation is complete, roll resilient tile flooring in accordance with manufacture's instructions.

3.5 INSTALLATION: BASE

- .1 Lay out base to keep number of joints at minimum.
- .2 Clean substrate and prime with one coat of adhesive.
- .3 Apply adhesive to back of base.
- .4 Set base against wall and floor surfaces tightly by using 3 kg hand roller.
- .5 Install straight and level to variation of 1:1000.
- .6 Scribe and fit to door frames and other obstructions. Use premoulded end pieces at flush door frames.

- .7 Cope internal corners. Use premoulded corner units for right angle external corners. Use formed straight base material for external corners of other angles.
- .8 Use toeless type base where floor finish will be carpet, coved type elsewhere.
- .9 Install toeless type base before installation of carpet on floors.
- .10 Heat weld base in accordance with manufacturer's printed instructions.

3.6 INSTALLATION: ACCESSORIES

- .1 Install feature strips and floor markings where indicated. Fit joints tightly.

3.7 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.8 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Remove excess adhesive from floor, base and wall surfaces without damage.
- .3 Clean, seal and wax floor and base surface to flooring manufacturer's printed instructions.

3.9 PROTECTION

- .1 Protect new floors from time of final set of adhesive until final inspection.
- .2 Prohibit traffic on floor for 48 hours after installation.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes resinous flooring systems with epoxy body and covered base.
- .2 Related Requirements:
 - .1 Section 03 35 00 – Concrete Finishing
 - .2 Section 07 92 00 – Sealants
 - .3 Section 09 99 99 – Materials List

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C307-23, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing's.
 - .2 ASTM C413-18(2023), Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing's and Polymers Concretes.
 - .3 ASTM C579-23, Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing's, and Polymer Concretes.
 - .4 ASTM C580-18(2023), Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing's, and Polymer Concretes.
 - .5 ASTM C811-98(2023), Standard Practice for Surface Preparation of Concrete for Application of Chemical-Resistant Resin Monolithic Surfacing's. (Withdrawn 2012)
 - .6 ASTM D2240-15(2021) Standard Test Method for Rubber Property – Durometer Hardness.
 - .7 ASTM D2794-93(2024), Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - .8 ASTM E648-23, Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
 - .9 ASTM F1869-23, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - .10 ASTM F2170-19a, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meeting one week prior to beginning work of this Section, with Contractor, Consultant, installer, manufacturer's representative to:
 - .1 Verify project requirements.

- .2 Review installation and substrate conditions.
- .3 Co-ordination with other building subtrades.
- .4 Review manufacturer's installation instructions and warranty requirements.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's technical data, application instructions, and general recommendations for each resinous flooring material required.
- .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Verification Sample: submit 150 mm x 150 mm samples of each type of resinous flooring required, applied to a rigid backing, in colour and finish indicated.
- .3 Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- .4 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART THREE - FIELD QUALITY CONTROL.
- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS:

- .1 Submit in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Submit copies of manufacturer's written maintenance information for inclusion in the operations manual including specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: materials, including primers, resins, curing agents, finish coats, aggregates and sealants are manufactured and tested under an ISO 9001 registered quality system.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Manufacturers: Obtain primary materials from a single manufacture with not less than ten years of successful experience in manufacturing and installing principal materials described in this Section. Contractor shall have completed at least five projects of similar size and complexity.
 - .2 Applicators: Use experienced applicators as approved by materials manufacturer who have completed a minimum of ten applications similar in material and extent to those indicated and whose work has a record of successful in service performance.
- .3 Single-Source Responsibility: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer. Provide secondary materials,

including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

.4 Mock-Ups:

.1 Provide required mock-up in accordance with Section 01 45 00 – Quality Control and as follows:

- .1 Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
- .2 Apply full-thickness mockups on 10 m² floor area selected by Consultant.
- .3 Include 1 m length of integral cove base.
- .4 Reviewed mockups may become part of the completed Work if undisturbed at time of Substantial Performance.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
- .2 Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.
- .3 Materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on-site weighing or volumetric measurements allowed.
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
 - .2 Maintain material and substrate temperature between 18°C and 30°C during resinous flooring application and for not less than 24 hours after application.
- .2 Site Conditions:
 - .1 Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
 - .2 Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.
 - .3 Concrete substrate shall be properly cured for a minimum of 30 days. A vapor barrier must be present for concrete subfloors on or below grade.

Otherwise, an osmotic pressure resistant grout must be installed prior to the resinous flooring.

1.9 WARRANTY

- .1 Provide manufacturer's written warranty covering both material and workmanship for a period of one full year from date of Substantial Performance, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of one full year from date of Substantial Performance.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements in this Section and as recommended by the manufacturer, manufacturers offering products that may be incorporated into the Work include the following:
 - .1 MAPEI Inc.
 - .2 Sika Canada Inc.
 - .3 Stonhard Group.

2.2 MATERIALS

- .1 Basis-of-Design Materials: Materials and colours listed below form the Basis-of-Design materials for this project.
- .2 Materials other than named products Basis-of-Design materials may be acceptable to the Consultant; submit information in accordance with Section 01 62 00 – Product Options and Substitutions no later than seven days prior to bid closing date and as follows:
 - .1 Proposed alternates shall match colour range, texture and performance characteristics of named products, and shall not require a change to colour board for Project.
 - .2 Proposed alternates found acceptable by Consultant will be listed in an Addendum.
 - .3 The Consultant is not obliged to accept any materials presented for their review and does not need to provide reasons for rejection of proposed alternates.

2.3 COMPONENTS

- .1 Resinous Flooring (EC1): troweled mortar base with broadcast topping. Liquid rich, slurry type systems will not be accepted.
 - .1 System Characteristics:
 - .1 Colour and Pattern: as indicated in Finish Schedule or as selected by Consultant from manufacturer's standards.
 - .2 Wearing Surface: medium.
 - .3 Integral Cove Base: as indicated in Finish Schedule or as directed by Consultant.

- .4 Overall System Thickness: nominal 6 mm.
- .2 System Components: Manufacturer's standard components that are compatible with each other and as follows:
 - .1 Primer:
 - .1 Resin: epoxy.
 - .2 Formulation Description: two component, 100 percent solids.
 - .3 Application Method: squeegee and roller.
 - .4 Number of Coats: one.
 - .5 Basis of Design Materials:
 - .1 Standard Primer, Stonhard Group.
 - .2 Mortar Base:
 - .1 Resin: epoxy.
 - .2 Formulation Description: three component, 100 percent solids.
 - .3 Application Method: metal trowel.
 - .1 Thickness of Coats: nominal 4 mm.
 - .2 Number of Coats: one.
 - .4 Aggregates: pigmented blended aggregate.
 - .5 Basis-of-Design Materials:
 - .1 Stonshield HRI Base, Stonhard Group.
 - .3 Undercoat:
 - .1 Resin: epoxy.
 - .2 Formulation Description: two-component, 100% solids, UV stable.
 - .3 Type: clear.
 - .4 Finish: gloss.
 - .5 Number of Coats: one.
 - .6 Basis-of-Design Materials:
 - .1 Stonshield undercoat, Stonhard Group.
 - .4 Broadcast Media:
 - .1 Type: pigmented.
 - .2 Number of Coats: one.
 - .3 Pattern: confirm with Consultant.
 - .4 Basis-of-Design Materials:
 - .1 Stonshield quartz aggregate, Stonhard Group.
 - .5 Sealer:
 - .1 Resin: epoxy.
 - .2 Formulation Description: two-component, 100% solids, UV stable.
 - .3 Type: clear.
 - .4 Finish: flat.
 - .5 Number of Coats: one.

- .6 Texture level: medium.
- .7 Basis-of-Design Materials:
 - .1 Stonshield Sealer, Stonhard Group.
- .3 System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
 - .1 Compressive Strength: 10,000 psi after 7 days per ASTM C579.
 - .2 Tensile Strength: 2,000 psi per ASTM C307.
 - .3 Flexural Strength: 4,300 psi per ASTM C580.
 - .4 Water Absorption: < 1% per ASTM C413.
 - .5 Impact Resistance: > 160 in. lbs. per ASTM D2794.
 - .6 Flammability: Class 1 per ASTM E648.
 - .7 Hardness: 85 to 90, Shore D per ASTM D2240.
- .4 Acceptable Materials:
 - .1 Sikafloor® Quartzite® HDB System, Sika Canada.
 - .2 Stonshield HRI®, Stonhard Group.
- .2 Resinous Flooring (RC1): troweled mortar base with broadcast topping. Liquid rich, slurry type systems will not be accepted.
 - .1 System Characteristics:
 - .1 Colour and Pattern: as indicated in Finish Schedule or as selected by Consultant from manufacturer's standards.
 - .2 Wearing Surface: medium
 - .3 Integral Cove Base: 203 mm high and as indicated in Finish Schedule.
 - .4 Overall System Thickness: nominal 6 mm
 - .2 System Components: Manufacturer's standard components that are compatible with each other and as follows:
 - .1 Primer:
 - .1 Resin: epoxy
 - .2 Formulation Description: two component, 100 percent solids.
 - .3 Application Method: squeegee and roller.
 - .4 Number of Coats: one.
 - .5 Basis of Design Materials: Stonhard Standard Primer.
 - .2 Mortar Base:
 - .1 Resin: epoxy
 - .2 Formulation Description: three component, 100 percent solids.
 - .3 Application Method: metal trowel.
 - .1 Thickness of Coats: nominal 6 mm.
 - .2 Number of Coats: one.
 - .4 Aggregates: pigmented blended aggregate.
 - .5 Basis of Design Materials: Stonclad GS

- .3 Topcoat:
 - .1 Resin: epoxy
 - .2 Formulation Description: two-component, 100% solids, UV stable.
 - .3 Type: pigmented.
 - .4 Finish: standard.
 - .5 Number of Coats: two.
 - .6 Basis of Design Materials: Stonkote GS4
- .3 System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
 - .1 Compressive Strength: 10,000 psi after 7 days per ASTM C579.
 - .2 Tensile Strength: 1,750 psi per ASTM C307.
 - .3 Flexural Strength: 4,000 psi per ASTM C580.
 - .4 Water Absorption: < 1% per ASTM C413.
 - .5 Impact Resistance: > 18 Nm. per ASTM D2794.
 - .6 Flammability: Class 1 per ASTM E648.
 - .7 Hardness: 85 to 90, Shore D per ASTM D2240.
- .4 Basis of Design:
 - .1 Stonhard, Stonclad GS

2.4 ACCESSORIES

- .1 Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
- .2 Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated.

Part 3 Execution

3.1 PREPARATION

- .1 General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.
- .2 Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 - .1 Mechanically prepare substrates as follows:
 - .1 Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - .2 Comply with ASTM C811 requirements, unless manufacturer's written instructions are more stringent.
 - .2 Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.

- .3 Verify that concrete substrates are dry.
 - .1 Perform in situ probe test, ASTM F2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 75 percent.
 - .2 Perform anhydrous calcium chloride test, ASTM F1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft. of slab in 24 hours.
 - .3 Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- .4 Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- .3 Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
- .4 Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- .5 Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations.

3.2 APPLICATION

- .1 General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - .1 Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 - .2 Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
 - .3 At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.
 - .1 Apply joint sealant to comply with manufacturer's written recommendations.
- .2 Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.
- .3 Integral Cove Base: apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, of cove base. Round internal and external corners.
- .4 Apply metal trowel single mortar coat in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, sand to remove trowel marks and roughness.

- .5 Undercoat: Remove any surface irregularities by lightly abrading and vacuuming the floor surface. Mix and apply undercoat with strict adherence to manufacturer's installation procedures and coverage rates.
- .6 Broadcast Media: Immediately broadcast quartz silica aggregate into the undercoat using manufacturer's specially designed spray caster. Strict adherence to manufacturer's installation procedures and coverage rates is imperative.
- .7 Apply topcoat(s) in number of coats indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.3 TERMINATIONS

- .1 Chase edges to "lock" the coating system into the concrete substrate along lines of termination.
- .2 Penetration Treatment: Lap and seal coating onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.
- .3 Trenches: Continue coating system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.
- .4 Treat floor drains by chasing the coating to lock in place at point of termination.

3.4 JOINTS AND CRACKS

- .1 Treat control joints to bridge potential cracks and to maintain monolithic protection.
- .2 Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.
- .3 Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.5 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.

- .4 Obtain reports within three days of review and submit.
- .5 Material Sampling: Owner may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.
 - .1 Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
 - .2 Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
 - .3 If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.6 CURING

- .1 Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 18 hours after application.

3.7 CLEANING

- .1 Cleaning: Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.

3.8 PROTECTION

- .1 Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application.
- .2 Protect surfaces after final coats.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Printable vinyl wall film.
- .2 Related Requirements:
 - .1 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM D1004-21, Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
 - .2 ASTM D3330/D3330M-04(2018), Standard Test Method for Peel Adhesion of Pressure-Sensitive Tape.
 - .3 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.
 - .2 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures (after meeting with Consultant as indicated in Quality Assurance):
 - .1 Submit two 610 x 610 mm samples of glazing film of each product specified. Submit one strike off sample for each glazing and wall location showing custom vinyl graphic. Allow for one revision and resubmittal.
- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00 – LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit copies of warranty to be issued including conditions and limitations.
- .2 Submit Closeout Submittals in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Submit maintenance and cleaning instructions describing proper cleaning procedures and proper cleaning solutions.

- .2 Follow manufacturers written instructions for care and maintenance of security and safety film.
- .3 Use only cleaning solution recommended by manufacturer for regularly scheduled cleaning of security film.

1.5 QUALITY ASSURANCE

- .1 Meetings: Supplier must attend one meeting at office of the Consultant to discuss the package prior to printing samples.
- .2 Film installation Subcontractor to be factory approved and have a minimum of three years documented experience on not less than five similar installations.
- .3 Use adequate numbers of skilled workmen, thoroughly trained and experienced in the installation of this film system.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 01 – LEED Product Requirements.
- .2 Provide and maintain dry, off-ground weatherproof storage.
- .3 Store rolls of film flat on cross supports. Do not stand rolls of film on end.
- .4 Remove from storage, in quantities required for same day use.
- .5 Store materials in accordance with manufacturers written instructions.
- .6 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 WARRANTY

- .1 Provide warranty for film to include in maintenance manuals as specified in Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 FILMS

- .1 Printable Wall Film: vinyl film, adhered to metal surfaces, computer generated and cut. Provide letters and shapes as indicated on Drawings in size and font as indicated on Drawings.
- .2 Colours: as indicated on Drawings or as directed by Consultant.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine substrates for compliance with requirements for non-porous, smooth surface and other conditions affecting the performance of work in this section. Do not proceed with installation until unsatisfactory conditions have been corrected.

- .2 Refer to manufacturer's installation guide to determine compatibility of finish to substrate.
- .3 Do not proceed with installation until unsatisfactory conditions have been corrected.
- .4 Proceed with installation only on surfaces which are satisfactory.

3.2 PREPARATION

- .1 Comply with manufacturer's instructions for surface preparation and as follows:
 - .1 Provide smooth substrate to avoid telegraphing of surface texture.
 - .2 Ensure that the existing paint, surface finish, or wall covering has excellent bond to the substrate area where material will be applied.
 - .3 Repair, prime and paint the substrate as required.
 - .4 An adhesion promoter maybe required to increase adhesion.
 - .5 Temperature and humidity are within recommended range.
- .2 Test and prepare surfaces in accordance with manufacturer's installation guide and as follows:
 - .1 Use manufacturer's recommended wall adhesion test to determine the compatibility of the application surface with the film material.
 - .2 Use manufacturer's recommended enhanced cleaning method to ensure that the application surface is ready to received the hold film materials.
- .3 Repair damaged application surfaces per manufacturer's installation guide.
- .4 Re-clean application surface with a lint-free cloth and in accordance with manufacturer's installation guide.

3.3 INSTALLATION

- .1 Install in accordance with manufacturer's written instructions.
- .2 Perform application by a qualified installer approved by manufacturer.
- .3 Do not proceed with installation until finishing work has been completed in and around the work area.
- .4 Measure the application surface and cut film to size with a minimum 13 mm extra on all side for trimming.
- .5 Install substrates with no gaps, wire seams, or overlaps. Form smooth, wrinkle-free, bubble-free surface for finished installation.
- .6 No exposed joints on corners or other open type joints permitted.
- .7 Verify pattern prior to material acquisition.
- .8 Apply over properly prepared substrates.
- .9 Remove air bubbles, wrinkles and blisters. Use procedures to prevent the formation of air bubbles, wrinkles, blisters and other defects.

3.4 CLEANING

- .1 Use cleaning methods recommended by manufacturer for applicable environment.
- .2 Remove debris and leave areas neat and clean.

3.5 PROTECTION

- .1 Protect completed film during remainder of construction period.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.
 - .2 Provide labour, materials, tools and other equipment, services and supervision required to complete interior and exterior, including above roof, painting and decorating work.
 - .3 Surface preparation for this section will be limited to priming and back-priming, and specific pre-treatments noted in this section or as specified in the Master Painters Institute (MPI) Painting Specification Manual.
- .2 Related Requirements:
 - .1 Technical sections as indicated.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM F1869-23, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 The Master Painters Institute (MPI):
 - .1 Approved Products List
 - .2 Architectural Painting Specification Manual.
 - .3 Maintenance Repainting/Restoration Manual.
 - .4 The Society for Protective Coatings (SSPC):
 - .1 SSPC Paint Series, Paint Guidelines.
 - .2 SSPC SP Series, Surface Preparation Guidelines.
 - .3 SSPC-PA Series, Paint Application Guidelines.
 - .5 Underwriters Laboratories ECOLOGO Certification Program (UL):
 - .1 UL 2768, Architectural Surface Coatings (formerly CCD 47).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Comply with requirements of Section 01 33 00 – Submittal Procedures.
- .2 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Product Data: Submit list of all painting materials used for the Work to the Consultant for review prior to ordering materials for each paint system indicated, including block fillers and primers:
 - .1 Material List: An inclusive list of required coating materials indicating each material and cross reference specific coating,

- finish system, and application; identify each material by manufacturer's catalogue number and general classification.
 - .2 Base Information: Confirmation of manufacturer's ability to supply paint in a variety of base tints, specific to the range of colours being used on this project; indicate colour of base tint used and amount of colourant added to establish Scheduled colours.
 - .3 Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
- .2 Samples: Provide stepped samples, defining each separate coat, including block fillers and primers using representative colours required for the project; label each sample for location and application, and as follows:
- .1 Samples for Verification: When requested by the Consultant, provide samples for each colour and material, with texture to simulate actual conditions, on representative samples of the actual substrate as follows:
 - .1 Painted Wood: 200 mm long or square samples for each colour and material on representative sample wood used for the Work.
 - .2 Stained or Natural Wood: 200 mm long or square samples of natural or stained wood finish on representative species of wood used for the Work.
 - .3 Painted Gypsum Board: 200 mm long or square samples for each colour and material.
- .3 Informational Submittals: Provide the following submittals when requested by the Consultant:
- .1 Certification: Submit certification reports for paint products indicating that they meet or exceed low VOC and coloured base requirements listed in this Section.
 - .2 Purchase Orders: Retain purchase orders, invoices and other documents for verification of compliance with specification and design requirements.
 - .3 Submit written proof of ability to supply a 100% two year Maintenance Bond, if Paint Association warranty option is not used with Bid Submission.
 - .4 Submit a list of all painting materials to the Consultant and the Paint Inspection Agency for review prior to ordering materials. If requested, provide an invoice list of all paint materials ordered for project work to Paint Inspection Agency indicating manufacturer, types and quantities for verification and compliance with specification and design requirements.
 - .5 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets acceptable to Labour Canada and Health Canada prior to commencement of work for review and for posting at job site as required.
 - .6 Submit work schedule for various stages of work for the Consultant's review and Owner's approval when painting occupied areas, if requested.

- .7 Provide an itemized list complete with manufacturer, paint type and colour coding for all colours used for Owner's later use in maintenance for use in the operations and maintenance manual specified in Section 01 78 00 - Closeout Submittals.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: Submit copies of paint manufacturer's written maintenance information for inclusion in the operations manual in accordance with Section 01 78 00 – Closeout Submittals including specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.

1.5 QUALITY ASSURANCE

- .1 Conform to the standards contained in the MPI Maintenance Repainting/Restoration Manual or MPI Architectural Painting Specification Manual.
- .2 Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in service performance, and as follows:
 - .1 Have a minimum of five years proven satisfactory experience and shall show proof before commencement of work that he will maintain a qualified crew of painters throughout the duration of the work.
 - .2 When requested provide a list of the last three comparable jobs including, name and location, specifying authority, start and completion dates and cost amount of the painting work.
 - .3 Only qualified journeymen who have a Tradesman Qualification Certificate of Proficiency shall be engaged in painting and decorating work.
 - .4 Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.
 - .5 Materials, preparation and workmanship shall conform to the standards contained in the latest edition of the MPI Maintenance Repainting/Restoration Manual or MPI Architectural Painting Specification Manual.
- .3 Painting work shall be inspected by a Paint Inspection Agency (Inspector) designated by the Consultant, and paid for by this section as follows:
 - .1 Inspector will be recognized by the local MPI Accredited Quality Assurance Association.
 - .2 Applicator shall notify the Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of the project painting specification, plans and elevation drawings, finish schedules and other pertinent details as required.

- .4 Paint manufacturer shall provide certification of all surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to the Owner where "special" coatings or decorating systems (i.e.: textured coatings or non-MPI listed products or systems) are used in painting.
- .5 Mock-Ups:
 - .1 Prepare mock-ups in accordance with Section 01 45 00 – Quality Control.
 - .2 Prepare and paint a designated interior and exterior surface, area, room or item to requirements of this section using specified paint or coating to indicate selected colours, gloss, sheen, texture and workmanship to MPI Painting Manual standards for review and acceptance by Consultant and Painting Inspector.
 - .3 Accepted surface, area, room or items shall become the standard of finish quality and workmanship for similar on-site painting work.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver painting materials in sealed, original labelled containers bearing manufacturer's name, brand name, type of paint or coating and colour designation, standard compliance, materials content as well as mixing and/or reducing and application requirements.
- .2 Store paint materials in original labelled containers in a secure (lockable), dry, heated and well ventilated single designated area meeting the minimum requirements of both paint manufacturer and authorities having jurisdiction and at a minimum ambient temperature of 7°C. Store only materials used on this project on site.
- .3 Provide adequate fireproof storage lockers, take necessary precautions, and post warning signs (i.e.: no smoking) where toxic, volatile, explosive, or flammable materials are being used or stored, as follows:
 - .1 Take necessary precautions and safety measures to prevent fire hazards and spontaneous combustion, and to protect the environment from spills.
 - .2 Materials considered to constitute a fire hazard include, but are not limited to, paints, solvents, drop clothes and similar materials.
 - .3 Storage containers considered as adequate include but are not limited to; manufacturers original closed and rated containers.
 - .4 Remove empty open containers from the site on a daily basis.
 - .5 Provide adequate storage facilities.
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Perform interior and exterior painting work only when ambient air and substrate temperatures and humidity level is within the manufacturer's recommended performance range.

- .2 Provide continuous ventilation and sufficient heating facilities to maintain minimum ambient air and substrate temperatures for 24 hours before, during and after paint application.
- .3 Provide supplemental ventilating and heating equipment where ventilation and heating from existing system is not adequate to meet minimum safety and performance requirements; gas fired heating units will not be permitted, unless accepted in writing by the Consultant and authorities having jurisdiction.
- .4 Test substrate surfaces (concrete, masonry, plaster and wood) for moisture and alkalinity using a properly calibrated electronic Moisture Meter, except that concrete floors can be tested using a cover patch test; maximum moisture shall not exceed:
 - .1 12% for concrete and masonry (clay and concrete brick, and concrete block), use concrete test ASTM F1869 for concrete floors.
 - .2 15% for wood.
 - .3 12% for plaster and gypsum board.
- .5 Provide a minimum lighting level of 323 Lux (30 foot candles) on surfaces being painted.
- .6 Apply paint only to dry, clean, and adequately prepared surfaces in areas where dust is no longer generated by construction activities such that airborne particles will not affect the quality of finished surfaces.
- .7 Additional exterior application requirements:
 - .1 Perform no exterior painting work when the ambient air and substrate temperatures are below 10°C.
 - .2 Perform no exterior painting work unless environmental conditions are within MPI and paint manufacturer's requirements or until adequate weather protection is provided. Where required, provide suitable weatherproof covering and sufficient heating facilities to maintain minimum ambient air and substrate temperatures for 24 hours before, during and after paint application.
 - .3 Perform no exterior painting work when the relative humidity is above 85% or when the dew point is less than 3°C variance between the air/surface temperature.

1.8 GUARANTEE

- .1 Furnish a two year Painting Association Guarantee or a 100% two year Maintenance Bond both in accordance with MPI Painting Manual requirements, and as follows:
 - .1 Obtain the Maintenance Bond from an approved bonding company and that warrants that all painting work has been performed in accordance with MPI Painting Manual requirements.
 - .2 Provide written proof of ability to submit Maintenance Bond at time of bidding, submitted with Bid.
- .2 All painting and decorating work shall be in accordance with MPI Painting Manual requirements and shall be inspected by the local MPI Accredited Quality Assurance Association's Paint Inspection Agency (inspector), whether using

either the MPI Accredited Quality Assurance Association's guarantee, or the Maintenance Bond option. The cost for such inspections, and for either the local MPI Accredited Quality Assurance Association's Guarantee, or the Maintenance Bond, shall be included in the Base Bid Price.

- .3 Painting and decorating Subcontractors choosing the Maintenance Bond option shall provide a maintenance bond consent from a reputable surety company licensed to do business in Canada. Cash or certified check are not acceptable in lieu of surety consent.

Part 2 Products

2.1 MATERIALS

- .1 Primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, and other painting materials shall be in accordance with the MPI Manual "Approved Product" listing and shall be from a single manufacturer for each system used.
- .2 Materials such as linseed oil, shellac, and other accessory materials shall be the highest quality product of an approved manufacturer listed in the MPI Manual and shall be compatible with other coating materials.
- .3 All materials and paints shall be lead and mercury free and shall have low VOC content where possible.
- .4 Use only MPI listed L rated materials and confirm VOC limits are met for version of LEED as required.
- .5 Unless otherwise specified, all painting work shall be done in accordance with MPI Premium Grade requirements.

2.2 COLOURS

- .1 Colours: as indicated on Finish Schedule on Drawings.
- .2 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 GLOSS/SHEEN RATINGS

- .1 Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following MPI gloss / sheen standard values:

Gloss Level	Description	Units @ 60 degrees	Units @ 85 degrees
G1	Matte or Flat finish	0 to 5	10 maximum
G2	Velvet finish	10 maximum	10 to 35
G3	Eggshell finish	10 to 25	10 to 35
G4	Satin finish	20 to 35	35 minimum
G5	Semi-Gloss finish	35 to 70	
G6	Gloss finish	70 to 85	
G7	High-Gloss finish	> 85	

- .2 Gloss level ratings of painted surfaces as indicated.

Part 3 Execution

3.1 PREPARATION

- .1 Prepare surfaces in accordance with MPI Manual requirements. Refer to the Manual for specific surface preparation requirements for each substrate material.
- .2 No painting work shall commence until all such adverse conditions and defects have been corrected and surfaces and conditions are acceptable to the Painting Subcontractor and Inspection Agency.

3.2 APPLICATION

- .1 Paint when substrates and environmental conditions (heating, ventilation, lighting and completion of other work) are acceptable for applications of products specified in this Section.
- .2 Paint surfaces requiring paint or stain finish to Premium MPI Manual finish requirements with application methods in accordance with best trade practices for type and application of materials used.
- .3 Continue paint finishes through behind wall mounted items.
- .4 Painting coats specified are intended to cover surfaces satisfactorily when applied at proper consistency and in accordance with manufacturer's recommendations.
- .5 Apply a minimum of four coats of paint where deep or bright colours are used to achieve satisfactory results.

3.3 EXTERIOR SURFACES

- .1 Unless otherwise specified, all exterior painting work to be in accordance with MPI Premium Grade finish requirements.
- .2 Asphalt Surfaces: (zone / traffic marking for drive and parking areas, etc.)
 - .1 EXT 2.1A Latex zone / traffic marking finish.
- .3 Structural Steel and Metal Fabrications: columns, beams, joists and miscellaneous metal:
 - .1 EXT 5.1R Water Based Light Industrial - gloss level as directed (over H.B. Epoxy).
- .4 Steel - High Heat: heat exchangers, breeching, pipes, flues, stacks, etc., with temperature range as noted:
 - .1 EXT 5.2A - Heat resistant enamel finish, maximum 205 degrees C.
 - .2 EXT 5.2B - Heat resistant aluminum enamel finish, maximum 427 degrees C.
 - .3 EXT 5.2C - Inorganic zinc rich coating, maximum 400 degrees C.
 - .4 EXT 5.2D - High heat resistant coating, maximum 593 degrees C.
- .5 Galvanized Metal: non chromate passivated; high contact/high traffic areas (doors, frames, railings and handrails, etc.):
 - .1 EXT 5.3M – W.B. Light Industrial Coating (over w.b. galvanized primer), gloss level as directed.

- .6 Dressed Lumber: Cedar soffit and siding:
 - .1 EXT 6.2N - Semi-transparent stain, W.B. (do not use on doors).
 - .1 Basis-of-Design Materials:
 - .1 Minwax 350 VOC Helmsman, Satin Spar Urethane, Sherwin-Williams.
- .7 Bituminous Coated Surfaces: cast iron pipe, concrete, etc.:
 - .1 EXT 10.2A - Latex gloss level as directed.

3.4 INTERIOR SURFACES

- .1 Paint interior surfaces in accordance with the MPI Manual premium grade painting systems listed in this section.
- .2 Structural Steel and Metal Fabrications: columns, beams, joists and miscellaneous metal:
 - .1 INT 5.1R - High performance architectural latex; gloss level as directed.
- .3 Steel - high heat: (boilers, furnaces, heat exchangers, breeching, pipes, flues, stacks, etc., with temperature range as noted):
 - .1 INT 5.2A - Heat resistant enamel finish, maximum 205 degrees C.
 - .2 INT 5.2B - Heat resistant aluminum paint finish, maximum 427 degrees C.
 - .3 INT 5.2C - Inorganic zinc rich coating, maximum 400 degrees C.
 - .4 INT 5.2D - High heat resistant coating, maximum 593 degrees C.
- .4 Galvanized Metal (doors, frames, railings, misc. steel, pipes, overhead decking, ducts, etcetera):
 - .1 INT 5.3M - High performance architectural latex gloss level as directed.
- .5 Paint copper water piping, plumbing, and drainage in wash bay area as follows:
 - .1 Int 5.5 Copper: MPI 5.5B – Epoxy (over epoxy primer)
- .6 Dressed Lumber: Cedar panelling, doors, door and window frames, casings, mouldings, etc.:
 - .1 INT 6.3Q - Polyurethane varnish finish, gloss level as directed.
 - .1 Basis-of-Design Materials:
 - .1 Minwax, Sherwin-Williams.
- .7 Plaster and Gypsum Board (gypsum board, drywall, and other sheet gypsum materials):
 - .1 INT 9.2B – High performance architectural latex gloss level as directed.
- .8 Acoustic Panels and Tiles, touch up paint:
 - .1 INT 9.3A – Latex flat finish.
- .9 Bituminous Coated Surfaces: (cast iron pipe, concrete, etc.)
 - .1 INT 10.2A Latex (over w.b rust-inhibitive primer).

3.5 MECHANICAL / ELECTRICAL EQUIPMENT AND RELATED SURFACES

- .1 Unless otherwise specified or noted, paint all "unfinished" conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and texture to match adjacent surfaces, in the following areas:
 - .1 where exposed-to-view in all exterior and interior areas.
 - .2 in all interior high humidity interior areas.
 - .3 in all boiler room, mechanical and electrical rooms.
- .2 In unfinished areas leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .3 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- .4 Do not paint over nameplates.
- .5 Paint the inside of all ductwork where visible behind louvers, grilles and diffusers for a minimum of 460 mm or beyond sight line, whichever is greater, with primer and one coat of matt black (non-reflecting) paint.

3.6 MAINTENANCE REPAINTING

- .1 Paint existing interior previously finishes surfaces in accordance with the MPI Manual painting systems listed in this section.

3.7 RESTORATION

- .1 Clean and re-install all hardware items that were removed before painting operations were undertaken, ensuring that tagged or labelled items are returned to the exact position from which they were removed.
- .2 Clean, prime and re-paint all bolts, nuts and fasteners after torqueing or re-tightening following specified paint finish.
- .3 Remove protective coverings and warning signs as soon as possible after operations cease.
- .4 Protect freshly painted surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.

3.8 FIELD QUALITY CONTROL: STANDARD OF ACCEPTANCE

- .1 Where "special" painting, coating or decorating system applications (i.e. elastomeric coatings) or non-MPI listed products or systems are to be used, paint or coating manufacturer shall provide as part of this work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Consultant.
- .2 Advise Consultant when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
- .3 Cooperate with inspection firm and provide access to areas of work.

- .4 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Consultant.
- .5 Notify the Paint Inspection Agency on award of contract and make application for assignment of an Inspector using appropriate forms supplied by the Agency as well as provide a copy of the project painting specification, drawings, colour schedule and list of proposed materials for review purposes prior to commencement of work.
- .6 Inspection
 - .1 Interior and exterior painting work shall be in accordance with MPI Painting Manual requirements and shall be inspected by the Painting Association whether using the Painting Association Guarantee or the Maintenance Bond option noted above.
 - .2 Cost for inspections and associated guaranties shall be included in the scope of work for this Section.
- .7 Fully cooperate at all times with the requirements of the Paint Inspection Agency in the performance of their duties, including providing access and assistance as required to complete inspection work, and as follows:
 - .1 All surfaces, preparation and paint applications shall be inspected.
 - .2 Painted surfaces shall be considered to lack uniformity and soundness if any of the following defects are apparent to the Painting Inspection Agency inspector:
 - .1 Brush or roller marks, streaks, laps, runs, sags, drips, heavy stippling, hiding or shadowing by inefficient application methods, skipped or missed areas, and foreign materials in paint coatings.
 - .2 Evidence of poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, corners and re-entrant angles.
 - .3 Damage due to touching before paint is sufficiently dry or any other contributory cause.
 - .4 Damage due to application on moist surfaces or caused by inadequate protection from the weather.
 - .5 Damage or contamination of paint due to blown contaminants (dust, spray paint, etc.).
 - .3 Painted surfaces shall be considered unacceptable if any of the following are evident under final lighting source conditions:
 - .1 Visible defects are evident on vertical surfaces when viewed at 90° to the surface from a distance of 1000 mm.
 - .2 Visible defects are evident on horizontal surfaces when viewed at 45° to the surface from a distance of 1000 mm.
 - .3 Visible defects are evident on ceiling surfaces when viewed at 45° to the surface.
 - .4 When the final coat on any surface exhibits a lack of uniformity of sheen across full surface area.
 - .4 Painted surfaces rejected by the inspector shall be made good at the expense of the Contractor, as follows:

- .1 Small affected areas may be touched up; large affected areas or areas without sufficient dry film thickness of paint shall be repainted.
- .2 Runs, sags of damaged paint shall be removed by scraper or by sanding prior to application of paint.

3.9 CLEANING

- .1 Remove all paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
- .2 Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials and debris.
- .3 Remove combustible rubbish materials and empty paint cans each day and safely dispose of it in accordance with requirements of authorities having jurisdiction.
- .4 Clean equipment and dispose of wash water or solvents, and other cleaning and protective materials (rags, drop cloths, masking papers, etcetera), paints, thinners, paint removers and strippers in accordance with the safety requirements of authorities having jurisdiction.

3.10 PROTECTION

- .1 Protect newly painted exterior surfaces from rain and snow, condensation, contamination, dust, salt spray and freezing temperatures until paint coatings are completely dry.
- .2 Curing periods shall exceed the manufacturer's recommended minimum time requirements.
- .3 Erect barriers or screens and post signs to warn of or limit or direct traffic away or around work area as required.

.1 Fill in schedule and submit to Consultant for review.

[illegible]

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Finish Code	Material	Manufacturer & Product	Colour	Remarks
Ceiling				
C1	Acoustical Ceiling Panel	Manufacturer: Armstrong Collection: FELTWORKS Acoustical Ceiling Panels Colour: White	White	Applies to Offices, Changerooms, Meeting Room, Lunch Room
C2	Painted Exposed Structure	Painted PT2, Flat Finish	Dark Grey	Field, unless noted otherwise
C3	Acoustical Ceiling Blades	Manufacturer: Armstrong Collection: FELTWORKS Blades - HookOn Peaks and Valleys Colour: Cotton Pattern: 1	White	Applies to main corridor
C4	Acoustical Ceiling Tile	Manufacturer: Armstrong Collection: Dune, Square Lay-In Item #: 1850 Size: 610mm x 610mm x 15.9mm	White	Applies to Changerooms, First Aid Room, Universal W/C
C6	Gypsum Board	Painted PT1, Flat Finish	White	Applies to Vestibules
Floor				
EC1	Epoxy Coating	Manufacturer: Stonhard Collection: Stonshield HRI Colour: Driftwood	Medium Grey	Applies to Wash Bay, Equipment Room, Garage, Multipurpose Tool/ Parts Room, Sign Garage, Wrap up walls 150mm to form cove base
RB1	Rubber Wall base	Manufacturer: Tarkett Collection: Johnsonite Traditional Duracove Type: Thermoplastic Rubber 1/8" (type TP) c/w toe Colour: Burnt Umber B 63 Height: 4" (102mm)	Dark Grey	Applies to Changerooms, Janitor, Universal W/C, First Aid Room, Offices, Vestibules, Meeting Room, Lunch Room
RC1	Resinous Coating	Manufacturer: Stonhard Collection: Stonclad GS Colour: Pewter	Medium Grey	Applies to Tool Room, Electrical, Mechanical, IT Rooms; Wrap up walls 150mm to form cove base
VCT1	Vinyl Composite Tile	Manufacturer: Armstrong Collection: Standard Excelon Imperial Texture Colour: Soft Cool Grey	Light Grey	Applies to Offices, Vestibules, Meeting Room, Lunch Room, Corridors
VCT2	Vinyl Composite Tile	Manufacturer: Armstrong Collection: Standard Excelon Imperial Texture Colour: Sterling	Medium Grey	Applies to Changerooms, First Aid Room, Janitor, Universal W/C
Walls & Paint Finishes				
PT1	Paint	Manufacturer: Benjamin Moore Colour: Chantilly Lace Product Code: 2121-70 Gloss Level: G3 - walls, G1 - ceilings	White	Field, Drywall ceilings, interior walls
PT2	Paint	Manufacturer: Benjamin Moore Colour: Wrought Iron Product Code: 2124-10 Gloss Level: G5	Dark Grey	Door frames and doors, and exposed structure, ducts, services, Interior Walls
PT3	Paint	Manufacturer: Benjamin Moore Colour: Mosaic Product Code: CC-874 Gloss Level: G5	Blue	Interior accent walls
WD1	Cedar Slat Wall		Cedar	Applies to Main Entrance Wall; Refer to Floor Plan and Details
WT1	Wall Tile	Manufacturer: Division9 Collection: Industria Colour: Zinc Size: 2" x 2" (Mosaic) Grout: Mapei, 93 Warm Gray, epoxy	Light Grey	Changerooms, Universal W/C
Millwork				
SS1	Solid Surface	Distributor: Willis Manufacturer: Corian Colour: Everest Size: 20mm thick goods, 4" (102mm) high coved backsplash c/w plywood and steel support framing to suit	White	Lunch Room Counter and backsplash
PL1	Plastic Laminate	Manufacturer: Wilsonart Product: High Pressure Laminate Finish Colour: 8246 Abisko Oak	Oak	Lunch Room Cabinets
Misc				
TS1	Floor Transition Strip	Manufacturer: Schluter Profile: Schiene Finish: Brushed Stainless Steel	SS	Floor transition between VCT1 and VCT 2. Contractor to confirm depth needed for application.
TS2	Wall Transition Strip	Manufacturer: Schluter Profile: Rondec Finish: Brushed Stainless Steel	SS	All outside corners of wall tile, floor to ceiling. Refer to finish plans.
WF1	Window Film	Manufacturer: Decorative Films Product: SXD-1818 Dots Height: As noted on drawings	White	Applies to systems glass partitions at Shared Office, District Manager Office

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Signboards, sign posts, supports, fasteners and installation.
- .2 Related Requirements:
 - .1 Section 03 30 00 – Structural Concrete
 - .2 Section 32 13 13 – Concrete Sidewalks and Curbs

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Association of State Highway and Transportation Officials (AASHTO):
 - .1 AASHTO LRFDLTS-1, LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 1st Edition, Includes 2022 Interim Revisions
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A276/A276M-24, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .3 ASTM B210/B210M-19a, Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
 - .4 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 Canadian General Standards Board (CGSB):
 - .1 CGSB 62-GP-11M, Marking Material, Retroreflective, Enclosed Lens, Adhesive Backing. (Withdrawn)
 - .4 Canadian Standards Association (CSA Group):
 - .1 CSA W47.2-11 (R2020), Certification of companies for fusion welding of aluminum, Includes Update No. 1 (2011), Update No. 2 (2012).

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Provide required submissions in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit product data for each type of product specified.
- .3 Submit shop drawings indicating fabrication and installation details for signs and the following:
 - .1 Show sign mounting heights, locations of supplementary supports provided by other sections, and accessories.

- .2 Provide message list, timesteps, graphic elements and layout for each sign.
- .4 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00-LEED Product Requirements.

Part 2 Products

2.1 PERFORMANCE / DESIGN REQUIREMENTS

- .1 Sign supports to be capable of withstanding summation of following loads:
 - .1 Wind load in any direction of 0.32 kPa on signboards.
 - .2 Dead load of signboards, sign supports and appurtenances.
- .2 Structural deflections and vibration in accordance with American Association of State Highway and Transportation Officials (AASHTO), LRFDLTS-1, LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

2.2 METAL SIGN

- .1 Flexible Post
 - .1 Flexible 57 mm diameter tubular, durable, non-colouring thermoplastic with 38 mm diameter reinforcement tube located and secured in the lower portion of the post.
 - .2 Hardware: integral with locking mechanisms.
 - .3 Colour: confirm with Consultant prior to ordering
 - .4 Basis-of-Design Materials:
 - .1 Safe-Hit, Safe-Hit Corporation, Telephone: 800-537-8958.
- .2 Metal Sign Posts
 - .1 Steel Supports for Small Signs: In accordance with ASTM B210/B210M; tubular supports.
 - .2 Base Plates: Ground mounted signage base plates in accordance with ASTM B209/B209M.
 - .3 Anchor and Connecting Bolts: 'U' clamps and miscellaneous hardware for overhead sign installations fabricated from Type 304 stainless steel in accordance with ASTM A276/A276M.
 - .4 Fasteners: Bolts, nuts, washers and other hardware for signs cast aluminum alloy or galvanized steel.
- .3 Signboards
 - .1 Aluminum sheet: In accordance with ASTM B209/B209M, pre-cut to required dimensions; 1.6 mm nominal thickness for signboards up to 750 mm wide; 2.1 mm nominal thickness for signboards 750 to 1200 mm wide.
 - .2 Connecting Straps and Brackets: In accordance with ASTM B209/B209M.

- .3 Silk Screen Ink: Transparent or opaque colours: In accordance with standard traffic signage requirements of Authorities Having Jurisdiction; script content to meet traffic signage regulations of the Authorities Having Jurisdiction.
- .4 Reflective Sheeting and Tape: In accordance with CGSB 62-GP-11M; adhesive, class of reflectivity and colour to meet traffic signage regulations of the Authorities Having Jurisdiction.

2.3 GREEN VEHICLES SIGNAGE

- .1 Green Vehicles Signage. Provide clear, permanently installed signage indicating parking stalls for sole use of green vehicles. Identify vehicles that are eligible to use the designated parking stalls.
- .2 Provide clear, permanently installed signage indicating parking stalls dedicated for the sole use of plug-in electric vehicle charging.
 - .1 Signage shall read as follows:
 - .1 Team to update text as desired, or provide graphic:
 - .2 Reserved for Electric Vehicle Charging Only.
 - .3 Please move vehicle when charging complete.
 - .2 Signage shall be located as indicated on plans.

2.4 FABRICATION

- .1 Supports:
 - .1 Weld support members in accordance with CSA W47.2 with welds of same strength as adjacent member or casting.
 - .2 Remove sharp edges and burrs.
- .2 Signboards:
 - .1 Cut and shape signboard blanks to required shapes and dimensions.
 - .2 Spray signboard back and edges with prime coat and two finish coats in the same colour as the sign face.
 - .3 Spray face with prime coat and two finish coats of required colour for non-reflective signboard faces.
 - .4 Cut and apply reflective background sheeting and lettering in accordance with manufacturer's instructions to match site signage requirements.

Part 3 Execution

3.1 INSTALLATION

- .1 Erect supports to locations indicated on Drawings.
- .2 Erect posts plumb and square to the following installation tolerances:
 - .1 +50 mm from vertical for direct buried supports.

- .2 +12 mm from vertical for signs erected on base plates and separate concrete footings; resting on levelling nuts and restrained with nuts and washers.
- .3 Coat underside of base plates with corrosion protective paint before installation.
- .4 Connect shoe base to shaft with inside and outside fillet welds.
- .5 Close open metal tubes and posts with metal cap to match; cut oblong holes in shoe bases to drain condensation; install bolt cover on each base plate restraining nut.
- .6 Steel Post Installation:
 - .1 Drive to required depth without damaging posts.
 - .2 Drill hole to required depth and set post in sand where rock or concrete is encountered.
 - .3 Backfill with concrete or grout in finished concrete surfaces.
- .7 Signboard Installation:
 - .1 Fasten signboard to supporting posts and brackets.
 - .2 Use T-shape metal stiffeners to join portions of sign panel on site; cover face of T-stiffener with material identical to face of sign panel.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Toilet partitions.
 - .2 Partition screens.
 - .3 Accessories and components such as anchors, hardware, pilasters, fasteners, hinges, latch set, coat hooks, door pulls and privacy closures.
- .2 Related Requirements:
 - .1 Section 05 50 00 – Metal Fabrications
 - .2 Section 06 10 00 – Rough Carpentry
 - .3 Section 06 40 00 – Architectural Woodwork
 - .4 Section 09 21 16 – Gypsum Board Assemblies
 - .5 Section 09 30 13 – Tiling
 - .6 Section 10 28 10 – Toilet and Bath Accessories
 - .7 Section 10 99 99 – Washroom Accessories Schedule

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A240/A240M-23a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM A480/A480M-23b, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat Resisting Steel Plate, Sheet, and Strip.
 - .3 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-71.20-M88, Adhesive, Contact, Brushable. (Withdrawn)
 - .4 Canadian Standards Association (CSA Group):
 - .1 CAN/CSA/ASC B651.2-22, Accessible Design for Self-Service Interactive Devices including Automated Banking Machines.
 - .5 Ontario Building Code, Barrier Free Design Section
 - .6 South Coast Air Quality Management District (SCAQMD):
 - .1 SCAQMD Rule 1168-22, Adhesives and Sealants Applications.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with contractor's representative and Consultant in accordance with Construction Schedule to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature for toilet partitions or components, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit Workplace Hazardous Materials Information System WHMIS SDS - Safety Data Sheets. WHMIS SDS acceptable to Labour Canada and Health and Welfare Canada for concrete floor treatment materials. Indicate VOC content. Indicate VOC's:
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate fabrication details, plans, elevations, hardware, and installation and backing details.
 - .2 Provide seismic restraint for partitions designed by a Structural Engineer in accordance with Section 01 35 00 – Delegated Design.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit duplicate 300 x 300 mm samples of panel showing finish on both sides, two finished edges and core construction.
 - .2 Submit duplicate representative samples of each hardware item, including brackets, fastenings and trim.
- .4 Manufacturer's Instructions:
 - .1 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.
- .5 Manufacturer's Field Reports: submit manufacturer's written reports within three days of review, verifying compliance of Work, as described in PART THREE - FIELD QUALITY CONTROL.
- .6 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit closeout data in accordance with Section 01 78 00 – Closeout Submittals:
 - .1 Provide manufacturer's printed recommendations for general maintenance, including cleaning instructions.

1.6 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle and store units in accordance with manufacturer's instructions.
- .2 Store units on raised wood pallets protected from the elements and corrosive materials.
- .3 Do not remove from crates or other protective covering until ready for installation.
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 WARRANTY

- .1 Provide Manufacturers Warranty as follows:
 - .1 Steel Partitions: 15 years against rust.
 - .2 Hardware: 5 years

Part 2 Products

2.1 MANUFACTURERS

- .1 Subject to compliance with the requirements of this Section and Drawings, manufacturers offering products that may be incorporated into the Work include the following:
 - .1 American Specialties Inc./ASI Global Partitions
 - .2 Access SMT
 - .3 Bradley Corporation
 - .4 General Partitions
 - .5 GSS (General Storage Systems).
 - .6 Hadrian Manufacturing Inc.

2.2 MATERIALS

- .1 Toilet Partition Type: Floor mounted, Overhead brace partitions.
- .2 Metal Toilet Partitions: sheet steel bonded to each side of paper honeycomb core with returned and sealed edges.
 - .1 Sheet steel: commercial quality to ASTM A653/A653M with ZF001 (A01) galvanized designation zinc coating.
 - .2 Minimum base steel thickness:
 - .1 Panels and doors: 0.80 mm.

- .2 Pilasters: .0.95 mm with 1.5 mm mounting shoes.
- .3 Reinforcement: 3.0 mm.
- .3 Pilaster support: adjustable bolts with stainless steel collar to ASTM A240/A240M.
- .4 Anchor Hardware: Wall and panel brackets, chrome plated non-ferrous die cast zinc alloy or clear anodized aluminum castings and extrusions. Overhead bracing with anti-grip design.
- .5 Pilaster shoe trim: 0.9 mm thick stainless steel, not less than 75 mm high.
- .6 Exposed fasteners: stainless steel, tamper-proof type.
- .7 Concealed fasteners: stainless steel.
- .8 Provide accessories as required for complete installation.

2.3 COMPONENTS

- .1 Hinges:
 - .1 Heavy duty, non-lubricating.
 - .2 Material/finish: stainless steel casting.
 - .3 Swing: as indicated on drawings
 - .4 Return movement: gravity
 - .5 Adjustable to hold door open at any angle up to 90 degrees
 - .6 Emergency access feature.
- .2 Latch set: built-in, combination latch, door-stop, keeper and bumper, stainless steel, with emergency access feature.
 - .1 Basis-of-Design Materials:
 - .1 Barrier-free lever latch, Hadrian.
- .3 Coat hook: combination hook and rubber door bumper, chrome plated non-ferrous.
- .4 Door pull: Barrier-free type suited for outswinging doors, stainless steel.
- .5 Privacy Closures at Vertical Spaces: Provide manufacturer's standard components to eliminate visible space between doors and pilasters, pilasters and panels, at walls and as follows:
 - .1 Hinge Filler: aluminum.
 - .2 Door Stops: Aluminum.
 - .3 F-channel: galvaneal steel or stainless steel.
 - .4 U-channel: galvaneal steel or stainless steel.

2.4 FABRICATION

- .1 Fabricate standard access stall doors a minimum 610 mm wide inward swinging and barrier free access stall doors a minimum 900 mm clear wide outward swinging or as noted on drawings with stall widths to minimum dimensions indicated on Drawings and in accordance with CAN/CSA/ASC B651 and Current Building Code.

- .2 Provide formed and closed edges for doors, panels and pilasters. Miter and weld corners and grind smooth.
- .3 Provide internal reinforcement at areas of attached hardware and fittings. Temporarily mark location of reinforcement for grab bars.

2.5 SHOP FINISHING

- .1 Clean, degrease and neutralize steel components with phosphate or chromate treatment.
- .2 Apply two (2) coats high solids polyester baking enamel paint, not less than 0.25 mm thickness, to 50% gloss.
- .3 Finish: doors, pilasters, and panels to be the same colour.
- .4 Colours as indicated in Section 10 99 99 - Washroom Accessories Schedule

Part 3 Execution

3.1 EXAMINATION

- .1 Examine site conditions where Work will be applied and ensure acceptability for complete and satisfactory installation. Report unsatisfactory conditions to Consultant.
- .2 Install partitions when unsatisfactory conditions have been corrected.

3.2 PREPARATION

- .1 Ensure supplementary anchorage, if required, is in place.
- .2 Do work in accordance with CAN/CSA/ASC B651.

3.3 INSTALLATION

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Install partitions secure, plumb and square.
- .3 Provide and install manufacturer's recommended components for complete privacy of visible spaces between doors and pilasters, pilasters and panels and at walls.
- .4 Anchor mounting brackets to masonry or concrete surfaces using screws and shields: to hollow walls using bolts and toggle type anchors, to steel supports with bolts in threaded holes.
- .5 Attach panel and pilaster to brackets with through type sleeve bolt and nut.
- .6 Provide for adjustment of floor variations with screw jack through steel saddles made integral with pilaster. Conceal floor fixings with stainless steel shoes.
- .7 Equip each door with hinges, latch set, and coat hooks, and as follows:
 - .1 Mount coat hook to door as indicated in Section 10 28 10 – Toilet and Bath Accessories.

- .2 Provide one coat hook at 1650 mm for standard stalls.
- .3 Provide one additional coat hook (two total) at 1200 mm from floor on barrier free door:
 - .1 Adjust and align hardware for easy, proper function.
 - .2 Set door open position at 30° to front. Install door bumper; door mounting.
- .8 Equip outswinging doors with door pulls on inside and outside of door in accordance with CAN/CSA/ASC B651.
- .9 Floor supported and overhead braced partition installation:
 - .1 Attach pilasters to floor with pilaster supports and level, plumb, and tighten installation with levelling device.
 - .2 Secure pilaster shoes in position.
 - .3 Secure headrail to pilaster face with not less than two fasteners per face.
 - .4 Set tops of doors parallel with overhead brace when doors are in closed position.
- .10 Screen installation:
 - .1 Provide urinal stall screens consisting of panel, pilaster and headrail.
 - .2 Anchor screen panels to walls with three panel brackets and vertical upright consisting of tubular headrail stock and end sockets, pilaster complete with floor shoes, anchored to floor.
 - .3 Secure to supplementary anchorage above ceiling finish to receive screen vertical upright.

3.4 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Movable partition system including panels, glazing, partition base, partition head, partition corners, seals, acoustic insulation, components including posts, connections, frames, doors, door hardware, sealants and accessories including battens and batten covers, trims, fasteners, clips, runners or tracks, levelling devices, and other accessories required for the installation as recommended by partition manufacturer.
- .2 Related Requirements:
 - .1 Section 07 92 00 – Sealants
 - .2 Section 08 71 00 – Door Hardware
 - .3 Section 08 80 50 – Glazing
 - .4 Section 08 87 53 – Glazing Films
 - .5 Section 09 21 16 – Gypsum Board Assemblies
 - .6 Section 09 22 00 – Non-Structural Metal Framing
 - .7 Division 26 – Electrical: coordination conduit, wiring, and other materials
 - .8 Division 27 – Communications: coordination communications cabling and other materials.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 Aluminum Association (AA):
 - .1 AA DAF 45-2003 (R2009), Designation System for Aluminum Finishes.
 - .2 American National Standards Institute (ANSI):
 - .1 ANSI/BIFMA X5.6-2016 (R2021), Panel Systems – Tests.
 - .3 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM B429/B429M-20 Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - .3 ASTM C1036-21, Standard Specification for Flat Glass.
 - .4 ASTM C1396/C1396M-17, Standard Specification for Gypsum Board.
 - .5 ASTM E72-22, Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
 - .6 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .7 ASTM E90-23, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

- .4 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .5 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 1.88 -92, Gloss Alkyd Enamel, Air Drying and Baking.
 - .2 CAN/CGSB 12.1-2017, Safety Glazing.
 - .3 CAN/CGSB 19.2-M87, Cold-Applied Sealing Compound, Aviation Fuel-Resistant. (Withdrawn)
- .6 National Glass Association (NGA) / Glass Association of North America (GANA):
 - .1 Glazing Manual, IYOG Edition 2022.
- .7 Underwriters Laboratories of Canada (ULC):
 - .1 ULC-102, Standard Method of Test for Surface Burning Characteristics of Materials and Assemblies (ULC-S102).

1.3 ADMINSTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate layout and installation of moveable partition system with other work. Installation of ceilings, floor coverings, lighting fixtures, HVAC equipment and fire suppression systems should be complete before moveable partition system is installed. Coordinate installation of moveable partition system with mechanical, electrical, and communication installation Sections.
- .2 Pre-installation Meeting: Convene pre-installation meetings one week prior to beginning work of this Section to:
 - .1 Verify project requirements.
 - .2 Review installation conditions.
 - .3 Co-ordinate with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals.
 - .1 Submit standard construction details, material descriptions, dimensions of individual components and finishes.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals.
 - .1 Indicate elevations, partition modules, materials, components, finishes, door and glazed openings, fastening to adjacent structure, and assembly details.
- .3 Submit samples in accordance with Section 01 33 00 – Submittals.
 - .1 Submit duplicate 200 x 300 mm samples of panel colours, textures and finishes and 300 mm long samples of trim.
 - .2 Submit sample of ceiling fixing device.
- .4 Manufacturer's Field Reports: submit copies of manufacturer's field reports.
- .5 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit closeout data in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Operation and Maintenance Data: Submit manufacturer's written instructions for maintenance of operable components and cleaning procedures, include name of original installer and contact information.

1.6 QUALITY ASSURANCE

- .1 Installer Qualifications: installer to have a minimum of two years documented experience in installing products of similar type and scope and must be approved by the manufacturer.
- .2 Obtain primary products specified in this Section from a single manufacturer.
- .3 Partitions: listed and labelled by an organization accredited by Standards Council of Canada.
- .4 Mock-Ups:
 - .1 Erect full size finished partitioning for one typical enclosed office including the following typical components:
 - .1 Exterior corner.
 - .2 Interior corner.
 - .3 Door frame.
 - .4 Window frame.
 - .5 Chases for installation of wiring and piping.
 - .2 Allow 48 hours for review of mock-up by Consultant before proceeding with work.
 - .3 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of finished work.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver moveable wall system components cartoned or crated to provide protection during transit and job storage.
- .2 Inspect moveable wall system components upon delivery for damage. Remove and replace damaged items as directed.
- .3 Store moveable wall system components on raised platforms in vertical positions with blocking between units to allow air circulation. Keep stored material covered and protected from damage.
- .4 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Maintain ambient conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not

install the system components under environmental conditions outside manufacturer's absolute limits.

- .2 Limitations: Do not deliver or install the system components until building is enclosed and finishing operations, including ceiling and floor covering installation and painting, are completed.
- .2 Site Conditions:
 - .1 Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where demountable partition system components are indicated to fit between or around other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - .2 Established Dimensions: Establish dimensions and proceed with fabricating demountable partition system without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual site dimensions correspond to established dimensions; allow for trimming and fitting.

1.9 WARRANTY

- .1 Manufacturer's Warranty: Submit manufacturer's standard ten year warranty starting from the date of Substantial Performance. Manufacturer's warranty is in addition to other rights contained within the Contract Documents.

Part 2 Products

2.1 MANUFACTURERS

- .1 Basis of Design Materials:
 - .1 Altos Portrait System, Teknion.
- .2 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section, and as established by basis-of-design materials, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 DIRT.
 - .2 Dormakaba
 - .3 Falkbuilt Ltd.
 - .4 Haworth.
 - .5 Steelcase.
 - .6 Teknion.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Partition system to be fully demountable and relocatable, non-progressive, extend in four directions at posts without disturbing other panels, accommodate floor/ceiling height variations of 25 mm in 3 meters.
- .2 Structural: Partition system shall be structurally stable and vibration free when subjected to impact loads of the type under normal used.
- .3 Seismic Requirements: Ensure appropriate fasteners and anchors and verified by a Professional Engineer, registered in the Province of the work.

- .4 Transverse load capacity: partition shall be able to sustain a 240 Pa minimum transverse loading, with panel deflection no greater than 1/120th of the vertical span when tested in accordance with ASTM E72.
- .5 Vertical Load Capacity: Comply with ANSI/BIFMA X5.6. Functional load capacity of 182 kg per panel to a maximum of 364 kg per 3.65 m wall run and proof load of 182 kg per panel to a maximum of 545 kg per 3.65 m wall run.
- .6 Fire Protection:
 - .1 Major components of system to be non-combustible.
 - .2 Exposed panel surfaces shall meet the following fire hazard classifications requirements in accordance with ULC S102 and ASTM E84:
 - .1 Flame Spread (Class A): 25 maximum.
 - .2 Fuel Contributed: 10 maximum.
 - .3 Smoke Developed: 40 maximum.
 - .3 Testing shall be performed by an independent testing agency approved by the authority having jurisdiction.
- .7 Acoustical: Partition system shall provide the following minimum sound transmission rating when laboratory tested to ASTM E90.
 - .1 Single Glass Wall:
 - .1 STC: 34 minimum.
- .8 If Consultant determines, by testing or other means, that performance of installed partition system has been compromised by:
 - .1 Modification to tested assembly not approved by Consultant, or
 - .2 Defective installation workmanship,take such remedial steps as may be directed by Consultant to improve performance to the specified level, with no increase in Contract Price.
- .9 Compatibility: Partition system shall accommodate the following:
 - .1 Concealed electrical wiring.
 - .2 Electrical Outlets: base mounted.
 - .3 Concealed voice and data communication wiring.
 - .4 Voice and Data Communications Outlets: base mounted.
 - .5 Wall mounted thermostats.
- .10 Partition System Dimensions:
 - .1 Panel Module: as indicated on Drawings.
 - .2 Height: as indicated on Drawings.
 - .3 Site verify dimensions prior to submitting Shop Drawings.

2.3 MATERIALS

- .1 Aluminum extrusions: Aluminum Association alloy AA6063-T54 or 6061-T6 and meeting the requirements of ASTM B429/B429M.
- .2 Steel Components: to ASTM A653/A653M with Z180 zinc coating.

- .3 Clear Tempered Glass: to CAN/CGSB-12.1 and as follows:
 - .1 Thickness: 12 mm thick.
 - .2 Type: Two - Tempered.
 - .3 Class: B - Float Glass.
 - .4 Category: II - 540 J impact resistance.
- .4 Sound/light seal: self adhesive, closed cell, inorganic, permanently elastic, sponge type stripping, 12 x 12 mm size, black.
- .5 Acoustical Insulation: fibreglass insulation as recommended by partition manufacturer to achieve STC rating specified.

2.4 COMPONENTS

- .1 General framing and retaining components: extruded aluminum, metal thickness and configuration to provide rigidity, safe support and fixing of partition system.
- .2 Posts: extruded aluminum, flush type, with plain faces.
- .3 Partition to Ceiling Connections: manufacturer's standard extruded aluminum track, attached to ceiling grid using non-marking clip, lined with closed cell neoprene seal.
- .4 Partition to Floor Connections: manufacturer's standard extruded aluminum channel/base assembly, designed to grip and hold to carpet flooring without damage to floor surface. Fill adjustable space with acoustic insulation.
- .5 Glazing frames: extruded aluminum with concealed glazing stops, of matching metal, for single glazing. Furnish neoprene glazing gaskets for setting glass. Prepare for single and sealed unit glazing.
 - .1 Glazing Tape: 100 percent polybutene vehicle. Extruded in ribbon form with paper separator. Tape shall have an integral shim strip where required.
 - .2 Setting Blocks: Neoprene, shore A" hardness 70-90; shims shore A" hardness 40-50.
 - .3 Glazing Compound: For glazing to metal, to CAN/CGSB-19.2.
- .6 Doors:
 - .1 Tempered glass doors with minimum 2 mm thick extruded aluminum top and bottom rail. Overall door thickness of 44 mm.
- .7 Door Hardware: pivot door configuration using manufacturer's standard attachment hardware and as follows:
 - .1 Tubular Pulls: supplied by moveable partition manufacturer and as indicated on Drawings.
 - .2 Locks: manufacturer's standard and as indicated on Drawings.
 - .3 Acoustics: provide door hardware to meet acoustic rating as required by wall assembly.

- .4 Accessible Hardware: In accordance with Section 08 71 00 – Door Hardware.
- .8 Partition head: extruded aluminum, flush cap.
- .9 Partition base: extruded aluminum.
- .10 External corners: extruded aluminum to match posts.
- .11 Sealants: Silicone, one component - clear, with primers, sealers, cleaners all as specified in Section 07 92 00 - Sealants.
- .12 Accessories: plastic extrusions for batten cover, miscellaneous trim, battens, fasteners, clips, runners or tracks, levelling devices, and other accessories required for the installation as recommended by partition manufacturer.
- .13 Glazing Film: as indicated on Drawings and as specified in Section 08 87 53 – Glazing Films.

2.5 FINISHES

- .1 Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
 - .1 Anodized: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class II, AA-M12C22A31, clear anodized.
 - .2 Unexposed aluminum: Mill finish.
- .2 Steel Surfaces: Epoxy powder coated. Colour as selected by Consultant from manufacturer's standard range.
- .3 PVC Components: Colours selected from manufacturer's standard range.
- .4 Slip-on Metal Frames: Clear anodized aluminum.
- .5 Castings for Slip-on Metal Frames: Same as frames.

Part 3 Execution

3.1 ERECTION

- .1 Install system after floor finishes and in accordance with manufacturer's instructions.
- .2 Fasten runners to floors, ceiling and abutting vertical surfaces at 600 mm oc. At ceilings use fasteners that rigidly support partition without damaging or defacing ceiling panels or grid system members.
- .3 Erect partitions plumb, square and level. Accurately fit and fasten to abutting surfaces. Shim under partitions at uneven floors to ensure level installation.
- .4 Install continuous light/sound seal at junction of ceiling height partitions with floors, ceilings and abutting walls and vertical surfaces.
- .5 Provide vertical posts, full height, in one piece.

- .6 Install acoustical insulation and caulking in sound rated partitions to correspond with tested assembly, according to manufacturer's instructions.
- .7 Coordinate partition system installation with work of other trades which are affected. Avoid damage to installed work.
- .8 For rail height partitions, secure posts to floor for lateral stability.
- .9 Install glass and accessories in accordance with GANA Glazing Manual.
- .10 Seal partitions in accordance with Section 07 92 00 - Sealants.
- .11 Apply glazing film as indicated on Drawings and in accordance with Section 08 87 53 – Glazing Films.

3.2 REPAIR

- .1 Remove and replace panels and other components that are damaged, improperly installed, or soiled beyond satisfactory cleaning.

3.3 ADJUSTING

- .1 Correct misalignment of exposed trim.
- .2 Adjust position of door frames for proper door operation.

3.4 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Obtain reports within three days of review and submit.

3.5 CLEANING

- .1 Clean soiled panel and trim surfaces after installation.
- .2 Clean floor, ceiling, and wall surfaces soiled as a result of work of this Section.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 08 80 50 - Glazing: Mirrors.
- .2 Section 10 99 99 – Washroom Accessories Schedule

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM A153/A153M-16a, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .2 ASTM A240/A240M-20A, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .3 ASTM A653/A653M-20, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .4 ASTM A666-15, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - .5 ASTM A924/A924M-20, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - .6 ASTM A1008/A1008M-21a, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - .7 ASTM B16/B16M-19, Standard Specifications for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
 - .8 ASTM B19-20, Standard Specification for Cartridge Brass Sheet, Strip, Plate, Bar, and Disks.
 - .9 ASTM B456-17, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
 - .10 ASTM C1503 -18, Standard Specification for Silvered Flat Glass Mirror.
- .2 Canadian Standards Association (CSA):
 - .1 CSA-B651-18, Accessible Design for the Built Environment, Includes Errata 1 (2020).
 - .2 CSA-G164-18 Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No.1 (2020).
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.81-M90, Air Drying and Baking Alkyd Primer for Vehicles and Equipment. (Withdrawn).
 - .2 CAN/CGSB-1.88-92, Gloss Alkyd Enamel, Air Drying and Baking.
 - .3 CGSB 31-GP-107MA, Non-Inhibited Phosphoric Acid Base Metal Conditioner and Rust Remover. (Withdrawn)
- .4 International Code Council (ICC):
 - .1 ICC A117.1-2017, Accessible and Usable Buildings and Facilities.

- .5 Ontario Building Code, Barrier Free Design Section

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate size and description of components, base material, surface finish inside and out, hardware and locks, attachment devices, description of rough-in-frame, backing, building-in details of anchors for grab bars.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Samples to be returned for inclusion into work.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit closeout data in accordance with Section 01 78 00 – Closeout Submittals:
 - .1 Provide maintenance data for toilet and bath accessories for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Include list of sources for disposable supplies, replacement parts and service recommendations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials
 - .1 Provide special tools required for accessing, assembly/disassembly or removal for toilet and bath accessories in accordance with requirements specified in Section 01 78 00 - Closeout Submittals.
 - .2 Deliver special tools to Consultant.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 WARRANTY

- .1 Provide manufacturers standard 3 year warranty for all products with extended warranties where they apply.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: subject to compliance with requirements specified in this Section and as established by the basis-of-design materials, manufacturers

offering products that may be incorporated into the Work include, but are not limited to, the following:

- .1 American Specialties Inc. (ASI)
- .2 Bobrick Washroom Equipment Company.
- .3 Bradley Corporation.
- .4 Frost Products Ltd.

2.2 MATERIALS

- .1 Sheet steel: to ASTM A653/A653M cold rolled, commercial quality, 0.912 mm minimum nominal thickness, with ZF001 designation zinc coating.
- .2 Stainless steel sheet metal: to ASTM A666, Type 304, finish as indicated in component list in 1.519 mm minimum nominal thickness.
- .3 Stainless steel tubing: Type 304, commercial grade, seamless welded, 1.2 mm wall thickness.
- .4 Fasteners: concealed screws and bolts hot dip galvanized after fabrication, tamper and theft resistant exposed fasteners to match material of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.
- .5 Provide universal keys for internal access to accessories for servicing and re-supplying. Provide minimum of six keys to Owner's representative.

2.3 COMPONENTS

- .1 Provide components as indicated in Section 10 99 99 – Washroom Accessories Schedule

2.4 FABRICATION

- .1 Weld and grind joints of fabricated components flush and smooth. Use mechanical fasteners only where approved.
- .2 Wherever possible form exposed surfaces from one sheet of stock, free of joints.
- .3 Brake form sheet metal work with 1.5 mm radius bends.
- .4 Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
- .5 Back paint components where contact is made with building finishes to prevent electrolysis.
- .6 Hot dip galvanize concealed ferrous metal anchors and fastening devices to CSA G164.
- .7 Shop assemble components and package complete with anchors and fittings.
- .8 Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates, details and instructions for building in anchors and inserts.
- .9 Provide steel anchor plates and components for installation on studding and building framing.

2.5 FINISHES

- .1 Chrome and nickel plating: to ASTM B456, satin finish.
- .2 Baked enamel: condition metal by applying one coat of metal conditioner to CGSB 31-GP-107MA, apply one coat Type 2 primer to CAN/CGSB-1.81 and bake, apply two coats Type 2 enamel to CAN/CGSB-1.88 and bake to hard, durable finish. Sand between final coats. Colour selected from standard range by Consultant.
- .3 Labels: Exposed faces, provide maximum 38 mm diameter stamped manufacturer logo.

Part 3 Execution

3.1 PREPARATION

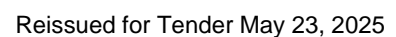
- .1 Verify wall thickness and construction that will accept recessed accessories.
- .2 Verify that solid blocking for support and anchoring of washroom accessories is installed where required. Confirm exact height and location with Consultant and Manufacturers Instructions.
- .3 Verify that frames and anchors provided, whether by this Section or others, are correctly and securely installed ready to accept the accessory scheduled for the specific location.
- .4 Verify that painting is complete and dry in area of installation before accessories are installed.

3.2 INSTALLATION

- .1 Install accessories at heights to meet barrier free compliance and in coordination with drawings. Confirm heights with Consultant prior to installation.
- .2 Install and secure accessories rigidly in place as follows:
 - .1 Stud walls: install steel back-plate to stud prior to plaster or drywall finish. Provide plate with threaded studs or plugs.
 - .2 Hollow masonry units or existing plaster/drywall: use toggle bolts drilled into cell/wall cavity.
 - .3 Solid masonry, marble, stone or concrete: use bolt with lead expansion sleeve set into drilled hole.
 - .4 Toilet/shower compartments: use male/female through bolts.
- .3 Install grab bars on built-in anchors provided by bar manufacturer.
- .4 Use tamper proof screws/bolts for fasteners.
- .5 Fill units with necessary supplies shortly before final acceptance of building.
- .6 Install mirrors in accordance with Section 08 80 50 - Glazing.

3.3 SCHEDULE

- .1 Locate accessories where indicated on drawings. Exact locations determined by Consultant.





Reissued for Tender May 23, 2025

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Lockers.
 - .2 Benches.
 - .3 Accessories including locking system, coat hooks, end panels, trim and number plates.
- .2 Related Requirements:
 - .1 Section 06 10 00 – Rough Carpentry.
 - .2 Section 10 99 99 – Washroom Accessories Schedule

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society of Civil Engineers (ASCE):
 - .1 ASCE 7-22, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, Includes Supplements 1 and 2 (2023).
 - .2 American Society of Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A1008/A1008M-23e1, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - .3 ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .4 ASTM D4446/D4446M-13, Standard Test Method for Anti-Swelling Effectiveness of Water-Repellent Formulations and Differential Swelling of Untreated Wood When Exposed to Liquid Water Environments (Withdrawn 2022).
 - .3 Canadian General Standard Board (CGSB):
 - .1 CAN/CGSB 1.300-2000, Applied Coating System of Semigloss Baked Finish for Metal Office Furniture. (Withdrawn)
 - .2 CAN/CGSB 44.40-2001, Steel Clothing Locker. (Withdrawn)
 - .4 Canadian Standards Association (CSA Group):
 - .1 CSA G40.20-13/G40-21-13 (R2023), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel, Includes Update No.1 (2014).
 - .5 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .6 Ontario Building Code, Barrier Free Design Section

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordinate size and location of prefabricated metal bases for metal lockers.
 - .2 Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related work specified in other Sections so that metal lockers can be supported and installed as indicated.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Indicate the following:
 - .1 Type and class of locker.
 - .2 Thickness of metal.
 - .3 Fabricating and assembly methods.
 - .4 Assembled banks of lockers.
 - .5 Tops, hooks, shelves, bases, trim, and numbers.
 - .6 Filler panels, end/back panels, doors, handles, locking method, and finishes.
 - .7 Indicate seismic bracing and fastening requirements in accordance with ASCE 7 – Minimum Design Loads for Buildings and Other Structures.
 - .2 Submit samples in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit duplicate 50 x 50 mm samples of colour and finish on actual base metal.
 - .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data indicating adjustments, repair methods and replacement of locker doors and latching mechanisms for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Installer to be an authorized representative of metal locker manufacturer for installation and maintenance of locker systems for this Project.
- .2 Obtain metal lockers and accessories through one source from a single manufacturer. Do not modify intended aesthetic appearance of metal lockers without the Consultant's written approval; submit comprehensive explanatory data to Consultant for review where modifications are necessary to meet project requirements before submission of Bids.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packaging Waste Management

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.8 SITE CONDITIONS

- .1 Existing Conditions:
 - .1 Site Measurements: Verify location of concealed framing, blocking, and reinforcements that support metal lockers before they are enclosed, and configuration of recessed openings by Site measurements before fabrication and indicate measurements on Shop Drawings.
 - .2 Established Dimensions: Establish recessed opening dimensions and proceed with fabricating metal lockers without Site measurements where Site measurements cannot be made without delaying the Work. Coordinate wall and floor construction so that actual recessed opening dimensions correspond to established dimensions.

1.9 WARRANTY

- .1 Provide Manufacturers standard 2 year warranty.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include the following:
 - .1 Access SMT.
 - .2 Canadian Locker Company Limited.
 - .3 General Storage Systems.
 - .4 Hadrian Manufacturing Inc.

2.2 MATERIALS

- .1 Sheet Steel: ASTM A653/A653M coating Designation Z275, commercial grade, stretcher leveled, wiped coat galvanized; to the following minimum base metal thicknesses:
- .2 Steel Plates, Shapes, and Bars: In accordance with CSA G40.20/G40.21, Grade 300W.
- .3 Fasteners: Zinc or nickel plated steel, slotless type exposed bolt heads, and self locking nuts or lock washers for nuts on moving parts.
- .4 Anchors: Select material, type, size, and finish required for secure anchorage to each substrate to seismic requirements in accordance with ASCE 7 and as follows:
 - .1 Provide nonferrous metal or hot dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
 - .2 Provide toothed steel expansion sleeves for drilled-in-place anchors.

2.3 MANUFACTURED UNITS

- .1 Lockers: to CAN/CGSB-44.40, Single full-height locker, Class Two - A bank of two or more lockers, freestanding.
 - .1 Size: as indicated in Section 10 99 99 – Washroom Accessories Schedule.
 - .2 Steel Thickness:
 - .1 Body: Side, Divider & Back: 0.61 mm thick
 - .2 Top, & Bottom: 0.76 mm thick
 - .3 Door Inner Face: 0.61 mm thick
 - .4 Door Outer Face: 0.91 mm thick
 - .5 Frame Vertical Components: 1.51 mm thick
 - .6 Frame Horizontal Components: 1.21 mm thick
 - .7 Hinges: 1.90 mm thick
 - .3 Assembly: welded construction.
 - .4 Top: flat
 - .5 Doors: one-piece double-wall envelope construction, steel thickness 0.95 mm (No.20 MSG), door swing left.
 - .6 Door handle: recessed handle steel with bright chromium finish.
 - .7 Door Strike: Continuous
 - .8 Hinges: Minimum three concealed leaf fast pin type hinges, minimum 50 mm long opening 180°; fabricated from 1.519 mm base metal thickness steel securely fastened to door and frame and having non-removable pins.
 - .9 Colours: Body to match doors to be chosen from manufacturer's standard colour range. Colours as indicated in Section 10 99 99 – Washroom Accessories Schedule.
 - .10 Basis-of-Design Materials:
 - .1 Emperor Lockers, Hadrian Manufacturing Inc.

2.4 BENCH

- .1 Bench Seat (BN):
 - .1 Basis-of-Design Materials:
 - .1 As indicated in Section 10 99 99 – Washroom Accessories Schedule.
 - .2 Combined Bench and Locker Base: on-site constructed bench and locker base, hardwood laminate top with clear lacquer finish and pedestals as detailed on Drawings, painted black.

2.5 ACCESSORIES

- .1 Locking system: padlocks supplied by Owner.
- .2 Accessories: Meeting CAN/CGSB-44.40 and as follows:
 - .1 Coat Hooks: Steel with chromium finish.
 - .2 Base: Fabricated bench/base as detailed on Drawings.

- .3 End Panels: Finished end panels to match body panel colour.
- .4 Trim: Steel trim to manufacturer's standard including corner angles, jamb trim and fillers.
- .5 Number Plates: Manufacturers standard plate to match Owner's numbering sequence.
- .3 Finish: Baked enamel or powder coat to match colour listed above.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine walls, floors, and support bases for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- .1 Assemble and install lockers in accordance with manufacturer's written instructions.
- .2 Securely fasten lockers to grounds and nailing strips.
- .3 Install seismic fastening in accordance with approved shop drawings.
- .4 Install wall trim around recessed locker banks.
- .5 Install filler panels (false fronts) where indicated and where obstructions occur.
- .6 Install finished end and back panels to exposed ends and backs of locker banks.
- .7 Install locker numbers.
- .8 Install bench with fasteners as directed by manufacturer and isolate dissimilar materials if required.

3.3 REPAIR

- .1 Touch up marred finishes or replace metal lockers that cannot be restored to factory finished appearance.

3.4 ADJUSTING

- .1 Clean, lubricate, and adjust hardware.
- .2 Adjust doors and latches to operate easily without binding.
- .3 Verify that integral locking devices operate properly.

3.5 PROTECTION

- .1 Protect metal lockers from damage, abuse, dust, dirt, stain, or paint.
- .2 Do not permit metal locker use during construction.

END OF SECTION

Washroom	Material	Manufacturer & Product	Colour	Remarks
Vanity				
MR-01	Fixed Position Tilt Mirror	Manufacturer: Bobrick Product: B-293 2448; 6mm glass mirror secured to concealed wall hanger with theft-resistant mounting Size: 18" W x 36" H (46 x 91cm) Mounting height: Refer to drawings	S.S.	York Region Design Standard
SP-01	Soap Dispenser	Manufacturer: Swish Product: Proline Soap Dispenser #WHB1LDS Size: 4-3/5"W x 4-9/10"D x 10"H Finish: White Mounting height: Refer to drawings	White	York Region Design Standard
PD-02	Paper Towel Dispenser and Waste Bin	Manufacturer: Frost Product: Recessed - Frost 427-60A Size: 4' - 8.17" x 17.25" x 12.5" (142 x 44 x 61 cm) Mounting height: Refer to drawings	S.S.	York Region Design Standard
Water Closet				
BR-01	Backrest	Manufacturer: Frost Model: Toilet backrest, 1028 Finish: Stainless steel Size: 38.3cm L x 20.3cm D x 10.2cm H (15.1"L x 8"D x 4"H)	S.S.	
CH-01	Coat Hook	Manufacturer: Bobrick Product: Stainless steel clothes hook, B-233	S.S.	
GB-01	Grab Bar	Manufacturer: Frost Product: 1-1/4" diameter 90-degree grab bar, 1003-SP30"x30" Size: 30"L x 30"D x 3.25"H (76.2cm L x 76.2cm D x 8.3cm H) Finish: brushed stainless steel w/ peened grip Mounting height: Refer to drawings	S.S.	York Region Design Standard
GB-02	Grab Bar	Manufacturer: Frost Product: 1-1/4" diameter straight grab bar, 1001-SP24" Size: 24"L x 3"D x 3.25"H (61.0cm L x 7.6cm D x 8.3cm H) Finish: brushed stainless steel w/ peened grip Mounting height: Refer to drawings	S.S.	York Region Design Standard
SD-01	Sanitary Napkin Disposal	Manufacturer: N/A (Provided by York Region Facilities Operations and Maintenance Team) Product: N/A (Provided by York Region Facilities Operations and Maintenance Team) Size: Approximately 19" W x 6" H x 21" D Finish: stainless steel Mounting height: Refer to drawings	S.S.	Owner to supply, contractor to install
TD-01	Toilet Tissue Dispenser	Manufacturer: Swish Product: Tork S6TR #889 DISP T/T JUMBO SIDE/SIDE T22 Size: 19" x 12" x 5.5" (49 x 30 x 14 cm) Finish: Smoke (transparent dark grey)	Smoke (Transparent Dark Grey)	York Region Design Standard
TP-01	Toilet Partition	Manufacturer: Hadrian Product: Headrail braced Standard Series Colour: 609 Colonial Blue	Blue	
UD-01	Urinal Divider	Product: Screen Colour: 609 Colonial Blue Size: 1219mm tall wall mounted Mounting height: Refer to drawings	Blue	
Shower				
SB-01	Shower Base	Manufacturer: MAAX Canada Model: Outlook Base 6036 AcryIX Alcove Shower Base with Center Drain Finish: White Size: 94cm x 150cm x 11.4cm (37" x 60" x 4 1/2")	White	
SB-02	Shower Base	Manufacturer: MAAX Canada Model: B3Round 3636 Acrylic Corner Left or Right Shower Base in White with Center Drain Finish: White Size: 91cm x 91cm x 10cm (35-7/8" x 35-7/8" x 4")	White	
SGB-01	Grab Bar (L-Shaped)	Manufacturer: Frost Product: 30"x40" L-Shaped Grab Bar 1 -1/4" Diameter, 1003-SP Size: 40"L x 30"H (102cm L x 76cm H) Finish: brushed stainless steel w/ peened grip Mounting height: Refer to drawings	S.S.	York Region Design Standard
SGB-02	Grab Bar (Vertical)	Manufacturer: Frost Product: 1-1/4" diameter straight grab bar, 1001-SP36" Size: 36"L x 3"D x 3.25"H (91.4cm L x 7.6cm D x 8.3cm H) Finish: brushed stainless steel w/ peened grip Mounting height: Refer to drawings	S.S.	York Region Design Standard

Washroom	Material	Manufacturer & Product	Colour	Remarks
SGB-03	Grab Bar	Manufacturer: Frost Product: 1-1/4" diameter straight grab bar, 1001-SP24" Size: 24"L x 3"D x 3.25"H (61.0cm L x 7.6cm D x 8.3cm H) Finish: brushed stainless steel w/ peened grip Mounting height: Refer to drawings	S.S.	York Region Design Standard
SBE-01	Folding Bench	Manufacturer: Bobrick Product: B-518 folding shower seat with padded cushion, left-hand seat Size: 21-1/4" W x 32-7/8" L (54 x 83.5cm) Mounting height: Refer to drawings	S.S. with white padding	
Locker				
LO-01	Locker	Manufacturer: Hadrian Product: Emperor Corridor Locker Size: 15" x 18" x 60" Colours: 609 Colonial Blue Mounting: Locker pedestal	Blue	
LO-02	Locker	Manufacturer: Hadrian Product: Emperor Corridor Locker Size: 15" x 18" x 60" Colours: 510 Black Mounting: Locker pedestal	Black	
LO-03	Locker	Manufacturer: Hadrian Product: Emperor Corridor Locker Size: 15" x 18" x 60" Colours: 541 Extra White Mounting: Locker pedestal	White	
BN-01	Bench	Manufacturer: Robinson Steel Company Product: Hardwood Locker Room Bench Top Size: 20" deep x 1.25" thick; length as required per drawings Mounting: Locker pedestal	Mixed Hardwoods	
BN-02	Bench	Manufacturer: Global Industria Product: ADA Locker Room Bench Top, Hardwood Size: 142"W x 20"D x 1-1/4"Thick Mounting: Wall Mount Brackets For 20" Deep ADA Locker Bench Top, Black, Pair Mounting height: Refer to drawings	Hardwood	

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Exterior roof mounted fall arrest and restraint anchors.
- .2 Related Requirements:
 - .1 Section 01 35 00 – Delegated Design
 - .2 Section 05 12 00 – Structural Steel
 - .3 Section 05 31 00 – Steel Deck
 - .4 Section 05 50 00 – Metal Fabrications
 - .5 Section 07 72 33 – Roof Hatch
 - .6 Section 07 92 00 – Sealants

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A36/A36M-19, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A53/A53M-22, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - .3 ASTM A153/A153M-23, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .4 ASTM A276/A276M-24, Standard Specification for Stainless Steel Bars and Shapes.
 - .5 ASTM A484/A484M-24, Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings.
 - .6 ASTM A780/A780M-20, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - .7 ASTM A999/A999M-23, Standard Specification for General Requirements for Alloy and Stainless Steel Pipe.
 - .8 ASTM A1011/A1011M-23, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra High Strength.
 - .9 ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .10 ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .11 ASTM C307-18, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
 - .12 ASTM C579-23, Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.

- .13 ASTM C580-18(2023), Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- .14 ASTM D570-22, Standard Test Method for Water Absorption of Plastics.
- .15 ASTM D1056-20, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
- .16 ASTM D2000-18, Standard Classification System for Rubber Products in Automotive Applications.
- .17 ASTM F593-22, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- .18 ASTM F594-22, Standard Specification for Stainless Steel Nuts.
- .19 ASTM F887-23, Standard Specifications for Personal Climbing Equipment.
- .20 ASTM F3125/F3125M-23, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
- .2 American National Standards Institute (ANSI):
 - .1 ANSI Z359.1-2020, The Fall Protection Code.
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 1.40-97, Anticorrosive Structural Steel Alkyd Primer. (Withdrawn)
- .4 Canadian Institute of Steel Construction (CISC):
 - .1 CISC Code of Standard Practice for Structural Steel, 8th Edition.
 - .2 Handbook of Steel Construction, 11th Edition.
- .5 Canadian Standards Association (CSA Group):
 - .1 CSA G40.20-13/G40.21-13 (2023), General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel, Includes Update No.1 (2014).
 - .2 CSA G164-18 (R2023) Hot Dip Galvanizing of Irregularly Shaped Articles, Includes Update No. 1 (2020).
 - .3 CSA S16:19, Design of steel structures, Includes Errata (2019) and Errata (2023).
 - .4 CSA S136-16, North American Specification for the Design of Cold Formed Steel Structural Members.
 - .5 CSA W47.1:19, Certification of companies for fusion welding of steel.
 - .6 CSA-W47.2 -11 (R2020) Certification of companies for fusion welding of aluminum, Includes Update No. 1 (2011), Update No. 2 (2012).
 - .7 CSA W48:23, Filler Metals and Allied Materials for Metal Arc Welding.
 - .8 CSA W55.3-08(R2023), Certification of Companies for Resistance Welding of Steel and Aluminum.

- .9 CSA W59-18 (R2023), Welded Steel Construction, Includes Errata (2020).
- .10 CSA W178.1-18 (R2023), Certification of Welding Inspection Organizations.
- .11 CSA W178.2-18 (R2023), Certification of Welding Inspectors.
- .12 CSA Z91-17(R2022), Health and Safety Code for Suspended Equipment Operations.
- .13 CSA Z259.12-16(R2021), Connecting Components for Personal Fall Arrest Systems (PFAS).
- .14 CSA Z271:20, Design of Suspended Access Equipment.
- .6 Ontario Industrial Roofing Contractors' Association (OIRCA):
 - .1 OIRCA Guide Specification.
- .7 The Society for Protective Coatings (SSPC)/National Association of Corrosion Engineers (NACE International):
 - .1 Coating Materials Guidelines.
 - .2 SSPC-SP6/NACE No. 3, Commercial Blast Cleaning.
 - .3 Application, Inspection and Quality Control Guidelines.
- .8 Ontario Occupational Health and Safety Regulation.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Provide setting diagrams, templates, instructions and directions for installation of components supplied by this Section to other Subcontractors, and necessary for the completion of work of this Section:
 - .1 Coordinate design of anchoring systems and maintenance equipment with the Consultant; provide anchoring and equipment loads acting on supporting structure in accordance with information below so that the primary structural system design can be completed.
 - .2 Coordinate installation of materials of this Section with Roofing Trade Contractor for sealing of membrane to anchors and flashing.
- .2 Pre-installation Meeting: Convene pre-installation meetings prior to beginning work of this Section with Contractor, Consultant, manufacturer's representative, and other components of the Work affected by work of this Section to:
 - .1 Discuss coordination issues, attachment requirements and use of fall restraints during the construction period.
 - .2 Meet a minimum of six weeks prior to beginning work of this Section, so that coordination issues affecting work of this section, or other Trade Contractors can be accounted for and corrected prior to any installation of materials.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit design calculations and anchor loadings to the Consultant within ten days of award of this contract, so that primary structural support system design can be completed.
- .2 LEED Submittals: provide LEED submittals in accordance with Section 01 61 00-LEED Product Requirements.

- .3 Provide required information in accordance with Section 01 33 00 – Submittal Procedures, and as follows:
 - .1 Provide product data for each type of product specified.
 - .2 Provide Work Plan Drawings showing individual primary suspension line and safety life line anchors used for support of exterior maintenance equipment and personnel.
 - .3 Provide shop drawings using CISC standard drafting practices; detailing fabrication of steel components including, but not limited to, the following:
 - .1 Indicate complete layout and configuration of system, locations, and all other components and accessories.
 - .2 Indicate design, fabrication details, plans, elevations, hardware and installation details, including details of cuts, connections, splices, camber, holes, and other pertinent data.
 - .3 Show interface with adjacent materials.
 - .4 Show locations of maintenance equipment and fall arrest anchors, configurations, dimensions, attachment details, and components required for complete system complying with provisions of this Section.
 - .5 Indicate methods of attachment to building structure.
 - .6 Indicate welds using CWB symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - .7 Type, size, and length of bolts, distinguishing between shop and field bolts; high strength bolted slip critical, direct tension, or tensioned shear/bearing connections.
 - .8 Shop drawings shall be signed and sealed by a professional engineer qualified in the province of the Work, and who was responsible for their preparation.
 - .9 Shop drawings shall include restrictive and non-restrictive working usage notes and general safety requirements.
 - .4 Provide setting diagrams, templates, instructions and directions for installation of components supplied by this Section to other Subcontractors, and necessary for the completion of work of this Section.
- .4 Submit Letters of Commitment and Compliance using sample formats contained in Section 01 35 00 – Delegated Design, and as follows:
 - .1 At the onset of work of this Section and prior to shop drawing submission, prepare and submit a Letter of Commitment, including a summary of the work covered by this Section.
 - .2 On completion of work of this Section, prepare and submit a Letter of Compliance, including a summary of the work covered by this Section.
 - .3 Commitment and compliance letters referred to above must cover all structural aspects of fall arrest and restraint anchors, equipment anchors, design of connections and erection, and as follows:
 - .1 Certifying that the anchors, layout, and installation meet or exceed the performance requirements of the Authorities Having Jurisdiction, and the requirements of the Ontario Occupational Health and Safety Regulation.

- .2 Certifying that system is engineered and designed to suit the requirements of the roof deck, roofing type, and location to accommodate structural requirements and to maintain watertight seal.
- .5 Submit a Current Letter of Validation; and in addition, submit copies of the following CWB documents:
 - .1 Company specific Welding Supervisor's Certificate, backside and front side indicating proper certification.
 - .2 Individual Welder Certificate with listing for type of work being performed.
- .6 Submit test data from a qualified testing laboratory indicating that anchors have been load tested after installation and prior to use in accordance with CSA Z271 to 360°, and to absolute failure (fracture).
- .7 Submit reduced plastic laminated as-built roof plan drawing indicating layout and location of anchors and tie-offs, and safe works and usage requirements that will be posted near roof access points in sufficient quantities for each access point to the roof or equipment access locations.
- .8 Submit the following for inclusion in operations and maintenance manuals:
 - .1 Special procedures, and conditions requiring maintenance during the operational stage for materials specified in this Section.
 - .2 Safety Inspection Log Books required for yearly inspections.
 - .3 Provide on-site orientation and demonstration to Owner's key personnel, and suggestions for incorporating safe work practices into the Owner's Safe Work Practices Policy.
 - .4 List of accessory equipment, product data, and samples that can be used with the installed anchoring system; submittal does not imply purchase by Owner.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operations and maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Conform with current local Occupational Health and Safety Regulations (OH & S), Fall Protection, Loading Requirements for Anchoring Systems.
 - .2 Conform with additional requirements of CSA Z91 and CSA Z259 Series for standards relating to requirements of this Section, except where in conflict with current local OH&S Regulations.
- .2 Manufacturer shall be a company specializing in the design and installation of permanent safety tie-back and life line anchor, horizontal life line systems, and exterior maintenance and window washing equipment systems having a minimum of five years of experience.

- .3 Manufacturer shall provide \$5,000,000.00 of specific product liability insurance for all aspects of their installation, design, and failure of the safety anchors and their installation.
- .4 Manufacturers shall comply with applicable CWB standards for classification of work being performed including, but not limited to, the following:
 - .1 Welding inspection: to CSA W178.
 - .2 Resistance welding: to CSA W55.3.
 - .3 Fusion welding: to CSA W59.
 - .4 Welding qualifications: to CSA W47.1
- .5 Installing Subcontractors, if different than fabricator, shall have completed welding work similar in material, design, and extent to that indicated for this Project; with a record of successful in service performance; having welders certified by CWB for classification of work being performed; and having the same certifications as required by CSA and CWB for the fabricator and manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials on pallets with manufacturer ' s original protective packaging and identifying labels intact.
- .2 Store products in an area protected from construction activities.
- .3 Packaging Waste Management.
 - .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURERS

- .1 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Atlas Anchor Systems (B.C.) Ltd.
 - .2 Innovative Fall Protection.
 - .3 Pro-Bel Enterprises Ltd.
 - .4 Safeguard Industries.
 - .5 Thaler Metal Industries Ltd.
- .2 Manufacturers meeting or exceeding the requirements of this section may apply to the Consultant prior to submission of bids for inclusion in the acceptable materials listing.

2.2 DELEGATED DESIGN REQUIREMENTS

- .1 Engineer and design a building maintenance system, fall protection and fall restraint systems sufficient for gaining access to exterior and interior vertical building surfaces that meets the requirements of the Ontario Occupational Health and Safety Act using a professional engineer registered in the province of the work, and as follows:

- .1 Fall Arrest and Fall Restraint System: Roof top maintenance system permitting free movement of persons over roof areas as required by CSA Z91 and ANSI Z359.1, and other standards referenced in above; where differences occur, the more restrictive requirement shall prevail.
- .2 Upright Anchors: As instructed by manufacturer in layout and design acceptable to Consultant.
- .3 Free Fall Distance: Limit maximum free fall vertical distance of 1220 mm with a fixed lanyard and 1980 mm with energy absorbing lanyard.
- .4 Travel Restraint Systems: Design for up to four persons on roof and having an ultimate load capacity of a minimum 22.2 kN in any direction that a load may be applied.
- .5 Fall Arrest System: Design for one person, without shock absorber and capable of supporting a minimum of 22.2 kN per worker attached.
- .6 Vertical Lifeline Systems: Design for a permanent one person vertical lifeline where it is required as a part of a ladder safety device; base design on specific load requirements for this Project.
- .7 Horizontal Lifeline Systems: Design for a permanent horizontal cable lifeline system; base design on specific load requirements for this Project.
- .8 Design structural connections to roof deck and additional reinforcement as required to prevent damage to roof deck; submit load requirements to the Consultant for their use in design the primary structures.
- .9 Design connections to supporting structural framing as required to resist pullout force and reinforce deck against damage and carry pull out force back to structural framing; submit load requirements to the Consultant for their use in design the primary structures.
- .10 Arrest Force: Limit to 4 kN or less.
- .11 Design an adequate fall protection system that will be suitable for the building structure, to comply with the relevant codes and regulations of the jurisdictional authorities. Provide the appropriate number of anchorage connectors as required by jurisdictional authorities to suit particular manufacturer's product.
 - .1 Fall arrest anchorage connectors designed:
 - .1 to a maximum force of 8.0 kN when wearing a body harness.
 - .2 capable of resisting in situ test load of 11.1 kN without any permanent deformation.
 - .3 to 22.2 kN against fracture of detachment.
 - .2 Delegated design engineer shall design and verify the installed system, any modification or additional anchor requirements, devices, and equipment required to complete the window cleaning and building maintenance system, and shall include costs in the contract price.

2.3 MATERIALS AND EQUIPMENT

- .1 Materials shall be new, free from defects impairing strength, durability or appearance, and of best commercial quality for purposes specified.

- .2 Equipment shall include all components, connections, devices, and controls required to make it fully and safely operable.
- .3 Fall Arrest Anchorage connectors:
 - .1 Fall arrest anchorage connectors shall be devices for support of safety lifeline. Fall arrest anchorage connectors shall be roof or wall mounted, designed by professional engineer in the province of work, in accordance with requirements of CSA Z259.
 - .2 Fall arrest anchorage connectors shall be capable without fracture and/or pull-out a force of 22.2 kN, applied in any direction.

2.4 STEEL PLATE AND UPRIGHT MATERIALS

- .1 Exposed Structural Units: Stainless steel, Type 304, 290 MPa, yield strength.
- .2 Single Insert: Cast stainless steel, Type 304.
- .3 Steel Pipe for Upright Anchors: ASTM A53/A53M Schedule 40, Type S, Grade A or B to suit strength requirements, galvanized for exposed locations, black for protected locations, heavy wall construction.
- .4 Steel Plate: ASTM A1011/A1011M Grade 45, minimum 10 mm thick.
- .5 Steel D-Ring Eyelets, Attachment Rings, and Other Hardware: In accordance with ASTM F887; drop forged, 22.2 kN proof load, 10 mm x 50 mm steel.
- .6 Safety Spirals and Pass-thru Brackets: Type 304 stainless steel with yield strength of 35 Ksi.
- .7 Hollow steel section (HSS) piers: mild steel, Type 300W with yield strength of 50 Ksi. Wall thickness to suit application, hot dipped galvanized to CSA G164.
- .8 Base plates and all other sections: galvanized mild steel as above with yield strength of 44 Ksi. Thickness and securement to suit application.
- .9 Welding Materials: in accordance with CSA W59.

2.5 FASTENERS

- .1 Non-Exposed Structural Components: ASTM A36/A36M or CSA G40.20/G40.21, Type 360W, mild steel, 350 MPa yield strength for high strength steel and 300 MPa for plate and other shapes; galvanized to the requirements of CSA G164.
- .2 Exposed Non-Structural Items: Seamless spun 6061-T6 aluminum alloy and temper, conforming to ASTM B221/B221M and ASTM B209/B209M.
- .3 Cold Rolled Non-Exposed Structural Steel Sections: CSA S136, 380 MPa yield strength, 460 MPa tensile strength.
- .4 Bolts, Nuts, and Washers: In accordance with ASTM F3125/F3125M or hot-dip galvanized in accordance with ASTM A153/A153M, Class C or D, as appropriate to installation.
- .5 Exposed Fasteners: Stainless steel Type 304, engineered by manufacturer for design loads and type of use; gasket with EPDM washers where penetrating roofing membrane.

- .6 Structural Thermal Break: High strength polyurethane closed cell sheet, 50 mm thick with R-value of 3.1 per 25 mm.
 - .1 Basis-of-Design Materials:
 - .1 Armatherm 500, Armadillo Structural Connections
- .7 Epoxy Adhesive System: Two component, injectable adhesive specifically manufactured for use in installing dowels or threaded anchor rods and inserts into new or existing concrete, and as follows:
 - .1 Base Composition: Solid base installation.
 - .2 Epoxy Composition: Sealed packaging containing resin, hardener, cement and water; components providing the following properties:
 - .1 Compressive Strength ASTM C579: 71.8 MPa
 - .2 Tensile Strength ASTM C307: 15.9 MPa
 - .3 Flexural Strength ASTM C580: 29.3 MPa
 - .4 Modulus of Elasticity ASTM C307: 7032 MPa
 - .5 Water Absorption ASTM D570: 0.12%
 - .6 Curing Time: Rapid set, high strength and stiffness; maximum time 45 minutes at 20°C.

2.6 FLASHING AND SEALING MATERIALS

- .1 Non-expanding Sealing Gaskets for Sealing under Anchor Bases: Pre-cut and predrilled, 40 durometer, 3 mm thick solid neoprene rubber meeting or exceeding ASTM D2000.
- .2 Expanding Compression Gaskets for Sealing under Steel Flashing Cap: 6 mm neoprene rubber meeting or exceeding ASTM D1056 Type I (Closed Cell), Class B or C (Petroleum Resistant).
- .3 Steel Flashing Cap: Minimum 0.45 mm metal core thickness, prefinished sheet steel; having boxed corners fit tightly over plate and compression gasket, with factory cut penetration configured to upright, and predrilled holes at corners for attachment with mechanical fasteners.
- .4 Joint Sealants: Non-skinning butyl sealant where not exposed to ultra-violet or neutral curing silicone sealant where exposed and as applicable to installation. Polyurethane sealant not accepted for this type of installation.
- .5 Rigid Foam: Watertight closures or closed cell foam, forming a part of the manufacturer's standard materials for filling pipes to prevent water infiltration.

2.7 FABRICATION

- .1 Accurately cut, machine and fit joints, corners, copes and mitres so that junctions between components fit together tightly and in true planes. Cap open ends of sections exposed to view.
- .2 Fabricate work with materials and component sizes, metal gauges, reinforcing, anchorage connectors, and fastenings of adequate strength to ensure that it will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended and specified use and with allowable design factors imposed by authorities having jurisdiction.

- .3 Connections: Weld and grind smooth in accordance with CWB requirements.
- .4 Pre-drill holes for fasteners at base plates.
- .5 Fabricate engineered window washing/fall restraint and fall arrest system suitable for roof and deck mounting with welded steel base plate and steel plate uprights or steel pipe uprights.
- .6 Provide drilled eye holes at steel plate uprights or D-rings at uprights suitable for attachment of catenary life lines.
- .7 Fill steel pipe uprights with urethane foam insulation or other accepted filler.
- .8 Size uprights for a minimum 200 mm exposure above roof membrane in accordance with OIRCA good roofing practices.
- .9 Fabricate seamless flashings where metal pier anchors are to be used.
- .10 Seal top of anchors with a one piece stainless steel cap.

2.8 FINISHES

- .1 Shop Preparation and Shop Primer: Track, supports, and other structural components: SSPC-SP6 ready for application of CAN/CGSB 1.40, anticorrosive primer.
- .2 Anchors Fabricated from Steel Pipe Uprights, Base Plates, and D-rings:
 - .1 Mild Steel Components: Hot-dip galvanize after fabrication, as follows:
 - .1 Pipe: ASTM A53/A53M.
 - .2 Plate: CSA G164.
 - .3 D-Rings: CSA G164 or ASTM A153/A153M.
 - .2 Stainless Steel Components: Manufacturer's standard.
- .3 Galvanizing Repair Compound: 95% zinc cold galvanizing compound in accordance with ASTM A780; field touch-up damaged galvanizing surface finishes with galvanizing repair compound.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions as satisfactory to receive work of this Section.
- .2 Beginning work constitutes acceptance of existing conditions.
- .3 Verify layout of roof fall arrest anchors and that structural connections are suitable for work of this Section.

3.2 PREPARATION

- .1 Supervise and assist in setting of anchorage devices required for installation of work of this Section, but which do not form a part of the work of this Section.
- .2 Protect all adjacent surfaces from damage due to work under this section.

3.3 INSTALLATION

- .1 Install building maintenance system and safety anchors in accordance with manufacturer's written instructions and provisions of the Contract Documents, under the supervision of structural engineer employed by manufacturer registered in the province of the work.
- .2 The manufacturer's engineer shall coordinate their activities with, and notify the Consultant where conflicts arise, or where site conditions require a modification to the engineered design indicated on the shop drawings.
- .3 Lay out building maintenance system and safety anchors in accordance with reviewed shop drawings.
- .4 Space materials symmetrically between roof elements such as ridges and sidewalls.
- .5 Space uprights at same spacing so that same line can be attached at different locations.
- .6 Coordinate fall arrest anchorage connector heights with building roof systems and locations with roof mounted equipment.
- .7 Coordinate installation with Roofing Contractor for sealing of membrane to anchorage connectors and flashing.
- .8 Install work to meet manufacturer's specifications, true, tightly fitted, and level or flush to adjacent surfaces, as applicable for the installation.

3.4 FIELD QUALITY CONTROL

- .1 Provide field review by manufacturer as follows:
 - .1 Provide field inspection and testing upon completion by manufacturer's technical representative.
 - .2 Note deficiencies and promptly make written report to Contractor, Owner and Consultant.
 - .3 Issue Letter of Compliance and certifications of system issued by a qualified professional engineer registered in the province of the Work.
 - .4 Complete inspection log book to certify the system for use; turn over to Owner's representative.
- .2 The Owner will require a complete commissioning of the fall arrest and restraint system, and window washing and equipment supports in accordance with the Owners commissioning plan.
- .3 Testing: provide third party on site load testing in accordance with item 11.3.3 in CSA Z271:20 and provide results to the Owner within ten days.

3.5 ADJUSTING

- .1 Verify work under this section that installed products function properly and adjust them to ensure proper operation.
- .2 Repair or replace defective installations not conforming with provisions of Contract Documents.

3.6 TRAINING

- .1 Train Owner's personnel in the use of the system.

3.7 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, and tools.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Microwave.
 - .2 Fridge.
 - .3 Installation.
- .2 Related Requirements:
 - .1 Section 06 40 00 – Architectural Woodwork
 - .2 Section 09 21 16 – Gypsum Board Assemblies
 - .3 Division 22 – Plumbing: Coordination of pipes and fittings and other materials.
 - .4 Division 23 – Heating, Ventilating and Air Conditioning (HVAC): Coordination of ventilation, ducts and other materials.
 - .5 Division 26 – Electrical: Coordination conduit, wiring and other materials.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A240/A240M-23a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - .2 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
 - .3 Canadian Standards Association (CSA Group):
 - .1 CSA C22.2 No.120-13 (R2023), Refrigeration Equipment.
 - .2 CSA C22.2 No.150-16 (R2021), Microwave Ovens, Includes Errata (2017) and Update No. 1 (2022) and Update No.2 (2023).
 - .3 CAN/CSA C338-15 (R2020), Energy performance and capacity measurement of household microwave ovens.

1.3 ACTION SUBMITTALS / INFORMATION SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Include manufacturers name, type, model, year, dimensions, capacity and finishes for each appliance.
 - .2 Include details of operation, servicing, maintenance and recommended spare parts list.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures, indicate:
 - .1 Construction details of equipment by drawings.
 - .2 Roughing in requirements for mechanical and electrical services.
 - .3 Installation details

- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01-LEED Product Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operations and maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Obtain products from a qualified manufacturer having a service centre capable of providing training, parts, and emergency maintenance repairs within 50 km of project site.
- .2 Appliances shall be labelled in accordance with requirements of CSA, ULC, CGA and other standards acceptable to the Authorities Having Jurisdiction.
- .3 Provide appliances that carry labels indicating energy cost analysis (estimated annual operating costs) and efficiency information qualifying for labelling under the Energy Star Program.

1.6 WARRANTY

- .1 Provide manufacturer's standard form of warranty stating that each appliance specified will be repaired or replaced that fail in materials or workmanship within manufacturers standard warranty period.

Part 2 Products

2.1 MANUFACTURERS

- .1 Materials other than named products Basis-of-Design materials may be acceptable to the Consultant; submit information in accordance with Section 01 62 00 – Product Options and Substitutions and as follows:
 - .1 Proposed alternates shall match colour range and performance characteristics of named products.
 - .2 Proposed alternates found acceptable by Consultant will be listed in an Addendum.
 - .3 The Consultant is not obliged to accept any materials presented for their review and does not need to provide reasons for rejection of proposed alternates.

2.2 COOKING APPLIANCES

- .1 Microwave:
 - .1 Capacity: 0.02 m³.
 - .2 Finish: Stainless steel.
 - .3 Features: Digital control panel with timer display.
 - .4 Power: 1000 W
 - .5 Size: 514 mm wide x 305 mm high x 419 mm deep.
 - .6 Basis-of-Design Materials:
 - .1 NE1054F, Panasonic.

2.3 REFRIGERATION APPLIANCES

- .1 Refrigerator/Freezer:
 - .1 Type: Freestanding, frost-free one door refrigerator with freezer on top.
 - .2 Dimensions: 1520 mm high x 610 mm wide x 727 mm deep.
 - .3 Storage Capacity: 0.33 cu. metre
 - .1 Fridge Storage: Two sliding glass shelves, one fixed glass shelf, fixed full width door rack, adjustable half width door rack, two adjustable can racks, two clear crispers.
 - .2 Freezer storage: Two fixed full width freezer door racks, full width freezer shelf.
 - .4 Temperature Controls: Separate temperature controls for each compartment, and with switch for condensation control heating element at freezer opening.
 - .5 Front Panel: Manufacturer's standard panels, Black.
 - .6 Basis-of-Design Materials:
 - .1 GPE12FGKBB, GE Appliances

Part 3 Execution

3.1 EXAMINATION

- .1 Examine conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- .2 Examine roughing in for piping and electrical systems to verify actual locations of piping and electrical connections before equipment installation.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- .1 Install equipment in accordance with manufacturer's instructions.
- .2 Coordinate connection of mechanical and electrical services.
- .3 Securely anchor built-in units to supporting cabinets or countertops with concealed fasteners; verify that clearances are adequate for proper functioning and rough openings are completely concealed.
- .4 Place free-standing units in final locations after finishes have been completed in each area; verify that clearances are adequate to properly operate equipment.
- .5 Adjust equipment for smooth and proper operation.

3.3 SITE QUALITY CONTROL

- .1 Test each appliance specified in this Section to verify proper operation; make necessary adjustments.
- .2 Verify that accessories required have been furnished and installed.

3.4 CLEANING

- .1 Remove packing material from appliances and leave units in clean condition, ready for operation.

3.5 DEMONSTRATION

- .1 Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain appliances.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Work of this section includes provision of manufactured metal shelving.

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheets. Include manufacture's installation and assembly instructions.
 - .2 Submit shop drawings: Show plan layout of shelving.
- .2 Submit closeout data in accordance with Section 01 78 00:
 - .1 Submit maintenance data: Include maintenance procedures, recommendations for maintenance materials and equipment.

1.3 QUALITY ASSURANCE

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Manufacturer: Obtain products listed in this Section from listed manufacturers with 10 years experience fabricating library metal shelving and that have local distribution and servicing facilities.
 - .2 Installers: Use installers that have completed manufacturer's authorized training program and that are certified to install and maintain units delivered for this Project.
- .2 Source Limitations: Obtain products through one source from a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle, store and protect materials in accordance with Section 01 61 00 – Common Product Requirements.
- .2 Sequence delivery of materials to take into account other contractors that may still be working on site.
- .3 Storage on site for materials will be limited to the immediate area of the Work:
 - .1 There will be no additional site storage available.
 - .2 Arrange and pay for any off site storage costs arising from bulk delivery of materials.
- .4 Schedule “Just-In-Time” delivery of materials to site and store materials in area of work:
 - .1 No other storage facilities are available on site.
 - .2 Be responsible for obtaining any required off-site storage required for materials of this project.

- .3 Schedule deliveries to avoid double movements of materials on site.
- .4 Cooperate with other contractors and schedule delivery of materials to allow for other contractors activities.
- .5 Storage and Protection:
 - .1 Protect products from scratches, handling marks and other damage.

1.5 WARRANTY

- .1 Provide manufacturer's warranty for a period of ten (10) years from the date of Substantial Performance of the Work.

Part 2 Products

2.1 PRODUCT:

- .1 Metal shelving (1 required) including:
 - .1 Shelf: three - galvanized steel mesh with 50 x 100 mm grid
 - .2 Adjustable: 50 mm increments for shelving
 - .3 Weight: each shelf holds up to 1360 kg
 - .4 Finish: powder coating
 - .5 Posts and supports: 1.63 mm (14 ga)
 - .6 Size: 1220 mm wide x 915 mm deep x 1828 mm tall
 - .7 Basis of Design:
 - .1 H-5415, U-Line Bulk Storage Racks
- .2 Metal shelving (2 required) including:
 - .1 Shelf: three - galvanized steel mesh with 50 x 100 mm grid
 - .2 Adjustable: 50 mm increments for shelving
 - .3 Weight: each shelf holds up to 1247 kg
 - .4 Finish: powder coating
 - .5 Posts and supports: 1.63 mm (14 ga)
 - .6 Size: 1828 mm wide x 915 mm deep x 1828 mm tall
 - .7 Basis of Design:
 - .1 H-4320, U-Line Bulk Storage Racks

2.2 FINISH

- .1 Electrostatically applied powder coat finish.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine subfloor surfaces, for compliance with requirements for installation tolerances of fixed storage units.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected

3.2 INSTALLATION

- .1 Install components and accessories after painting and finishes have been completed.
- .2 Install shelving units to comply with final layout drawings, in accordance with manufacturer's printed instructions and structural calculations.
- .3 Position unit's level and plumb.
- .4 Install wood panels to tops and ends.

3.3 CLEANING AND PROTECTION

- .1 Clear components and surfaces, remove surplus materials resulting from installation upon completion of work and leave areas of installation in clean condition.
- .2 Protect system against damage during remainder of construction period. Advise Owner of additional protection required to ensure shelving units will be without damage or deterioration at time of Substantial Performance of the Work.

3.4 DEMONSTRATION AND TRAINING

- .1 Provide complete training to end-user's staff. Training shall include general safety and operation instructions, and basic preventative maintenance procedures.

END OF SECTION



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MECHANICAL SPECIFICATIONS

FOR

YORK REGION

NORTH ROADS OPERATIONS CENTRE

TO

GEC ARCHITECTURE

DATED

MAY 23, 2025

REISSUED FOR TENDER

Contact Person: David MacKeracher
Phone: (416)-729-3703
Email: DMackeracher@mcw.com

MCW Project No. 23137

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DEFINITIONS AND TERMS

- .1 The following Definitions and Terms shall be read in conjunction with the Definitions included in the Division 01 Specifications and all Mechanical Division Contract Documents.
 - .1 **barrier-free:** means when applied to a building and its facilities, that building and its facilities can be approached, entered and used by persons with physical or sensory disabilities in accordance with requirements of local governing building code.
 - .2 **concealed:** means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
 - .3 **delete** or **remove:** includes tenses of "delete" or "removed" means to disconnect, make safe, remove obsolete materials including any back box and exposed piping and raceways; patch, and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions; and properly dispose of deleted products off site unless otherwise instructed by Consultant.
 - .4 **exposed:** means work normally visible, including work in equipment rooms, tunnels, and similar spaces.
 - .5 **finished:** means when in description of any area or part of an area or a product which receives a finish such as paint or in case of a product may be factory finished.
 - .6 **OSHA** and **OHSA:** stands for Occupational Safety and Health Administration and Occupational Health and Safety Act respectively, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
 - .7 **Work:** includes tenses of "work" when used in the Mechanical Division Documents it means all equipment, permits, materials, labour and other services as may be necessary for a complete Mechanical system as described in the Mechanical Division Documents.
 - .8 **Documents:** Include one or more combinations of Mechanical Division Drawing(s), Specification(s), Plan(s), Report(s), Design(s), Model(s), or similar means of communicating the Basis of Design, and may be in paper or electronic format, and must be considered in their entirety.
 - .9 **Basis of Design:** refers the mechanical design intent inherent in the Mechanical Division Documents to establish a specific performance expectation and/or requirement. The Basis of Design may refer to specific equipment and/or products that have been used to establish an energy performance benchmark, and/or space constraint, and/or structural load, and/or a specific equipment arrangement, and/or operating sequence, and/or other similar consideration specific to the mechanical design intent.
 - .10 **Consultant:** when used in the Mechanical Division Documents it means the Prime Consultant and MCW Consultants Limited, Queen's Quay Terminal, 207 Queen's Quay West, Toronto, Ontario M5J 1A7.
 - .11 **Acceptable Manufacturer(s):** also referred to as "Standard of Acceptance", and/or "Alternative Manufacturer", "and/or Acceptable Alternative" and/or similar language that describes manufacturers other than the manufacturer used as the Basis of Design and shall all have the same meaning throughout the Mechanical Division Documents. Acceptable Manufacturers may be used in the Work in lieu of the Basis of Design manufacturers subject to meeting conditions stipulated elsewhere in the Documents.

- .12 **Supply:** includes tenses of "supply" when used in the Mechanical Division Documents means supply only for installation by Trades other than Mechanical Division Trades or under separate agreement. Additional obligations may be required by the Documents.
- .13 **Install:** includes tenses of "install" when used in the Mechanical Division Documents means install, connect, test, balance, and start-up complete. Additional obligations may be required by the Documents.
- .14 **Provide or provision of:** includes tenses of "provide" when used for any part of the Work of the Mechanical Division Documents it means to Supply, Install, connect, test, balance, and start-up. "Provide" or "provision of" includes preparation of Coordination Drawings, preparation of Final Set of "As-built" or "As-constructed" Drawings, and Commissioning in accordance with the Basis of Design. Further, "provide" or "provision of" means to procure, prepare, supervise, pay for, and take responsibility for the services referenced. Additional obligations may be required by the Mechanical Division Documents.
- .15 **Authorities or Authorities Having Jurisdiction or AHJs:** when used in the Mechanical Division Documents it means any and all agencies that enforce the applicable Laws, By-laws, Codes, Standards, Ordinances, Rules, Regulations, and Interpretations of same in the place of Work. There may be more than one AHJ.
- .16 **Acceptable:** when used in the Mechanical Division Documents, it means acceptable to the Consultant.
- .17 **Performance:** when used in the Mechanical Division Documents in relation to specified equipment, it means the performance inherent in the Basis of Design, and includes, but is not limited to;
- the flow capacity of equipment and systems as it applies to air, steam, water and other hydronic mediums,
 - heating and/or cooling energy, and energy transfer capacity,
 - the pressure capacities of equipment and systems as it applies to air, steam, water and other hydronic mediums;
 - physical limitations including, but not limited to, weight and space (both occupied and service requirements);
 - effect on ambient sound levels.
- .18 **BAS:** refers to the Building Automation System; also refers to "BMS" (Building Management System), also refers to "FMS" (Facility Management System), also refers to "DDC" (Direct Digital Control system). References to "BAS", "BMS", "FMS" and "DDC" generally have the same meaning; refer to Section 25 05 10 BAS General Requirements for additional information.
- .19 Wherever terms "indicated", "shown", "noted", "listed", or similar words or phrases are used they are understood, unless defined otherwise, to mean "indicated", "shown", "noted" or "listed" in the Mechanical Division Documents.
- .20 Wherever terms "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in the Mechanical Division Documents they are understood, unless defined otherwise, to mean that work or product(s) referred to as "reviewed by", "to the satisfaction of", "submitted to", the Consultant.
- .2 Additional Definitions and Terms are included in succeeding Mechanical Division 20, 21, 22, 23 and 25 Specification Sections, and in other Documents, and are inclusive to the list of Definitions and Terms above.

1.03 WORK INCLUDED

- .1 Sections of the Specifications are not intended to delegate functions, or to delegate Work or apply to any specific trade. The Work of the Contractor includes all labour, materials, equipment, permits and tools required for a complete and working installation as described in the Mechanical

Division Contract Documents, and are not necessarily limited to items in the following Mechanical Specification Sections:

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Division 22 - Plumbing and Drainage Sections:

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1.04 CONTRADICTION AND AMBIGUITY

- .1 Where there is apparent contradiction or ambiguity in the documents, or where there are apparent discrepancies in or omissions from the documents, or if there is any doubt as to the intent of the Contract Documents, the bidder shall request and obtain written clarification(s) from the Consultant prior to Bid submission.
- .2 Consideration will not be granted for misunderstanding of the intent of the Contract Documents or the extent of the Work to be performed.
- .3 Attend the job site prior to Bid submission and verify all conditions. Prior to submitting Bid price, the Mechanical Trade Contractor shall review any discrepancies and verify the locations of existing services that are being extended and the routing of new services. Report all ambiguities, discrepancies, departures from Laws, Building Code requirements, Regulations, By-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Trade Contractor. Include in the Bid submission price for any alternative routing of new or existing services to accommodate site conditions.

1.05 REGULATORY REQUIREMENTS

- .1 Comply with all requirements of the Authorities having Jurisdiction ("AHJs").
- .2 Comply with requirements of all Municipal, Provincial and Federal Bylaws and Ordinances as well as requirements of Utilities such as Ontario Gas Utilization Code and The Ontario Electrical Safety Code.
- .3 Do not reduce quality of any part of the Work shown on the Contract Documents and/or specified references by the Associations and Agencies in the following paragraphs.
- .4 In general, and as applicable, perform all Work of the Mechanical Trade Contractor such that it complies in all respects with the physical and chemical properties, characteristics and performance requirements of recognized Associations and Agencies as required by these Specifications, and as follows:

AMCA -	Air Moving & Conditioning Association
ADC -	Air Diffusion Council
ANSI -	American National Standards Institute
AHRI -	Air Conditioning Heating & Refrigeration Institute
ASCII -	American Standard Communication Information Interchange
ASHRAE -	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME -	American Society of Mechanical Engineers
ASPE -	American Society of Plumbing Engineers
ASTM -	American Society for Testing and Materials
AWWA -	American Water Works Association

CGA -	Canadian Gas Association
CGSB -	Canadian General Standards Board
CSA -	Canadian Standards Association
EIA -	Electronic Industry Association
ETL -	Electrical Testing Laboratories
FM -	Factory Mutual
ISA -	Instrument Society of America
IAO -	Insurers Advisory Organization
MMAH -	Ministry of Municipal Affairs and Housing
MTC -	Ministry of Transportation and Communication
NBC -	National Building Code of Canada
NPC -	National Plumbing Code of Canada
NFC -	National Fire Code of Canada
NFPA -	National Fire Protection Association
OESC -	Ontario Electrical Safety Code
OBC -	Ontario Building Code
OFC -	Ontario Fire Code
MOEE -	Ontario Ministry of Environment and Energy
OML -	Ministry of Labour and Worker's Compensation Requirements
TSSA -	Technical Standards & Safety Authority
ULC -	Underwriter's Laboratories of Canada
UL -	Underwriter's Laboratories Inc.
cUL -	Underwriter's Laboratories Inc. (testing completed to Canadian Standards)

1.06 STANDARDS

- .1 Provide new materials and equipment of proven design and quality. Provide current models of specified equipment manufactured in Canada or the United States of America, unless specified otherwise with published ratings certified by recognized North American testing and standards agencies.
- .2 Comply with ASHRAE/IES 90.1 Standards in the supply and installation of all parts of the Work.
- .3 Conform to the best modern practices of workmanship and installation means and methods, and employ only skilled tradesmen working under the direction of fully qualified personnel.

1.07 LEED REQUIREMENTS

- .1 The building will be certified under the Canadian Green Buildings Council, Leadership in Energy and Environmental Design. This requires all Construction Trades to adhere to certain requirements with respect to cleanliness, recycling, materials reuse and other practices which are part of the Contract requirements.
- .2 In addition to the above, ensure the following requirements are observed on site:
 - .1 Smoking shall not be permitted within the Work area, or outside the Work area but within the existing building. Refer to 'Smoking' Article in this Section of the specifications.
 - .2 Open ended ductwork shall be protected with plastic sheeting.
 - .3 Open ended piping shall be capped to limit ingress of debris.
 - .4 All trades shall practice recycling of waste, under direction of the Construction Manager.

- .3 Preparation and Implementation of a Demolition/ Construction IAQ Management Plan**
- .1 Prior to the commencement of Demolition/ Construction the Contractor shall prepare an IAQ Management Plan for review by the Owner's Project Manager and the Consultant. The purpose of the IAQ Management Plan is to identify potential sources of contamination at the site and to minimize their impact through appropriate preventative or mitigative controls.**
- .2 The Contractor shall be responsible for implementing all measures described in the reviewed IAQ Management Plan.**
- .3 Monitoring and documentation of implemented measures shall be required to demonstrate compliance with the IAQ Management Plan.**
- .4 The IAQ Management Plan shall include the following approaches for the demolition and construction stages of the Work:**
- .1 HVAC system protection as specified in this Section,**
- .2 Source Control Measures as follows:**
- .1 Control sources of contamination through implementation of the following practices to manage the anticipated or potential contaminant sources:**
- .1 Contractor shall notify the Owner's Project Manager when a construction activity is anticipated to cause contamination of the indoor air (i.e. excess dust, increased humidity, use of a product that will result in off-gassing to indoor air).**
- .2 Notification shall be made at least 48 hours before the planned commencement of the activity.**
- .3 The Contractor shall ensure that proper source control measures are in place prior to commencement of the activity.**
- .2 All adhesives, sealants, paints, coatings, flooring and wood products are to be low-emitting VOCs; shop drawings and/or product data sheets identifying the product's emissions and VOC content shall be submitted to the Owner's Project Manager for review prior to installation or application. Products that have not been approved are to be removed from the site.**
- .3 For potential off-gassing products, i.e. cleaning solutions, the Contractor shall follow the safe material handling procedures specified for the product. As necessary, additional temporary ventilation or exhaust measures shall be provided in the Work area.**
- .4 Contractors shall utilize demolition and construction techniques that minimize the release of contaminants, including airborne dust.**
- .5 Contractors shall utilize temporary dust extraction measures where possible to minimize airborne dust.**
- .6 Contractors are to immediately report any uncontrolled odours, dust or other contaminants identified in the work areas to the Owner's Project Manager.**
- .7 No vehicles are to idle in areas where emissions could be drawn into the building interior.**
- .8 Contractors will select electric powered rather than gasoline powered equipment to reduce emissions.**
- .9 Equipment will be turned off when not in use.**
- .10 Containers of wet products will be kept closed when not in use.**

- .11 **Waste materials that release dust or odors will be covered or sealed.**
- .3 **Pathway Interruption measures as follows:**
 - .1 **Where a contaminant source(s) cannot be satisfactorily controlled, the Contractor shall implement the following Pathway Interruption measures:**
 - .1 **A negative pressure will be created in the work area subject to contamination (i.e. air borne dust particles and other related pollutants).**
 - .2 **The negative pressurization will reduce contamination of other work areas.**
 - .3 **Make-up air for that being exhausted shall be achieved by the installation of portable fans. Air supply to the negative pressure spaces will be 100% fresh air.**
 - .4 **Exhaust air shall not be discharged where it can be drawn back into to the building (a minimum of 10m (30 ft.) of separation distance shall be provided to any building opening or air intake. Filtration for the temporary system may be required, depending on the controlled contaminant.**
 - .5 **Barriers will be erected to contain the construction area.**
 - .6 **Wood cutting will be conducted behind barriers to control dust.**
 - .7 **Persons working near drywall dust must wear protective masks.**
 - .8 **Welding arc exhaust fumes will be controlled with a point source exhaust system.**
 - .9 **As required, equipment or activities that produce excessive contaminants shall be located outdoors and away from air intakes so as not to compromise indoor air quality.**
- .4 **Housekeeping Measures as specified in this Section.**
- .5 **Scheduling measures as follows:**
 - .1 **The Contractor shall identify and schedule the Work to address and manage any potential IAQ concerns related to Demolition/ Construction activities.**
 - .2 **Scheduling measures shall address the following:**
 - .1 **Protection measures proposed,**
 - .2 **Source control measures proposed,**
 - .3 **Pathway interruption measures proposed,**
 - .4 **Specific housekeeping measures proposed.**
- .5 **Documentation, Inspection and Maintenance of IAQ Management Plan**
 - .1 **Requests to modify management processes outlined in this IAQ Management Plan must be submitted in writing to Owner's Project Manager for approval.**
 - .2 **Contractor's responsibilities with regard to the IAQ Management Plan will be communicated at the weekly contractor site meetings.**
 - .3 **A copy of the IAQ Management Plan shall be posted on site in a location available to all Trades.**

- .4 ***Contractor shall take digital photographs throughout the construction to capture the steps taken to comply with the requirements of the IAQ Management Plan. The Contractor shall forward photographs complete with date taken and identification of type of control measure highlighted.***
- .5 ***The Consultant shall conduct site inspections to ensure that the controls specified in the plan are being implemented. Information from Contractors, site inspection checklists and photographic documentation of the management controls will be collected to document compliance with the IAQ Management Plan. The Contractor shall be informed in writing of any deficiencies found during the site review.***
- .6 ***The Contractor shall provide 18 photographs—six photographs taken on three different occasions during construction—along with identification of the SMACNA approach featured in each photo. All SMACNA approaches used should be represented by at least one photo. The Region's consultant or Project Manager shall take additional photographs during routine site visits to document compliance with the IAQ Management Plan.***
- .7
- .8 ***Where deficiencies are identified by the Consultant or the Owner's Project Manager, the Contractor shall take corrective action and provide photographic evidence of correction within 48 hours.***
- .9 ***The Project Indoor Air Quality (IAQ) Management Checklist shall be completed by the project LEED Consultant and/pr the Owner's Project Manager; Checklist shall be provided to the successful Contractor following Contract award.***
- .10 ***The Contractor shall complete the Weekly Indoor Air Quality (IAQ) Management Checklist on a weekly basis and provide copies to the project consultants and the Owner's Project Manager. Any noted issues will be rectified immediately. Weekly Indoor Air Quality (IAQ) Management Checklist shall be provided to the successful Contractor following Contract award.***
- .11 ***The Contractor shall complete the Filter Listing at the end of the project and provide copies to the Consultants and the Owner's Project Manager. Filter Listing shall be provided to the successful Contractor following Contract award.***
- .6 ***Complete the An IAQ testing or flush-out procedure Specified in Section 20 08 10. Submit a copy of the IAQ testing and/or flush-out/ procedures and the documented results.***
- .7 ***Modifications to IAQ Management Plan***
 - .1 ***The IAQ Management Plan identifies the indoor air quality management controls to be implemented, maintained, and monitored on this project, however, it should be considered a "living document" that may be changed or adapted during the life of the project to be effective.***
 - .2 ***Changes or adaptations to the IAQ Management Plan may occur under the following conditions:***
 - .1 ***Controls and/or practices are not achieving the desired results,***
 - .2 ***Project scheduling prevents certain activities from being completed, or***
 - .3 ***An alternative procedure for control that meets the intent of the original plan and is approved by the Owner's Project Manager.***
- .8 ***Copies of all photographs, Project Indoor Air Quality (IAQ) Management Checklist, Weekly Indoor Air Quality (IAQ) Management Checklists, Pre-Occupancy Filter List***

and flush-out/IAQ testing procedures and results shall be provided to the Owner's Sustainable Building Engineer, Property Services Branch for LEED submission purposes.

- .9 ***Periodic checks for Plan compliance will be made by the LEED Facilitator.***
- .4 Mechanical initiatives selected to be designed into the project include the following:
 - .1 Use of ultra-low flow plumbing fixtures throughout the project.
 - .2 Energy efficient cooling and heating systems through the use of internal energy reclaim, condensing gas boilers, variable speed drives on multiple pumps and fans, and other measures inherent in the design.
 - .3 Use of CO2 sensors and air flow measurement to monitor and control air quality on each high density occupied HVAC Control zone;
 - .4 Use of high efficiency building envelope and glazing systems.
 - .5 Commissioning of all mechanical building systems, including verification by a third party.
 - .6 Use of non-chlorinated refrigerants in all equipment.
 - .7 ***An IAQ Management Plan as Specified above.***

1.08 PERMITS, FEES & INSPECTIONS

- .1 Apply for, pay for, and obtain all permits, licenses, inspections, examinations and fees required for the Work. Also submit, when required by the Authorities Having Jurisdiction ("AHJs"), information such as heat loss calculations, and other data that may be obtained from the Consultant. Should the AHJs require the information on specific forms, fill in these forms by transcribing the required information provided by the Consultant.
- .2 Before starting any work, submit the required number of copies of Drawings and Specifications to the AHJs for their approval and comments. Comply with any changes requested as part of the contract, but notify the Consultant immediately of such changes. Prepare and submit any additional drawings, details or information as may be required.
- .3 Arrange for inspection of all Work by the Authorities Having Jurisdiction ("AHJs") over the Work. On completion of the Work, present to the Consultant the final unconditional certificate of acceptance of the inspecting AHJs.
- .4 In case of conflict, codes and regulations take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the Drawings and Specifications by applying any of the Codes and Standards referenced in these Specifications.

1.09 CONTRACT DRAWINGS

- .1 The Drawings for Mechanical Work are performance drawings, diagrammatic, intended to convey the scope of work, indicate general Design Intent, arrangement and approximate location of mechanical equipment. The Drawings do not intend to show Architectural and Structural details.
- .2 Do not scale Drawings. Obtain information involving accurate dimensions from dimensions shown on Architectural and Structural Drawings, and by site measurement.
- .3 Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (pipes or ducts around beams and columns and other structural elements).
- .4 Alter, at no additional cost, the locations of materials and/or equipment as directed that do not necessitate additional material.
- .5 Install ceiling mounted or exposed components (examples include diffusers, sprinkler heads, grilles) in accordance with reflected ceiling drawings or floor plans.
- .6 Confirm on the site the exact location and mounting elevation of outlets and fixtures as related to existing Mechanical and Electrical components and Architectural and Structural details.

1.10 EXAMINATION OF THE PLACE OF THE WORK AND DOCUMENTATION

- .1 Prior to submitting tender, carefully examine conditions at the place of the Work that could affect the Work of the Mechanical Trades. Refer to and examine all Contract Documents.
- .2 Verify that materials and equipment can be delivered to the Place of the Work and that sufficient space and access is available to permit installation thereof in locations shown on the Drawings.
- .3 Verify location and elevation of existing services (water, electrical, sanitary, storm sewers, equipment, ductwork and piping) which may affect the Tender and Work of the Mechanical Trades. Repair any damage to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.
- .4 Please direct any inquiries regarding the bid documents in writing to: dmackeracher@mcw.com. Other forms of communication will be ignored. All questions will be responded to in writing and submitted to all active proponents. Directly contacting any other member of the Owner's staff with respect to this RFP at any time prior to the award of a Contract or the termination of the RFP, and the Owner may reject the Proposal of any Proponent that makes any such contact.

1.11 PRODUCT STANDARDS, ACCEPTABLE MANUFACTURERS, AND REQUESTS FOR PRODUCT SUBSTITUTION

- .1 Provide new material and equipment as specified and to acceptance of the Consultant. Acceptable Manufacturers' names are listed to set a standard of quality, performance, capacity, size, weight, appearance and serviceability.
- .2 Where no Acceptable Manufacturer is indicated, provide only as specified. Where "or equivalent" or "or equal" is noted in the Specifications under Acceptable Manufacturers, a request for acceptance of an equivalent Manufacturer or Product not listed must be submitted not less than seven (7) working days prior to the bid submission date. Submissions for an equivalent or equal manufacturer made after bid submission must be accompanied by a credit offering to the Owner for consideration, otherwise the listed Manufacturer shall be provided.
- .3 Assume full responsibility for ensuring that when providing Acceptable Manufacturers, all performance, space, weight, connection sizes and location (mechanical and electrical), power and wiring requirements, are included within the scope of the item quoted, and costs for any variances therefore are included in the quoted Tender amount. Equipment requiring greater than specified energy requirements, or greater installation and service space requirements, or requiring greater than the structural capacity allowed for, or otherwise adversely affecting the appearance or integrity of the building may be considered grounds for rejection by the Consultant.
- .4 All electrically operated equipment and electrical materials to bear the label of approval of CSA or be so stamped, or have special approval of the Authorities Having Jurisdiction. All material, wiring and devices to conform to the Canadian Electrical Code for the purpose for which they are to be used. All electrical equipment to be designed and manufactured in accordance with applicable EEMAC and ANSI specifications.
- .5 All gas fired equipment to bear the label of the CGA or be so stamped.
- .6 All plumbing products such as fixtures, faucets, flush valves and shower heads to bear the label of approval of the CSA or be so stamped.

1.12 IDENTIFICATION OF NON-CONFORMING MATERIALS AND EQUIPMENT

- .1 Submit documentation at time of bid, identifying nature and extent of non-conformance and/or variances from specifications or referenced standards.
- .2 Failure to submit this documentation at time of bid will be interpreted as confirmation that materials and equipment, including workmanship, hardware, software and other related ancillaries required will be provided in strict accordance with the Mechanical Contract Documents.

1.13 SHOP DRAWINGS

- .1 As soon as possible after the award of the Contract the Contractor shall submit to the Consultant a summary of Shop Drawing submissions for review.
- .2 Submit shop drawings for review in sufficient quantities to satisfy contractual requirements. Shop drawings pertain to each particular item as specified; show project and component name, item

reference number, certified physical and performance data; and clearly indicate all applicable parts and accessories. Affix Contractor's "Approved" stamp on all copies of all shop drawings prior to their submittal to the Engineer for review. Approval stamp shows name of firm, date the approval was made and the checker's signature or initials. Should the above requirements not be adhered to, submitted shop drawings will be returned without further Consultant review for proper re-submittal.

- .3 Submit shop drawings for items and equipment specified in the sections of the Mechanical Division. Identify the equipment by system name and number as similarly identified on the drawings.

- .4 Each Shop Drawing will be stamped by the Consultant in the following format:

<input type="checkbox"/> NOT REVIEWED	<input type="checkbox"/> REVIEWED
<input type="checkbox"/> RESUBMIT	<input type="checkbox"/> REVIEWED AS MODIFIED
<input type="checkbox"/> NOT SPECIFIED BY MCW, REVIEWED FOR MEP ONLY	

This stamp will be applied by the Consultant to each shop drawing.

- .5 This review by the Consultant is for the sole purpose of ascertaining conformance with the design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which to remain with the Contractor, and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or responsibility for meeting all requirements of the Mechanical Division Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of the work of other interfacing Trades as well as compliance with all Codes and requirements of the Authorities Having Jurisdiction.
- .6 Products not specified by MCW are reviewed to confirm compliance with services provided only. Any changes required between provided services and shop drawing requirements will be identified for coordination between trades.
- .7 It is the Contractor's responsibility to bring to the attention of the Consultant all physical, performance or other deviations from the Contract requirements. The Contractor shall provide a cover sheet with each Shop Drawing submission, on the Contractor's letterhead, including a summary clearly highlighting any and all deviations from the requirements of the Mechanical Division Contract Documents.
- .8 For equipment, provide performance, physical and operating data as described in the Mechanical Division Contract Documents and listed in equipment schedules. Provide performance curves for all pumps and fans specified. Include sound power data for any equipment such as fans, pumps, terminal devices, grilles and diffusers, chillers, cooling towers, or whenever equipment performance affects sound sensitive spaces.
- .9 Provide dimensions and mounting details for all items of equipment, and weight and support point loads of equipment weighing in excess of 14 kg (30 lbs.).
- .10 All dimensions, weights and performance characteristics to be in the same units used in the Specifications and shown on the Drawings (SI or Imperial). Shop drawings not submitted in conformance with the foregoing may be considered grounds for rejection.
- .11 Where equipment is specified with control panels or electrical control components such as float switches, control valves, level controllers, relays and similar components provide wiring diagrams and descriptions that are specific to the item. General data covering a wide range of similar devices or components is not acceptable.
- .12 Bind one complete set of "Reviewed" or "Reviewed as Modified" shop drawings in the Operating and Maintenance ("O&M") manuals; do not include shop drawing marked "Revise and Re-Submit".

1.14 PATENTS

- .1 Pay all royalties and license fees, and defend all suits or claims for infringement of any patent rights, and save the Owner and Consultant harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters patent or rights.

1.15 RIGHTS RESERVED

- .1 Rights are reserved to issue any additional Detail Drawings, which in the judgement of the Consultant may be necessary to clarify the Work, and such Drawings shall form a part of the Contract.

1.16 EQUIPMENT NAMEPLATES

- .1 Provide apparatus (including electric motors) with proper nameplates affixed thereto, showing the size, name of equipment, serial number and all information usually provided, which also includes voltage, cycle, phase and horsepower of motors and the name and address of the Manufacturer.

1.17 COMPLETION

- .1 The following are considered to be the minimum requirements of mechanical systems readiness in order that they may be considered by the Owner as ready for the intended use of the Work contracted to be performed in accordance with requirements described in the Ontario Construction Lien Act regardless of the value of Work remaining to be performed.
- .2 General completion requirements:
 - .1 Mechanical Commissioning complete in accordance with Section 20 08 10.
 - .2 Operating and Maintenance ("O&M") Manuals submitted to Engineer for review.
 - .3 Letter of Completion and documentation from all Sub-trade(s) submitted.
 - .4 Mechanical wiring including all power, control and communication wiring, has been completed and accepted by the Authorities Having Jurisdiction (AHJs)
 - .5 All certification, test and inspection certificates submitted.
 - .6 Integrated Systems Testing of Fire Protection and Life Safety Systems shall be completed in accordance with CAN/ULC-S1001 with the participation of all affected Trades.
 - .7 Final Record Set of "As-Constructed" or "As-built" Drawings completed, checked and submitted for HVAC, and Plumbing & Drainage.
 - .8 Final Record Set of "As-Constructed" or "As-built" Drawings completed, checked and submitted for fire protection.
 - .9 Confirm program for warranty period, including site visits and assistance to Owners for Operations and maintenance and controls. Extended warranty forms completed and submitted.
 - .10 System performance tests complete and verified.
 - .11 Cleanup completed (air filters, strainers, and other similar equipment cleaned and/ or replaced).
 - .12 Confirm access to equipment and other components requiring servicing (valves, dampers, and other similar serviceable equipment and devices).
 - .13 Thermometers, pressure gauges and filter gauges in place.
 - .14 Flexible connections and isolators free from binding.
 - .15 Painting, identification and valve tagging completed.
 - .16 Equipment lubricated and accessible for maintenance.
 - .17 Testing, Adjusting and Balancing ("TAB") work completed or nearing completion.
 - .18 Vibration and sound control verified in accordance with reference levels.

- .19 Insulation repaired and proper finish applied.
- .20 Pipe, duct and equipment identification completed.
- .21 Fire-stopping completed.
- .22 Turnover seminar and instructions to Owner completed.
- .3 Plumbing and Drainage system completion requirements:
 - .1 Pumps adjusted, balanced and operating correctly.
 - .2 Hydro-pneumatic and/ or expansion tank(s) charged and functioning correctly.
 - .3 All backflow preventers installed and functioning.
 - .4 Plumbing fixtures cleaned and water flows adjusted.
 - .5 Proper access to all cleanouts confirmed.
 - .6 Equipment drains taken to hub or funnel drain.
 - .7 Expansion and contraction provisions satisfactory.
 - .8 Thermometers and gauges installed.
 - .9 Gas connections to all equipment completed and inspected.
- .4 Fire Protection and Life Safety System completion requirements:
 - .1 Sprinkler systems tested and inspected as per NFPA 13.
 - .2 Standpipe systems tested and inspected as per NFPA 14.
 - .3 Emergency power generating equipment, transfer switches and distribution systems are complete and operational.
 - .4 Emergency power natural gas service and distribution systems are complete and operational.
 - .5 Fire extinguishers installed (or turned over to Owner if mutually agreed).
 - .6 Fire dampers, smoke dampers and combination fire and smoke dampers installed, tested and functioning as intended.
- .5 Hot Water Heating and Hydronic Circulation System completion requirements:
 - .1 Chemical cleaned piping and treatment charged.
 - .2 Expansion tank charged.
 - .3 Terminal units operating.
 - .4 Pumps adjusted, balanced and operating correctly.
 - .5 Boiler test fired and results submitted.
- .6 Chilled Water Cooling and Hydronic Circulation System completion requirements:
 - .1 Chiller start-up and commissioning complete;
 - .2 Cooling tower and/ or similar heat rejection equipment start-up and commissioning complete.
 - .3 Chemical cleaned piping, feed pump installed and treatment charged.
 - .4 Expansion tank charged.
 - .5 Pumps adjusted, balanced and operating correctly.
 - .6 Terminal unit isolators installed and units secured to mounting pads.
 - .7 Heat trace and freeze protection installed and tested.
 - .8 Refrigerant charged.
 - .9 Terminal unit controls tested and operating.

- .10 Terminal units commissioned test and results submitted.
- .11 Leak exhaust system installed and tested.
- .7 Heating Water System completion requirements:
 - .1 Chemical cleaned piping, feed pump installed and treatment charged.
 - .2 Heat pump start-up and commissioning complete.
 - .3 Humidifier operation verified.
- .8 Ventilation System completion requirements:
 - .1 Building exhaust systems serving building are complete, operational and balanced.
 - .2 Air handling system and exhaust fan system controls are complete, operational and balanced.
 - .3 Supply, return and exhaust air distribution ductwork complete and pressure tested.
 - .4 Supply, return and exhaust air outlets tested, adjusted and balanced.
 - .5 Distribution ductwork and air intake and exhaust plenums cleaned.
 - .6 Construction filters removed and new permanent air filters provided.
 - .7 Space ambient sound levels verified and any excess noises resolved.
 - .8 Shipping blocks removed.
 - .9 Start-up reports completed.
 - .10 Cooling coil condensate drains installed, cleared and flowing freely.
- .9 Rooftop HVAC Equipment completion requirements:
 - .1 Roof-mounted exhaust fans secured on bases.
- .10 Building Automation Systems ("BAS") and Control system completion requirements:
 - .1 Building Automation Systems ("BAS") and Control systems for all building systems are complete, operational and verified as functioning correctly.
 - .2 Panel layout sheets complete with point name, point address and wire identification number. One copy attached to each respective panel door.
 - .3 All points tagged with point name, point address and panel number.
 - .4 "As-built" control drawings submitted.
 - .5 "As-built" program flowcharts submitted.
 - .6 "As-built" ladder wiring diagrams showing all hardware interlocks submitted.
 - .7 Complete O&M Manual submitted (including apparatus and O&M Manual for all sensors, transducers, solid state relays, and similar equipment and devices).
- .11 ***IAQ Testing or Flush-out Procedure as specified in Section 20 08 10 completed.***

1.18 WARRANTIES

- .1 Provide warranties on specified products, equipment and components as well as on the installation of these items. Include for all costs for cutting and patching, removal of equipment and restoration materials and work and repairs to other equipment affected in performance of warranty work.
- .2 Provide warranty certificates, wherever given or required, that are in excess of the normal warranty period showing the name of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.
- .3 Warranty periods for temperature controls and Building Automation System ("BAS") to start on the date of verification of acceptance issued in writing by the Consultant.

- .4 The date of verification of acceptance is independent of Substantial Performance of the Work and may occur after certification of Substantial Performance.
- .5 Acceptance of the Building Automation System ("BAS"); refer to Section 25 10 10.
- .6 Include verification of acceptance certificates with the maintenance and operating manuals in the appropriate sections.

1.19 SCHEDULE

- .1 Comply with the Owner's target Substantial Performance date.
- .2 As soon as possible after the award of the Contract the Contractor shall submit to the Consultant a Schedule for review that achieves the target Substantially Performance date.
- .3 Building Services and normal operation of the remainder of the building shall be maintained.
- .4 Include for all necessary premium or overtime costs to perform work outside of normal working hours that, in the Owner's opinion, would disrupt the normal operation and use of the building.
- .5 Existing services shall be cut back and connections capped at concealed locations. Finishes shall be made good to match adjoining surfaces.
- .6 Where existing equipment is to be re-used, but interferes with the new construction, the existing work shall be temporarily relocated until new work is complete. Services to temporarily located equipment shall be maintained at all times.
- .7 Unless noted otherwise, existing mechanical equipment and materials which become redundant shall be completely disconnected and removed from the site. At the Owner's instruction, equipment and materials shall be turned over to the Owner on site. Disposition shall be confirmed with the Owner prior to removal.

1.20 SCHEDULE OF VALUES

- .1 As soon as possible after the award of the Contract the Contractor, shall submit to the Consultant for review a Schedule of Values (SOV) breaking down of the Contract amount according to Trades performing the Work, major equipment purchases, and site mobilization and demobilization costs.
- .2 Site mobilization costs shall be no more than 1.5 times the value of site demobilization costs.

1.21 CHANGES TO THE WORK

- .1 Unless otherwise stated in the Contract, the Supplementary Conditions or General Instructions, whenever Consultant proposes in writing to make a Change or revision to design, arrangement, quantity, or type of any work from that required by the Documents, prepare and submit to Consultant for review, a quotation for executing the Change or revision. The Change or revision shall be determined by one or more of the following methods as determined by the Consultant:
 - .1 By estimate and acceptance of a lump sum ("Lump Sum Method"); or
 - .2 Where unit prices, discounts and allowances are set out in the Contract Documents or subsequently agreed upon, in accordance with such unit prices ("Unit Price Method"); or
 - .3 By actual time and material costs and a fixed or percentage fee for overhead and profit ("Time and Material Method").
- .2 Changes in the Work evaluated using the Lump Sum Method or Time and Material Method shall be based on the following factors:
 - .1 For Materials and Equipment - The latest edition of Allpriser published list prices, less the following discounts:

	Item	Discount
1	Steel Pipe	50%

	Item	Discount
2	Copper Pipe	45%
3	Cast Iron Soil Pipe	45%
4	Stainless Steel Pipe and fittings:	45%
5	Welded Fittings:	50%
6	Grooved Fittings:	30%
7	Threaded Fittings:	40%
8	Cast Iron Screwed Fittings:	40%
9	Copper Fittings:	45%
10	Cast Iron MJ Fittings:	35%
11	Valves:	25%
12	Insulation Materials:	35%
13	All Other Materials:	25%
14	Equipment Rental:	Actual Rate, but not to exceed local rates.

- .2 For Base Labour Units:
 - .1 mechanical labour unit costs are to be in accordance with Mechanical Contractors Association of America (MCAA) Labor Estimating Manual;
 - .2 electrical labour unit costs are to be in accordance with National Electrical Contractors Association (NECA) Manual of Labor Units;
 - .3 other such standardized trade units that may exist, on a Journeyman basis.
- .3 Provide copies of the Allpriser published list prices used to estimate material and equipment costs, and copies of the NECA, MCAA, SMACNA or other such standardized trade rates used to determine labour units when requested by the Consultant.
- .4 It is understood that each change may have a variety of non-typical or abnormal factors that will require adjustments. Under no circumstances shall the cumulative total of additional factors exceed 20% of the hours established using Base Labour units.
- .5 Labour rates shall include all associated project management, estimating, supervision, scheduling, coordination, interference, as-built drawing production/updates, travel time and associated expenses, delivery charges, clean-up, printing, telephone and other office expenses, and applicable employee benefits and burdens including, but not limited to:
 - .1 Base Rate
 - .2 Vacation/Stat Pay
 - .3 Union Deductions
 - .4 Legislated Burdens
 - .1 Employer Health Tax (EHT)
 - .2 Workplace Safety and Insurance Board (WSIB)
 - .3 Employment Insurance (EI)
 - .4 Canadian Pension Plan (CPP)

- .5 Retail Sales Tax (RST) on Hardware.
 - .5 Expendable Small Tools
 - .6 Additional Unionized Charges
 - .7 Finance Payroll
 - .8 Rest Breaks
 - .9 Idle Time
 - .10 Safety
 - .1 Job Box Talks
 - .2 WHMIS
 - .3 Fall Protection
 - .4 Personal Protective Equipment
 - .5 Committees
 - .11 Labour Warranties
- .3 The following additional requirements apply to all Change quotations submitted:
 - .1 costs for Journeyman and Apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing the work;
 - .2 Change pricing must be such that Site Superintendent's involvement is necessary; cost for Site Superintendent must not exceed 10% of total hours of labour estimated for Change or revision;
 - .3 Change quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .4 The Contractor shall at the request of the Owner, and/or the Project Manager, and/or the Consultant provide all required supplementary documentation requested by the Owner, and/or the Project Manager, and/or the Consultant for any Change.
- .5 Where Changes are evaluated using either the Lump Sum Method, or the Time and Material Method, the cost to the Owner shall be the actual cost of credits and, where additional work is required. The cost to the Owner shall be the actual cost plus a percentage covering overhead and profit, after all credits included in the Change have been deducted.
- .6 Where Changes are evaluated using either the Lump Sum Method, or the Time and Material Method, credit pricing for deleted work not already performed shall have a credit value assessed that is not less than 80% of the value of charges for similar new work.
- .7 Where Changes are evaluated using either the Lump Sum Method, or the Time and Material Method, the mark-up for overhead and profit shall be limited to and be calculated as follows:
 - .1 Work carried out by the Trade Contractor or Trade Subcontractor: 10% overhead and profit combined.
 - .2 Trade Contractor's overhead and profit on Trade Subcontractor's work: 5% overhead and profit combined.
- .8 The cumulative total percentage for overhead and profit charged by the Trade Contractor, Trade Subcontractor and others shall not exceed 20% of the cumulative total value of such change in the work, net of overhead and profit.
- .9 Trade Contractor and Trade Sub-contractor's overhead and profit shall be calculated based on net additional work only.
- .10 For Changes involving net deletions only, overhead and profit shall not be deducted, but shall include taxes and duties.
- .11 Where Changes are evaluated using the Unit Price method, the value of the change shall be based on the net difference in quantities with the appropriate Unit Rate applied.

- .12 Where changes are extensive, or where requested by the Owner, and/or Project Manager, and/or Consultant, material and labour take-offs shall be organized on a drawing-by-drawing, or area-by-area basis by the Contractor to more readily facilitate verification of quantities and labour hours.
- .13 Change quotation summaries shall itemize HST separately.
- .14 Change quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal.
- .15 Failure to submit a proper quotation to enable the Owner, and/or Project Manager, and/or Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .16 Submit proposed Change quotations in writing for review by Consultant; if Consultant agrees a Change Order will be issued.
- .17 Do not execute any Change or revision until written authorization for Change or revision has been issued by the Consultant.

PART 2 - PRODUCTS

2.01 GENERAL

- .1 ***Generally, and unless specified otherwise, HVAC equipment, shall be provided as "Thermostat-Ready" meaning that the Building Automation System (BAS) shall have direct control over terminal equipment, and custom fabricated air handling units (AHUs) and other similar built-up equipment that include dampers, control valves, heating and cooling stages without the requirement of BACnet, Lonworks or other type of communication interface. Factory installed interlocks, safeties and anti-cycle timers shall be provided as required.***

2.02 INTERFERENCE/ COORDINATION MODEL

- .1 The Mechanical Trade Contractor shall take the lead role in preparation of electronic Three Dimensional (3D) Building Information Model (BIM) interference/ coordination model with drawing sheet files set similar to Consultant drawings views. Use all other disciplines electronic drawings as basis for preparation of interference/coordination model. Position all Mechanical Trade and Sub-trade services to accommodate the work of other Construction Trades.
- .2 The tender documents including, the BIM model are not complete, nor fully coordinated. The model is not to be considered sufficiently detailed to build from.
- .3 Continuously update the interference/coordination model to accurately reflect all instructions issued by the architect and consultants in whatever format these instructions are issued. Assume for Bid submission purposes, that an updated BIM model will not be issued with each instruction.
- .4 Prior to commencement of work, submit for Consultant review the Mechanical Trade Contractor shall fully develop their own interference/coordination model using models from all other Construction Trades, and fully coordinate the installation prior to fabrication or installation of any services on site. All sub-trades whose work is affected by the information presented on each of these interference/coordination models shall sign-off on the drawings and thereby agrees to coordinate their parts of the work. Submit the completed interference/coordination model for review using the same procedures as specified for Shop Drawings.
- .5 Coordinate equipment placement to ensure that all components will have adequate access for operation, service and maintenance prior to commencement of Work. Services shall be laid out in an organized manner, including running services in parallel or at right angles from one another where these are exposed. Adequate access points shall be provided to service, maintain and operate the equipment as required.
- .6 Use the project's Architectural Revit model as the starting point for the creation of interference/coordination model. The contractor's drawings will show angles, braces, supports, and similar equipment that are not in the design model. Use the electrical contractor's model and not the electrical design files; use the structural steel contractor's model and not the structural design files.

- .7 Prepare interference/coordination model in conjunction with other Construction Trades, wherever a potential conflict due to the positioning of Mechanical Trade Contractor equipment, piping, ductwork or other Work exists.
- .8 Dimension proposed location of Mechanical Trade Contractor Work with respect to building elevations and established grid lines.
- .9 Prepare fully dimensioned details of all shafts, duct spaces and pipe spaces. Show sleeving, recessed and formed holes required in concrete for Mechanical Trade Contractor Work. Include information pertaining to access, clearances, tappings, housekeeping pads, drains and electrical connections.
- .10 Base information used to prepare interference/coordination model on reviewed Shop Drawings.
- .11 Provide field interference/coordination model showing the position of various services when required by Consultant.
- .12 The Mechanical Trade Contractor shall be responsible for the full coordination of all mechanical services with the existing building, new construction, and all new and existing services from all Construction Trade disciplines.
- .13 Submit a list of access doors and panels showing proposed type, size and location. The interference/coordination model shall incorporate Architectural details including reflected ceiling plans prior to submission.
- .14 Revise or alter the arrangement of work that has been installed without proper coordination, study and review, in order to conceal the work behind finishes, or to allow the installation of other work, at no additional cost. If any conflicts are identified submit alternate proposal to the consultant for review prior to proceeding with any work.
- .15 All shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .16 The Contractor and their Sub-trades shall take complete responsibility for remedial work that results from failure to coordinate the work prior to fabrication, purchasing and/or installation. Pay for the cost of alterations to other work required by the alterations work made necessary due to a lack of preparing a comprehensive interference/coordination model.

2.03 EMBEDDED MECHANICAL SERVICES DRAWINGS

- .1 Prepare embedded mechanical services drawings, showing size and location of elements including any conduit and inslab services required.
- .2 Prepare insert setting drawings for work to be cast into concrete and/or mortared into masonry elements.
- .3 Submit embedded mechanical services drawings to the Consultant and Structural Engineering Sub-Consultant for review.

2.04 SLEEVING DRAWINGS

- .1 Prepare sleeving drawing in conjunction with all affected Trades. Showing sleeves and openings for passage through structure, and all inserts, equipment bases, sumps, pits and supports, and relate these to suitable grid lines and elevation datum.
- .2 Submit sleeving drawings to the Consultant and Structural Engineering Sub-Consultant for review.

2.05 FINAL RECORD SET “AS-CONSTRUCTED” OR “AS-BUILT” DRAWINGS

- .1 Meet the requirements of Division 01 and the following.
- .2 Suitably store and protect Record “As-Constructed” or “As-built” Drawings on site and make available at all times for inspection.

- .3 Record inverts of underground piping at building entry/exit and below floor slab at each branch, riser base, change in direction as well as at least three points on straight runs.
- .4 Show locations of access doors and panels and identify the equipment and components that they serve.
- .5 Transfer all of the Mechanical Trade Contractor's "As-Constructed" or "As-built" information to an electronic, editable version of the Consultant's BIM model format Record Drawings prior to submission to Consultant for review.
- .6 Submit Final Record Set of "As-Constructed" or "As-built" Drawings for review in PDF format and hard copy for review. Submit reviewed Final Record Set of "As-Constructed" or "As-built" Drawings in an editable format with the O&M Manuals.

2.06 OPERATING AND MAINTENANCE ("O&M") MANUALS

- .1 Each O&M Manual shall contain the following information:
 - .1 The Mechanical Trade Contractor(s) and Subcontractor(s) contact information including name, address, telephone number and email address;
 - .2 Mechanical Equipment Suppliers and Mechanical Sub-trades names and telephone numbers;
 - .3 description of each system with description in layman's terms of each major component of system;
 - .4 complete sets of "Reviewed" or "Reviewed as Modified" Shop Drawings and other Submittals including Interference/ Coordination Model, Embedded Mechanical System's Drawings, and Sleeving Drawings;
 - .5 equipment manufacturer's installation, start-up and operation manuals;
 - .6 equipment manufacturer's recommended spare parts lists;
 - .7 equipment wiring diagrams;
 - .8 lubrication schedule for all equipment;
 - .9 equipment identification list with serial numbers;
 - .10 page size valve tag schedule and flow diagrams;
 - .11 final balancing reports;
 - .12 water treatment procedure and tests;
 - .13 complete set of Mechanical Trade Contractor Final Record Set of "As-constructed" or "As-built" Drawings including updated Control Drawings and Schematics;
 - .14 full and final sequences of operations;
 - .15 facility operating schedules (climate control, security, lighting, access, and similar);
 - .16 relevant fire and emergency systems and procedures;
 - .17 energy conservation strategy, optimization benchmarks, and tests;
 - .18 seasonal start-up and shutdown procedures;
 - .19 copies of posted instructions;
 - .20 environmental authorities' compliance requirements;
 - .21 problem- and issue-reporting procedures;
 - .22 the potential consequences if the equipment or system malfunctions;
 - .23 alternative and backup systems that should be used in the event of a breakdown or failure.
 - .24 extended warranty documentation if applicable;
 - .25 certificates for:

- .1 equipment start-up and Commissioning complete;
 - .2 Controls and Building Automation Systems Commissioning complete;
 - .3 Pressure tests (domestic water piping, drainage system piping, fire protection piping, heating/cooling piping, ductwork) certifying system tested, pressure held, time of test and date and certification by the Consultant.
- .2 Ensure that the terminology used in various sections of the O&M Manual is consistent.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Periodic inspections of the work in progress will be made to check general conformity of the work to the Contract Documents. Observed deficiencies will be reported. Correct deficiencies immediately upon notification.
- .2 Comply with Manufacturer's requirements for the installation of all specified equipment and the requirements of all Laws, Bylaws, Codes, Regulations, and all requirements of the Authorities Having Jurisdiction ("AHJs"). Furnish certificates and evidence that Mechanical Trades Work meets the requirements of the Authorities Having Jurisdiction.
- .3 Where the Contract Documents, instructions or where the Authorities Having Jurisdiction ("AHJs") require Mechanical Trades Work to be tested, inspected, or approved, give sufficient notice of its readiness for inspection and schedule the date and time for such inspection.
- .4 Uncover Work performed by Mechanical Trades that is covered up without consent, upon Consultant request, for examination and restore at no extra cost to the Owner.
- .5 Provide all required Mechanical equipment, including all devices, components and other ancillaries required for the intended system operation inherent in the Design as outlined in the Drawings and Specifications.
- .6 Include for all labour necessary for the successful completion of point-to-point verification of equipment, including all devices, components and other ancillaries as part of the project commissioning requirements.
- .7 Include for all labour necessary for the successful completion of performance verification of equipment, including all devices, components and other ancillaries as part of the project commissioning requirements.

3.02 FIREWATCH

- .1 ***Throughout all construction activities, Fire Alarm and Life Safety Systems shall remain operational. If any portion of a Fire Alarm System including zones or devices needs to be bypassed, or otherwise deactivated to complete the Work, the Contractor shall implement a Firewatch.***
- .2 ***Firewatch procedures are to be conducted in accordance with latest edition of the Ontario Fire Code. Where interpretations are required, coordinate with the Owner, the Consultant and Authorities Having Jurisdiction (AHJ). Refer to the Ontario Fire Code for Firewatch requirements and expectations.***
- .3 ***The following outlines the anticipated Firewatch procedures required:***
 - .1 ***Contact the Owner a minimum of 48 hours (2 business days) prior to initiation of Firewatch.***
 - .2 ***Contractor shall subcontract an Owner approved fire alarm contractor to put the device(s) or zone(s) affected on bypass. If the building fire alarm devices are addressable, the devices can be bypassed individually. If a building has a "conventional" fire alarm system, the entire zone affected must be bypassed. Under no circumstances is an entire panel to be bypassed.***
 - .3 ***If devices are covered during the Work the Contractor shall follow the manufacturer's recommended procedures. Covers shall be removed at the end of each working day.***

- .4 ***Other activities that generate dust or airborne particulate including spray painting may disturb or actuate fire alarm devices. Such activities may warrant fire alarm bypass and Firewatch procedures.***
- .5 ***During Firewatch, Contractor personnel conducting the watch shall:***
 - .1 ***carry a radio for communication with the Owner's security personnel,***
 - .2 ***remain onsite for the duration of the Firewatch, and***
 - .3 ***tour building areas affected once every hour.***
- .4 ***Once the Firewatch has ended;***
 - .1 ***Owner approved fire alarm contractor to verify the fire alarm system including all devices affected are back online and ensure all "trouble signals" at the fire alarm panel are cleared.***
 - .2 ***Return the radio(s) to the Owner.***
 - .3 ***Once the Work is completed, all devices that were covered are to be re-verified.***
 - .4 ***Notify the Owner the Firewatch has ended.***

3.03 SMOKING

- .1 ***Smoking is at all times be prohibited inside demolition or construction zones in all areas of the Work.***
- .2 ***The Contractor shall post signage indicating the prohibition of smoking in all areas of the Work and shall enforce the no-smoking policy.***
- .3 ***Smoking outside of areas of the Work shall only be permitted in a designated location agreeable to the Owner, but in no case shall be allowed within 9m of any building opening or air intake.***

3.04 HOUSEKEEPING MEASURES

- .1 ***The following housekeeping measures shall be practiced for the duration of the Work, at all times, to limit accumulation of contaminants and debris at the construction site:***
 - .1 ***Maintain a dry, clean workspace throughout construction.***
 - .2 ***The Contractor shall visually inspect job site daily for dust, dirt and water accumulation and take remedial action to correct deficiencies. Increase frequency of cleaning as required to maintain the site in clean and dry condition.***
 - .3 ***Wherever possible, an efficient dust collection method other than dry sweeping shall be used (damp rag, wet mop or vacuum).***
 - .4 ***If dry sweeping is the only alternative, it shall be accompanied by a dust suppression agent. Vacuuming with HEPA filtered vacuum cleaners shall be used to prevent aerosolization of settled dust.***
 - .5 ***Waste products shall be diverted to the appropriate enclosed waste bins or storage areas.***
 - .6 ***Low emitting cleaners shall be used that are certified in accordance with project LEED requirements.***
 - .7 ***All surfaces shall be kept clean, including higher ledges and behind equipment or furniture.***
 - .8 ***Building materials shall be protected from precipitation and other contamination prior to installation. This includes protection of porous materials (i.e. insulation, drywall, and ceiling tile) from exposure to moisture and sources of contamination.***
 - .9 ***Materials shall not be stored directly on the floor. All materials will be elevated by a minimum of 75mm on pallets or by other means.***

- .10 ***Acceptable areas to store the building materials on-site will be identified by the Owner's Project Manager.***
- .11 ***All coils, air filters, fans and duct work will remain clean during the installation and will be cleaned prior to performing testing, adjusting and balancing of systems.***
- .12 ***Any accumulation of water in the building will be immediately removed.***

3.05 SPECIAL CLEANING

- .1 Vacuum clean and remove debris from the inside of air handling systems, fans, ducts, coils and terminal units.
- .2 Clean exposed surfaces of Mechanical equipment, ductwork and piping. Polish plated work.
- .3 Comb all bent fins to proper configuration on all coils in indoor and outdoor air handling units.

3.06 PROTECTION

- .1 ***Protect all Work from damage. All Mechanical Equipment, including existing equipment, shall be protected from exposure to moisture and from collecting dust, debris, odours and other contaminants while demolition and construction activities are ongoing.***
- .2 Cover openings in equipment and cover equipment where damage may occur from weather. Cover temporary openings in ducts and pipes with minimum 6-mil polyethylene sheeting, until final connection is made. Cover all items cast into concrete floors or walls such as floor drains and cleanouts prior to pour, with heavy plastic tape or duct tape.
- .3 ***Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.***
- .4 Cover and seal, with polyethylene sheeting, all equipment, coils and motors in place during construction to prevent entry of dust, paint and debris.
- .5 ***Ductwork Protection:***
 - .1 ***Provide adequate access into ductwork for cleaning purposes.***
 - .2 ***The ends of all ductwork and duct open ends in HVAC equipment are to be sealed tightly, whether they are installed or being stored prior to installation. All ductwork and equipment that is waiting to be installed must be kept off the floor a minimum of 75 mm.***
 - .3 ***Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.***
 - .4 ***Where heavy dust loading is expected to impact operating HVAC systems, higher efficiency MERV 12 filters shall be used to provide increased protection where minimum airflow can be maintained.***
 - .5 ***Equipment filtration shall be replaced immediately prior to occupancy.***
 - .6 ***Upon completion flush-out or successful IAQ testing, HVAC and lighting systems shall be returned to their designed or modified operation.***
 - .7 ***Prior to start-up, the project Architect, Mechanical Designer and/or Commissioning Authority and the Region's Project Manager shall verify that the HVAC systems are free of contamination.***
 - .8 ***If after inspection by the project Consultants, Commissioning Authority or Region Project Manager the ductwork system is deemed to be unacceptable due to construction or demolition activities, the Contractor shall, at its cost and prior to operation or test and balance, clean systems and equipment including but not limited to ductwork (supply/return/exhaust), air handling equipment, plenums, terminal units, fans, dampers, grilles/registers/diffusers with high power vacuum machines.***
- .1 ***At the discretion of the Region's Project Manager, cleaning shall be performed in accordance with National Duct Cleaners Association (NADCA)***

- standards, and by agent specializing in this field of work, and a member in good standing with NADCA.*
- .2 *Submit report, verified by Testing and Balancing Agent, identifying the extent of duct system cleaning and certifying that NADCA standards have been met.*
- .9 **Return/Exhaust Side Protection:**
- .1 *Immediately after installation, the open ends of return and exhaust ductwork shall be sealed with 6-mil polyethylene sheeting.*
- .2 *Where feasible, permanent HVAC equipment shall not be operated during demolition.*
- .3 *If air handlers must be used during demolition or construction, temporary filtration media with a minimum MERV 8 rating shall be used at each return air grille or opening. Filters shall be inspected regularly during demolition and construction and be maintained in good condition. Filters shall be removed prior to occupancy.*
- .4 *Where ceiling cavities are used as return air plenums, replace all missing ceiling tiles and seal all return air grilles and openings.*
- .5 *Mechanical rooms with return-side equipment will not be used to store construction or waste materials.*
- .10 **Supply Side Protection:**
- .1 *HVAC systems in areas where major demolition is scheduled shall be de-energized during the performance of the Work.*
- .2 *Equipment left in place during demolition and construction shall be wrapped in 6-mil polyethylene sheeting.*
- .3 *Where HVAC systems are disabled for the duration of construction, equipment, including VAV boxes, open ductwork, grilles and diffusers installed on the supply side of the HVAC systems shall be sealed with 6- mil polyethylene sheeting following installation.*
- .6 **Porous Building Materials:**
- .1 *Porous building materials, those materials that have pores that may allow fluids or gasses to pass through; this includes drywall, insulation, carpeting, ceiling tiles, and similar.*
- .2 *Porous materials shall be protected from exposure to precipitation, other moisture sources and VOCs contaminants.*
- .3 **Protection measures may include:**
- .1 *Storing the porous products in a location free from moisture and contamination sources prior to installation.*
- .2 *Installing porous products utilizing recommended environmental conditions.*
- .3 *Avoiding installation of products in environments subject to high- VOCs emissions.*
- .4 *Depending on the result of the visual assessment and moisture readings, temporary dehumidification, heating and air circulation equipment may be required in the applicable areas or alternative drying methods may be required to the acceptance of the Consultant and the Owner.*
- .7 **Repair any damage caused by improper protection of equipment and materials.**

3.07 TEMPORARY SERVICES

- .1 Provide temporary mechanical services in accordance with the requirements of Division 01.

- .2 ***Temporary ventilation and heating units shall be used as needed while construction is ongoing.***
- .3 Make arrangements for connections to temporary ***energy sources (electrical power, natural gas, water, drainage and similar) for use by during construction.***
- .4 Provide and maintain temporary fire protection services as required by the Authorities Having Jurisdiction (AHJs).
- .5 When the permanent water service is installed, it shall be used to supply water for the use of other Construction Trade Contractors.
- .6 Perform operations necessary for checking, testing and balancing after written approval is given to start up systems. Ensure that care is taken to protect equipment from damage and to prevent distribution of dust through duct systems.
- .7 ***Do not use permanent plumbing, heating or air conditioning systems for temporary services during construction, except with written permission from Consultant. Permanent HVAC equipment shall not be used to dry out the building materials during, or immediately following, completion of any Work.***

3.08 INTERRUPTION OF EXISTING SERVICES

- .1 Arrange, schedule and perform Demolition Work with minimum disturbance to existing facilities and services.
- .2 Submit a complete schedule of service interruptions and changeovers with approximate dates required, durations and times of day, for approval before proceeding.
- .3 Notify Owner in writing at least 72 hours in advance of planned interruption to existing services.
- .4 Interruption of service must occur at the times and for the duration stipulated by the Owner.
- .5 Keep service interruption duration to an absolute minimum. Carry out all preparatory Work, measurements, performance evaluation, and similar, without interruption of existing services.
- .6 If the Owner requires service interruptions during the night or on weekends, include any premium time in the Bid Price. No extra charges will be allowed at a later date for failure to include for premium time.

3.09 RUN-IN

- .1 Systems shall be run-in, tested and balanced for proper operation prior to application for Substantial Performance of the Work.

3.10 TRIAL USAGE, TESTING AND COMMISSIONING

- .1 Testing shall be performed as required by Codes, Bylaws, and Authorities Having Jurisdiction ("AHJs"); commissioning shall be performed in accordance with Section 20 08 10.
- .2 Perform testing and commissioning as instructed by the Consultant to demonstrate that the work conforms to the contract documents, and where required, perform any additional testing requested by the AHJs.
- .3 Repeat tests as necessary to demonstrate Contract compliance to the satisfaction of the Consultant and the AHJs.
- .4 Include, as part of the Work, trial usage of Mechanical Systems and equipment for the purpose of testing and commissioning, including assistance for the Owner's staff to learn the operation and maintenance procedures, for new equipment and systems.
- .5 Assist in trial usage over a length of time sufficient to confirm specified equipment capacities and operating characteristics.
- .6 Maintain full responsibility for all mechanical equipment and systems required to temporarily operate during trial usage. Warranty period commencement for any equipment operated during trial usage will not occur until certification of Substantial Performance.

3.11 INSTRUCTIONS TO OWNER'S STAFF

- .1 Instruct the Owner's designated staff on all aspects of the operation of systems and equipment. Advise the Consultant at least one week in advance of the schedules of all instruction sessions.
- .2 Obtain the services of Sub-trade and Manufacturers' representatives to provide information and instructions on each part of the Mechanical Work and on items of equipment.
- .3 Submit to the Consultant immediately following final inspections a "Confirmation of Instructions to Owner's Operating and Maintenance Staff" statement for each system or item of equipment confirming:
 - .1 Date and time instructions commenced for each system.
 - .2 Duration (hours) instructions were given for each system.
 - .3 Names of Owner's staff receiving instructions.
 - .4 Other parties present (Manufacturer's representative, consultants, any other project stakeholders).
 - .5 Signatures of each of the Owner's staff in attendance.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements and all Documents referenced therein.

1.02 SCOPE OF WORK

- .1 Supply required tools and services, and supply and install basic materials with methods required to complete the work.
- .2 Final detailed construction and installation requirements to be responsibility of the Mechanical Trades.
- .3 Manufacturers listed in Sections 20, 21, 22, 23 and 25 are intended to demonstrate the level of quality anticipated for the project and alternative manufacturers of equivalent quality, complying with the fundamental performance requirements and acceptable to the Consultant shall be considered acceptable.

1.03 SUBMITTALS

- .1 Submit shop drawings for the following:
 - .1 access doors,
 - .2 fire stopping,
 - .3 roof curbs;
 - .4 frames and covers,
 - .5 valves,
 - .6 thermometers and gauges,
 - .7 grooved end components
- .2 Provide Submittals for piping anchors prepared and stamped by a professional Structural Engineer registered in the jurisdiction of the Work.
- .3 Submit a letter from pipe anchor design engineer stating engineer has visited the site to examine installation of pipe anchors, and that the pipe anchor installation is in accordance with reviewed pipe anchor Submittal(s).

PART 2 - PRODUCTS

2.01 ACCESS DOORS

- .1 Provide rounded safety corners hinged access doors as constructed of primed 16 gauge steel as manufactured by William Brothers or Acudor equal to fire rating of wall or ceiling in which installed.
- .2 Provide doors with minimum size of 300mm x 300mm (12"x12"). Access doors to be sized of adequate size to permit service of equipment and/or resetting dampers. Provide minimum size of 600mm x 460mm (24" x 18") where personnel entry is required. Provide minimum size of 600mm x 750mm (24" x 30") where personnel entry is required for regular equipment maintenance.
- .3 Provide for plaster surfaces recessed 16 ga. prime painted steel door and welded metal lath, ready to take plaster. Provide with concealed hinge and stainless steel studs with brass sleeves
- .4 Provide for tiled surfaces, recessed type 16 ga. primed steel (stainless steel for ceramic tile and shower areas) doors to suit type and dimension of tile used. Size door to be as close as possible to 300mm x 300mm (12" x 12") by fitting to single or multiple tile dimensions. Provide with concealed hinges and stainless steel studs with brass sleeves.
- .5 Provide, to suit wall surface or type of construction, other factory prime coated access doors of welded 16 gauge steel, flush type with concealed hinges, lock and anchor straps.

- .6 Lay-in type ceiling tiles, properly marked, may serve as access panels.
- .7 Access doors in fire rated construction shall be ULC listed and labelled, meeting the requirements of Authorities having jurisdiction and rated to maintain the fire separation integrity.

2.02 FIRE STOPPING

- .1 Provide ULC listed fire stopping for all Mechanical Work that penetrates a fire rated separation.
- .2 Provide ULC listed fire stopping products by 3M, Hilti or Specified Technologies Inc. which have been tested in accordance with CAN4-S115.

2.03 FLASHING

- .1 Flashing shall be by Mechanical Trades for roof curbs required to suit the Mechanical Work.
- .2 Provide flashing for pipe openings, duct openings, or pre-manufactured roof curbs required for all mechanical systems.
- .3 Provide counter-flashing for roof mounted mechanical equipment and for pipes and ducts passing through roof. Fit counter-flashing over flashing or curb. Pitch pockets are not acceptable.

2.04 ROOF CURBS

- .1 Curbs required for Mechanical Work shall be provided by Mechanical Trades.
- .2 Pre-manufactured curbs for roof mounted mechanical equipment provided by equipment manufacturer shall be installed by Mechanical Trades.
- .3 Provide curbs for roof mounted equipment, around ducts passing through roof and surrounding groups of pipes and/or ducts pass through Service Room floors, Kitchens and similar areas.
- .4 Provide roof curbs of a sufficient height, minimum 18" (450 mm), above finished roof assembly, unless exceeded by Architectural requirements.
- .5 Provide concrete curbs around openings in Service Room floors, extending at least 6" (150 mm) above finished floor. Make watertight connection between curb and floor.

2.05 CONCRETE

- .1 Provide minimum 4" (100 mm) concrete housekeeping pads, unless noted otherwise, complete with reinforcing steel under all floor mounted mechanical equipment and supports. Extend pads over the full equipment base and isolator area.
- .2 Concrete work, including housekeeping pads, required for Mechanical Work shall be provided by Mechanical Trades.
- .3 Provide all concrete required in isolation bases for pumps and fans.
- .4 Provide other concrete work required for Mechanical Work, complete with reinforcing steel.

2.06 FRAMES AND COVERS

- .1 Supply frames for installation by Concrete and Formwork Trades.
- .2 Provide covers for pits and sumps.
- .3 Provide gas tight gaskets for sewage pits.
- .4 Trench gratings will be provided by Mechanical Trades.
- .5 All covers/grates shall be suitable for the traffic loading requirements within space.

2.07 STEEL

- .1 Provide steel required for Mechanical Work not shown on Structural or Architectural Drawings. Provide steel for equipment support, framing, lintels, and other services as required for the installation.
- .2 Provide steel of adequate strength to support equipment and materials during all operating and test conditions. All support steel shall be secured and supported by/from building structure.

- .3 Support suspended equipment from the bottom or from manufacturer's designated suspension points. Support tanks and similar equipment with adequate beam strength by saddles with curvature to match the equipment. Continuously support all other equipment.
- .4 Provide base supports for all pipe risers. Design to distribute operating and static loads.
- .5 Fabricate steel supports in contact with water or humidity conditions from materials having approved corrosion resistance or galvanize after fabrication or brush welds clean and apply a prime coat of rust inhibiting paint.

2.08 HANGERS AND PIPING SUPPORTS

- .1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:
 - .1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;
 - .2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.
- .2 Hangers:
 - .1 Hangers and supports for horizontal suspended piping as follows:
 - .1 adjustable steel clevis hanger – MSS Type 1
 - .2 adjustable swivel ring band hanger – MSS Type 10;
 - .3 equal to Grinnell Fig. 65 for pipe sizes up to and including 65mm (2"); for pipe sizes 75mm (3") and larger, provide adjustable Clevis type equal to Grinnell Fig. 260.
 - .4 Provide Grinnell FM approved Fig. 104 split swivel or Fig. 69 swivel type hangers on fire protection piping.
 - .5 On copper piping, provide copper plated type hanger or separate piping from hanger with an approved insulating plastic coating; tape shall not be considered acceptable.
 - .6 Grinnell adjustable ring type fig. 97 and fig. 97c (coated) are acceptable on copper piping up to 65 mm (2").
 - .7 Provide oversized hangers to pass over insulation on all cold water (chilled water, condenser water, domestic cold water) piping.
 - .2 For hydronic piping carrying fluids at an operating temperature equal to or greater than 167°F (75°C) provide adjustable roller hanger – MSS Types 41, 43, and/or 45, with MSS Type 39 steel protection saddle.
- .3 Piping supports:
 - .1 For pipe risers, provide supports equal to Grinnell Fig. 40, black carbon steel, sized to carry the operating weight of the piping.
 - .2 Supports for horizontal pipe on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe clip – MSS Type 26;
 - .3 single steel pipe hook – Myatt Fig. 156;
 - .4 epoxy coated steel pipe stays are not permitted.
 - .3 Floor supports for vertical risers as follows:
 - .1 copper tubing riser clamp – MSS Type 8;
 - .2 heavy-duty steel riser clamp – MSS Type 8.

- .4 Supports for vertical piping on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;
 - .3 extension split pipe clamp – MSS Type 12;
 - .4 epoxy coated steel pipe stays are not permitted.
- .4 For horizontal pipe on racks, Unistrut or approved equal galvanized steel pipe racks with pipe securing hardware as follows:
 - .1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;
 - .2 For hydronic heating piping with operating temperatures in excess of 167F (75C) provide adjustable roller chair provide MSS Type 44 with MSS Type 39 steel protection saddle.
- .5 Roof Mounted Piping:
 - .1 For piping on existing roof: Portable Pipe Hangers (Canada) Inc. "PP" Series prefabricated portable pipe support system components to suit pipe, complete with required accessories, and as follows:
 - .1 Use PPH model SS-8R or PP10 with roller for piping up to 2 ½" (65mm) and use model PS-1-2 for pipes over 3" (75mm) and up to 8" (200mm).
 - .2 For refrigeration piping and conduits, use PPH model PS1-2.
 - .3 For pipes over 75mm (3"), use PPH-RB18 with clamps, base and all other applicable support.
 - .4 Support bases to be galvanized structural steel frames, and galvanized steel pipe hangers with stainless steel clamps and rollers.
 - .5 Membrane pads to be close-cell extruded polystyrene insulation equal to Dow Chemical Roofmate.
 - .2 For piping on new roofs: Lexcor "Flash-Tite" or Thaler Roofing Specialties Products Inc. "MERS" Series, insulated aluminum support risers with diameter, height, securement method and flashing to suit the application, channel type aluminum cross members, and galvanized steel pipe hangers and supports conforming to MSS SP-58, complete with required accessories.
 - .3 For roof mounted gas piping: On stable flat bed roof, use pipe supports by Quick Block with oversized stainless steel clamps for roof mounted gas piping up to 125mm (5"). Use PPH-RB18 with rollers and clamps for roof mounted gas piping up to 125mm (5"). Supports for gas piping must be CGA certified & listed and meeting the requirement of gas code B149.1.
- .6 Special hangers and supports for various applications as follows:
 - .1 vibration isolated riser supports: black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between clamp and floor;
 - .2 for groups of pipes having same slope: MSS Type 32 welded steel brackets, Anvil Fig. 46, or approved equal, universal trapeze assemblies, or Unistrut, or approved equal, support assemblies, all with U-bolts, clamps, and ancillaries necessary to secure pipes in place;
 - .3 for sections of piping connected to vibration isolated equipment: hangers and supports as specified above but complete with MSS Type 48 spring cushions;
 - .4 for glass drain and vent piping: special padded hangers supplied by pipe supplier;
 - .5 for plastic piping: generally as specified above but in accordance with pipe manufacturer's recommendations;

- .6 for fire protection piping: generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard(s) applicable to the piping system;
- .7 for bare horizontal copper piping: generally as above but factory vinyl coated to prevent direct copper/steel contact;
- .8 for bare copper vertical piping: corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;
- .9 insulation protection shields on piping size up to and including 1-½" (40mm): MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger; piping 2" (50mm) and larger shall be provided with insulation inserts with integral shields.
- .7 Base support for vertical piping risers in excess of 20 ft. (6m) high extending out from floor mounted equipment shall consist of a base elbow support with flange.
- .8 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but minimum 9.5 mm (3/8") diameter.
- .9 Acceptable manufacturers are:
 - .1 E. Myatt & Co. Inc.;
 - .2 Anvil International Inc.;
 - .3 Empire Industries Inc.;
 - .4 Hunt Manufacturing Ltd.;
 - .5 Unistrut Canada Ltd.;
 - .6 Nibco Inc. "Tolco";
 - .7 Taylor Pipe Supports.

2.09 EQUIPMENT RIGGING SUPPORTS

- .1 Provide eyebolts suitable for block and tackle connection, adequately supported by the structure above for:
 - .1 heat exchanger and shell heads
 - .2 submersible sump pumps
 - .3 pumps in Mechanical Equipment Rooms
 - .4 motors
 - .5 other equipment which will require block and tackle handling

2.10 INSERTS

- .1 Use only factory made, threaded or toggle type inserts as required for supports, and anchors, properly sized for the load to be carried.
- .2 Use factory made expansion shields where inserts cannot be placed, but only as accepted by the Consultant and for light weights.
- .3 Do not use explosive activated tools except with written acceptance of the Consultant.

2.11 PROVISION FOR PIPE EXPANSION, CONTRACTION AND BUILDING SHRINKAGE

- .1 Provide expansion loops and offsets to permit the safe expansion and contraction of piping due to thermal effects, building shrinkage and movement. Where space limitations do not permit the use of expansion loops or offsets, provide Flexonics, or equivalent, expansion joints properly selected for system operating pressures according to the following:
 - .1 For piping up to and including 2-1/2"(65 mm), select ends to suit specified pipe fittings. Pressure ratings for Model H and HB expansion compensated as 200 psi (1400 kPa) and 150 psi (1050 kPa).

- .2 Steel Piping - Flexonics Model H expansion compensator with two ply stainless steel bellows.
- .3 Copper Piping - Flexonics Model HB expansion compensator with two ply bellow, all bronze construction.
- .4 For piping 3" (75 mm) and above, use flanged ends.
- .5 Steel Piping - Flexonics controlled, flexing expansion joint with stainless steel pressure carrier, flanged ends.
- .6 Copper Piping - Flexonics controlled, flexing expansion joint with monel pressure carrier, and brass flanged ends.
- .7 Flexible hose connectors for chilled or heating water shall be Goodyear stainless steel braided rubber hose with crimped on brass ends, 2400 kPa pressure rating, -40°C to 93°C temperature rating, EPDM liner size and length to suit application.
- .8 Flexible hose connectors for glycol media shall be Weatherhead stainless steel braided with smooth bore Teflon hose, complete with crimped on steel hose ends. 2070 kPa pressure rating, -53°C to 230°C temperature rating, size and length to suit application.

2.12 PIPE GUIDES AND ANCHORS

- .1 Refer to Architectural and structural drawings for location of embedments and structural beams required for the support of pipe risers.
- .2 Be responsible for the design and installation of guides and anchors in all vertical and horizontal piping, including hydronic piping, steam and condensate piping, generator exhaust piping and/or breeching, boiler breeching, and similar equipment imposing a dynamic load on the building associated with variations in system temperature.
- .3 Submit to Consultant for review, drawings showing the riser sizes, offsets, location of expansion joints, anchors and guides and other pertinent information. Provide details of the design of riser anchors, guides, attachments and loads imposed on structure. All designs and calculations shall be stamped and sealed by a Professional Engineer retained by the Mechanical Trades.
- .4 The concrete structure will undergo elastic shortening as it is built. Make due allowance for shrinkage of the building. The exact amount is to be determined by the Structural Engineer, and will be approximately 0.3" (8 mm) per floor. Ensure sleeve openings are adequate to accommodate movement and that sufficient resilient packing is left. Ensure that pipe and duct will not shear as a result of shrinkage.
- .5 Mechanical Trades shall review all sleeved penetrations in the core and shall provide a written report testifying that all sleeves and anchorages have provision for shrinkage.
- .6 Pipe Alignment Guides:
 - .1 Provide prime coat painted black carbon steel pipe alignment guides sized and fabricated to suit the pipe size and the pipe insulation thickness.

2.13 SLEEVES, WALL AND FLOOR PLATES

- .1 For pipe sleeves through concrete block and concrete walls and floors, use machine cut and reamed standard weight steel piping.
- .2 Concealed perimeter risers and runouts may have sleeves of {1.31 mm} [18 gauge] galvanized steel set around section of insulation to provide freedom of movement of piping. Extend {50 mm} [2"] above finished floor level.
- .3 For piping through exterior walls, cooperate with the waterproofing trade at all times, and do not break any waterproofing seal without consent of the waterproofing trade. Provide waterproof link seals.
- .4 Provide leak plates where pipe sleeves pass through exterior building walls. Each leak plate shall be a {3.42 mm} [10 gauge] steel plate, welded to the sleeve, {100 mm} [4"] diameter greater than sleeve outside diameter.

- .5 Provide {1.31 mm} [18 gauge] galvanized steel duct sleeves. Provide adequate bracing for support of sleeves during concrete and masonry work. For fire rated floors and walls, build fire damper assemblies into structure to attain fire rated construction, in a manner acceptable to the governing authorities.
- .6 Cover pipe sleeves in walls and ceilings of finished areas, other than Equipment Rooms, with satin finish stainless steel, or satin finish chrome or nickel plated brass escutcheons, with non-ferrous set screws. Do not use stamped steel split plates. Split cast plates with screw locks, however, may be used.
- .7 Cover exposed duct sleeves in finished areas with {1.31 mm} [18 gauge] galvanized steel plates in the form of duct collars. Fix in position with non-ferrous metal screws.

2.14 DRAINS

- .1 Provide NPT 1" (25 mm) minimum size copper pipe drains from overflows, condensate pans and pump bases to floor drains.
- .2 Provide minimum NPT ¾" (20mm) ball valve with hose end adapter, metal cap and chain at all low points of all systems. Locate to allow easy connection of hose.
- .3 Provide NPT 1 ½" (40mm) minimum size drains from ductwork connected to intake hoods and wall louvers. Equip drains with deep seal traps. Locate traps in heated areas.
- .4 Provide NPT ¾" (20mm) valves with metal caps and chains at the base of all pipe risers. Install hose end ball valve in conjunction with 18" (450mm) minimum length full line size dirt leg.

2.15 PRESSURE GAUGES AND THERMOMETERS

- .1 Provide pressure gauges, thermometers and accessories as follows:
 - .1 pressure gauges – No. 600 Series to ANSI Standard B40, Grade A, fully adjustable, 4-1/2" (115 mm) diameter, complete with a cast aluminum casing, clear glass window, white dual scale (psi and kPa) dial, red tipped black pointer, bronze bushed movement, pressure snubber, and "T" handle gauge cock;
 - .2 thermometers – No. BX93403-1/2 CAN/CGSB Standard 14.4-M88 fully adjustable angle, 9" (225 mm) white dual scale (degrees F. and degrees C.), complete with cast aluminum case, clear acrylic window lens, front red reading mercury tubing, separable brass socket, brass piping well, and extension necks where used in insulated pipe or equipment.
- .2 Pressure gauge and thermometer scale ranges shall be such that the working temperature or pressure of the system for which the instrument is provided is at approximately the mid-point of the instrument scale.
- .3 Pressure gauges in steam piping shall be complete with Trerice No. 885 Series coil syphons.
- .4 Pressure gauges in sprinkler and standpipe fire protection piping shall be Winters Model Q1721 or equal ULC listed pressure gauges.
- .5 Pressure gauges in medical gas piping systems shall conform to CSA Z7396.1-12 and shall be identified with the name of the service it is provided for as well as "USE NO OIL".
- .6 Instruments and associated accessories shall be registered with Technical Standards and Safety Authority (TSSA) and shall be complete with a CRN No. Where possible, the CRN No. shall be permanently fixed to the component.
- .7 Provide pressure gauges with cocks in the following locations:
 - .1 in valved tubing across the suction, suction strainer (if applicable), and discharge piping of each circulating pump;
 - .2 in the supply and return piping connections to main heating, cooling and heat recovery coil(s);
 - .3 in the hot side and cold side supply and return piping connections to water and/or glycol solution heat exchangers;
 - .4 in the steam piping connection to steam activated heat exchanger(s);

- .5 in closed expansion tank(s).
- .8 Thermometers in ductwork shall be equipped with Trerice No. 065-0015 or equal mounting flanges.
- .9 Provide an angle type or straight type (as required by the installation) thermometer in the following locations:
 - .1 in the supply and return piping connections to main heating, cooling and heat recovery coil(s);
 - .2 in the hot side and cold side supply and return piping connections to water and/or glycol solution heat exchanger(s);
 - .3 in water or glycol solution supply and return piping connections to steam actuated heat exchanger(s);
 - .4 in supply and return piping connections to domestic hot water heaters;

2.16 PIPE AND DUCTWORK IDENTIFICATION

- .1 Provide pipe markers on all pipe coverings with flow arrow and alternating wording. For outside diameters up to {150 mm} [6"], allow marker to completely wrap pipe. For larger outside diameters, secure markers with stainless steel springs. Secure markers on vertical piping and elsewhere where markers could be inadvertently moved.
- .2 Use stencils and stencil paint on ductwork or ductwork insulation. Apply solid black capitalized lettering {50 mm} [2"] high and solid black flow arrows {150 mm} [6"] long x {50 mm} [2"] wide.
- .3 Locate identification and flow arrows so they can be seen clearly from floor and service platforms as follows:
 - .1 at least once in each room
 - .2 at each piece of equipment
 - .3 at each branch connection close to main piping and ductwork
 - .4 at not greater than intervals of 50 ft (15 meter) on straight runs of exposed piping and ductwork; radioisotope drainage piping and fume exhaust ductwork shall be identified at minimum 3m (10 ft) intervals.
 - .5 at entry and leaving point to pipe and duct chases, or other concealed spaces
 - .6 both sides where piping and ductwork passes through walls, partitions and floors
 - .7 on vertical pipes and ducts approximately 6 ft (1800 mm) above floor
 - .8 behind each access door and panel
 - .9 at valves, identify piping upstream of valves and identify branch, equipment, building part or building serviced downstream of valve
- .4 Colour code pipes to meet code and Owner's requirements. At minimum, colour code pipes with {50 mm} [2"] wide bands.
- .5 Identify electrical tracing of pipes on pipe insulation.
- .6 Provide {40 mm} [1-1/2"] dia., {1 mm} [0.040"] thick brass tags with {10mm} [3/8"] high die-stamped black letters or {10 mm} [3/8"] Lamacoid tags with engraved black.
- .7 Attach to valves with {100 mm} [4"] long brass chains.
- .8 Tag all valves except for small valves isolating a single piece of equipment such as a unit heater, fan coil unit, terminal reheat coil and radiation section.
- .9 of equipment such as a unit heater, fan coil unit, terminal reheat coil and radiation section.

2.17 EQUIPMENT IDENTIFICATION AND NAMEPLATES

- .1 Identify equipment, starters, and, remote control devices in a manner consistent with the Drawings.

- .2 Use solid black capitalized lettering {100 mm} [4"] high.
- .3 Where equipment size does not permit stencil identification, use lamacoid labels, engraved white on black, mechanically fastened to the equipment. Minimum lettering size {10 mm} [3/8"].

2.18 V BELTS

- .1 Fit reinforced toothed belts in sheave matched to drive. Multiple belts on unit to be matched set.
- .2 Use steel sheaves secured to shafts with removable keys.
- .3 For motors 1.3 HP to 10 HP: standard adjustable pitch drive sheaves, having +/-10% range.
- .4 Use mid-position of range for specified r/min.
- .5 For motors over 10 HP: Sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre-line adjustment and belt tension adjustment.
- .8 Tension belts to manufacturer's recommendations before start up and after the first 100 h of operation using calibrated belt tensioning gauge.
- .9 1 1/2" (38 mm) dia holes on both shaft centres for insertion of tachometer.
- .10 Provide means to permit lubrication and use of test instruments with guards in place.
- .11 Install belt guards to permit movement of motors for adjusting belt tension.
- .12 For flexible couplings, provide removable, "U" shaped, 12 gage (2.7 mm) thick galvanized frame and 18 gage (1.2 mm) thick expanded mesh face.
- .13 Provide 3/4" (19 mm) galvanized mesh wire screen on inlet or outlet of exposed fan blades.
- .14 Provide belt and rotating shaft guards for exposed drives and shafts.
- .15 Acceptable Manufacturer (as listed or equal): Opti-Belt, Goodyear, Gates.

2.19 GUARDS

- .1 All belt guards for remote fans shall be provided with a complete guard which covers the front and back of the belt.
- .2 Provide guards for exposed drives. This includes the drives within the air handling units.
- .3 All guards shall meet the requirements outlined in the OSHA Regulations.
- .4 Guards for drives shall have:
 - .1 Expanded metal screen welded to 1" (25 mm) steel angle frame.
 - .2 18 gauge (1.2 mm) thick galvanized sheet metal tops and bottoms.
 - .3 Removable side for servicing.
 - .4 1 1/2" (40 mm) dia. holes on both shaft centers for insertion of tachometer.
- .5 Provide means to permit lubrication and use of test instruments with guards in place.
- .6 Install belt guards to permit movement of motors for adjusting belt tension.
- .7 Provide 3/4" (20 mm) galvanized mesh wire screen on inlet or outlet of exposed fan blades.

PART 3 - EXECUTION

3.01 INSTALLATION

- .1 Install equipment, ductwork, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the acceptance of the Consultant. Install ducts and pipes parallel and perpendicular to building planes. Install piping and ductwork concealed in chases, behind furring, or above ceiling. Install exposed systems grouped to present a neat appearance. Comply with manufacturer's installation instructions.

- .2 Install gauges and thermometers to permit easy observance from floor level.
- .3 Install all equipment and apparatus with adequate space allowance for wiring, maintenance, adjustment and eventual replacement.
- .4 Install control devices to guarantee proper sensing. Shield elements from direct radiation and avoid placing them behind obstructions.
- .5 Install equipment in accordance with Manufacturer's requirements. Include all Work shown on shop drawings.
- .6 Install all ceiling mounted components (Diffusers, Grilles, and similar) in accordance with reflected ceiling Drawings.
- .7 Leave space clear and install all work to accommodate future materials and/or equipment and to accommodate equipment and/or materials supplied by other trades. Verify spaces in which work is to be installed. Install pipe and ductwork runs to maintain maximum headroom and clearances and to conserve space in shaft and ceiling spaces.
- .8 Confirm on the site the exact location of equipment and fixtures. Confirm location of equipment supplied by other trades and mechanical requirements thereof.
- .9 Do not suspend any equipment, piping, ducting or any other mechanical components from formed hollow steel decking.

3.02 EQUIPMENT CONNECTIONS

- .1 Install piping connections to pumps and all other equipment without strain at the pipe connections. Remove, where requested by the Consultant, bolts in flanged connections or disconnect piping after the installation is complete to demonstrate that the piping has been so connected.
- .2 Provide shut-off valves on supply and return piping connections on all items of equipment.
- .3 Provide flexible connectors on supply and return piping connections on all based mounted pumps.
- .4 Corrosion Prevention: Install dielectric couplings as specified above at the following locations:
 - .1 Connections to copper/aluminium perimeter convectors, radiant ceiling panels and coils with copper connections in steel piping systems.
 - .2 Connections between copper and steel pipe.
 - .3 Connections to cooling coil condensate drains.
 - .4 Connections to expansion tanks and domestic hot water tanks in copper piping systems.
 - .5 In either steel or copper piping systems, do not put short black steel nipples and individual black steel fittings between brass or bronze components such as valves - use only copper, brass or bronze components. Use a minimum of eight times the mass of steel pipe or components between any two brass, bronze or copper fittings or components.
 - .6 Use brass or bronze valves in a copper or copper alloy piping; do not use copper alloy (brass and bronze) fittings and valves in place of specified dielectric couplings.

3.03 PIPING SYSTEM INSTALLATION

- .1 Install all piping in accordance with the best practices of the trade.
- .2 The piping shown on the drawings is diagrammatic for clearness in indicating the general run and connections and may or may not be, in all instances, shown in its true position. Take responsibility for the proper erection of systems of piping in every respect suitable for the work intended and as described herein.
- .3 Keep plugged or capped all openings in pipe or fittings during installation.
- .4 Install piping to avoid any interference with the installation or removal of equipment, other piping and ducts.
- .5 Install all valves, strainers and specialties to permit easy operation and access.

- .6 Provide means of isolation (shut-off valves or flow balancing valves) for all plumbing and HVAC piping risers, at the base when supplied from the below, or at the top when fed from above.
- .7 On horizontal piping, install valves in an upright position. Where there are space constraints mount valves at a maximum 45° off vertical.
- .8 Install strainers to provide easy strainer basket removal.
- .9 Install systems to provide thorough drainage and air elimination.
- .10 During welding or soldering procedures, provide a fire retardant cloth, mat or blanket to protect the structure, and adequate fire protection equipment at all locations where work is being done. Close off shaft or confined areas with a fire retardant mat or cloth to prevent sparks or pieces of hot metal from falling down the shaft or area way.
- .11 Provide long turn pipe fittings having not less than pipe wall thickness. Provide line size tees. Where branch lines are more than two sizes smaller than the main, weldolets may be used.
- .12 Where it is necessary to offset piping to avoid obstructions, use 45° rather than 90° elbows.
- .13 Provide suitable cleanouts on every other change in direction and slope all condensate drip drains.
- .14 Make all threaded pipe joints on water piping using a thread paste or teflon tape suitable for the service for which the pipe is to be used. Use of hemp or similar materials on threaded joints will not be permitted.
- .15 Comply with manufacturer's installation instructions for all Grooved Couplings and Fittings piping products. Ensure that grooved pipes are in compliance with the current manufacturer's specifications and recommendations.
 - .1 Ensure that the surface area from the pipe end to the front edge of the groove is free from indentations, scores, seams, projections or roll marks.
 - .2 Use only lubricants which are non-toxic and non-injurious to the gasket material.
 - .3 Upon completion of assembly, the bolt pads of each coupling must be fully drawn together, except for Victaulic HP-70 couplings in pipe sizes to 100mm (4").
 - .4 All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - .5 The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
 - .6 A factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation as requested by the Consultant. Contractor shall remove and replace any improperly installed products.
- .16 Install all piping requiring insulation with sufficient clearance to apply, seal and finish the insulation.
- .17 Provide sufficient space between piping to install valves arranged in straight rows or equally spaced steps. Valve wheels, handles and operators to be easily accessible and operable.
- .18 Do not install horizontal piping within masonry walls. Any piping installed in this manner will not be accepted.
- .19 Use only non-ferrous metals in high humidity areas.

3.04 DRAINS

- .1 Pipe all discharge from relief valves and drains from equipment, outside air plenum/ louver, chemical pot feeders and tanks to nearest floor drain or suitable receptacle.
- .2 Provide 20mm (3/4") ball valves with hose ends, caps and chains at strainers, all piping system low points, pumps, coils and at each piece of equipment.

- .3 Provide deep seal traps (minimum 6" [150mm] trap seal) on all air handling equipment condensate drains and on floor drains located within air handling unit plenums. Provide trap seal primers on all floor drain traps and gang traps.

3.05 CONTROL COMPONENTS

- .1 Install all pipe line devices required by the Section 25 30 10 such as flow switches, valves and submersible wells for temperature controllers and sensors.

3.06 DIRT ACCUMULATION IN CONTROL VALVES

- .1 Remove any dirt accumulated under seats of automatic control valves during the first year's operation. Replace damaged valve parts at no additional cost to the Owner.

3.07 FIELD WELDING

- .1 Only persons holding current welding certificates for the applications required for the Work to be permitted to do any welding. Perform all welding to Standards specified by Authorities Having Jurisdiction. Do not weld to structural members of the building.

3.08 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- .1 Provide all required pipe hangers and supports.
- .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.
- .3 Hanger rods may be attached to beam or joist clamps, brackets, or concrete inserts. Explosive actuated tools are not permitted. Do not weld to structural steel unless accepted by the Consultant.
- .4 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.
- .5 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1½") dia. are to be adjustable clevis type.
- .6 Space hangers and supports in accordance with following:
- .1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;
- .2 plastic pipe – conform to pipe manufacturer's recommended support spacing;
- .3 copper and steel pipe – hang or support at spacing in accordance with following Table:

<u>Nominal Pipe Size</u>	<u>Steel Pipe Maximum Support Spacing</u>	<u>Cooper Pipe Maximum Support Spacing</u>
to ¾" (20mm)	7'-0" (2.1m)	5'-0" (1.5m)
1" (25mm)	7'-0" (2.1m)	6'-0" (1.8m)
1-¼" (32mm)	7'-0" (2.1m)	7'-0" (2.1m)
1-½" (40mm)	9'-0" (2.7m)	8'-0" (2.4m)
2" (50mm)	10'-0" (3.0m)	8'-0" (2.4m)
2-½" (65mm)	11'-0" (3.3m)	9'-0" (2.7m)
3" (75mm)	12'-0" (3.6m)	10'-0" (3.0m)
4" (100mm)	14'-0" (4.2m)	12'-0" (3.6m)
6" (150mm)	17'-0" (5.1m)	14'-0" (4.2m)

8" (200mm)	19'-0" (5.6m)	n/a
10" (250mm)	22'-0" (6.7m)	n/a
12" (300mm)	23'-0" (7.0m)	n/a

- .4 flexible grooved pipe/coupling joint piping: in accordance with Table above but with not less than one hanger or support between joints.
- .5 Note that spacing and capacities are based on straight pipe lengths filled with water. Additional valves and fittings increase the load and therefore closer hanger spacing shall be required.
- .7 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 12" (300mm) from elbow, and where pipes drop from tee branches, support tees in both directions not more than 2" (50mm) on each side of tee.
- .8 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.
- .9 Provide roller hangers or supports for heat transfer piping greater than or equal to 6" (150mm) diameter and conveying a material 167°F (75°C) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.
- .10 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:
 - .1 support vertical pipes at maximum 10ft. (3m) intervals or at every floor, whichever is lesser;
 - .2 for sections of vertical piping with a length less than 10ft. (3m), support pipe at least once;
 - .3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;
 - .4 for vertical steel pipe risers in excess of 10ft. (3m), weld shear lugs to pipe to carry load;
 - .5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.
- .11 Support piping on the roof as follows:
 - .1 on existing roof – provide support members as specified in Part 2 of this Section spaced as per schedule above and of a type to suit the application, and, for each support, carefully scrape away roofing gravel, bed support in a heavy covering of roofing mastic, then scrape gravel back up around support and secure pipes to supports;
 - .2 on new roof – supply manufactured roof supports as per Part 2 of this Section to accommodate piping involved and support spacing specified above, and hand supports to roofing trade on roof for installation as part of roofing work, then secure piping in place on supports.
- .12 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.
- .13 For insulated horizontal piping 1¼" (32mm) and larger, provide galvanized steel insulation protection saddles between insulation and hanger or support in accordance with the following table:

Pipe Insulation Saddle Sizing Tables, Outside Diameter (in.)						
Pipe Size (inches)	Insulation Thickness (in.)					
	½	1	1½	2	2½	3
1¼	3	3½	5	5½	6½	7½
1½	3	4	5	5½	6½	7½
2	3½	4½	5½	6½	7½	8½
2½	4	5	6½	7½	8½	9½
3	4½	5½	6½	7½	8½	9½
4	5½	6½	7½	8½	9½	11
6	7½	8½	9½	11	12	13
8	9½	11	12	13	14	15
10	—	13	14	15	16	17
12	—	15	16	17	18	19
14	—	16	17	18	19	20
16	—	18	19	20	21	22
18	—	20	21	22	23	24

- .1 Saddles up to 5-½" outside diameters shall be 22 gauge galvanized steel, 12" (300mm) long;
- .2 Saddles 6" outside diameter and larger shall be 20 gauge galvanized steel, 18" (450mm) long;
- .3 Install saddles immediately after pipe is insulated.
- .14 Do not support piping from steel deck without written consent from Owner and review with Consultant.

3.09 EXPANSION JOINTS

- .1 Install expansion loops, joints and compensators in accordance with the Drawings and Manufacturer's instructions in regard to proper length, anchoring and guiding, pre-compression, removal of spacers and testing.

3.10 RIGGING AND HOISTING OF EQUIPMENT

- .1 The Contractor shall provide all rigging, hoisting and handling of equipment as necessary in order to place the equipment in the designated area in the building.
- .2 Direct this work by qualified personnel normally engaged in rigging, hoisting and handling of equipment.

3.11 CONCRETE

- .1 Except as specifically indicated on the Mechanical Drawings or where indicated on the Architectural or Structural Drawings as provided by other Sections, provide all concrete work required for mechanical work (bases, curbs, anchors, thrust blocks, manholes, catch basins).
- .2 Provide reinforced concrete housekeeping pads (equipment bases) at least 100 mm (4") high under all floor mounted equipment.

3.12 METALS

- .1 Steel construction required solely for the work of Mechanical trades and not shown on Architectural or Structural Drawings shall be provided by Mechanical Trades to the acceptance of the Consultant. Provide one coat of primer on all steel supports located outdoors.

3.13 CUTTING AND PATCHING

- .1 Provide all cutting and patching of building finishes as necessary to complete the Work.
- .2 Obtain the Owner's written approval for locations and methods before starting to cut openings in load bearing members.
- .3 Provide all cutting and patching for services penetrating walls, floors and roofs as shown on the Drawings. Cut only to suit dimensions required and for minimum clearances.
- .4 Include for x-ray of slab to determine the location of reinforcing steel prior to drilling.
- .5 Seal around services passing through cut openings with materials commensurate with the fire rating of the wall, floor or roof.
- .6 Ensure sealing is weatherproof for openings through exterior walls and roofs. Before sealing, provide prime coat of paint on all repaired surfaces.
- .7 Finish all cutting and patching work to match base building finishes and make invisible.

3.14 LINTELS

- .1 Lintels for openings in masonry to conform to requirements given on structural drawings and as required by By-laws.
- .2 Pay all costs for lintels over openings required solely by the mechanical trades.

3.15 INSERTS, SLEEVES AND ESCUTCHEONS

- .1 Provide all sleeves required for ductwork, piping and access openings unless they are specifically shown on Architectural and Structural Drawings.
- .2 Place inserts only in portion of the main structure and not in any finishing material.
- .3 Supply and locate all inserts, holes, anchor bolts and sleeves in time when walls, floors and roof are erected.
- .4 Provide the following for pipe sleeves:
 - .1 Through interior walls, exterior walls above grade, interior non waterproof floors: Machine cut schedule 40 steel pipe, medium cast iron or 18 gauge galvanized steel.
- .5 Seal all sleeves as follows:
 - .1 Through fire rated walls and floors and within mechanical assemblies (ducts): Stop insulation flush with all wall and floor surfaces and seal space between duct or pipe and sleeve with ULC approved and listed fire stopping material as manufactured by Double AD Distributors Ltd. (416) 292-2361 or M. W. McGill and Associates Ltd. "Fire-Bloc" (416) 291-8393 or Dow RTV Silicon Foam or "Metacaulk" as distributed by EMCO Ltd. (416) 742-6220].
 - .2 Through all non-fire rated walls and floors stop insulation, where applicable, at wall and floor surfaces. Ram-pack ULC labelled mineral wool materials around piping and ductwork. Apply an approved caulking compound over the ram packed material on both sides.
- .6 Cover sleeves and openings around exposed piping in all finished areas with chrome plated escutcheons. Cover exposed duct sleeves in finished areas with an 18 gauge galvanized steel collar fixed to wall or floor.

3.16 FIRE STOPPING

- .1 Mechanical service penetrations of required fire separations shall be fire stopped using ULC listed fire stopping products that have been tested in accordance with CAN4-S115.
- .2 Provide all fire stopping affected by the Mechanical Work to maintain required listed ratings of fire separations.

3.17 ACCESS PANELS AND DOORS

- .1 Install all concealed Mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels and doors. Install systems and components to result in a minimum number of access panels.
- .2 Access doors are required in walls, ceilings and ductwork for the following:
 - .1 Fire dampers and motorized dampers (for inspection, repair and resetting). Provide access doors on both upstream and downstream sides of automatic dampers.
 - .2 Duct mounted coils (duct access upstream and downstream sides for cleaning).
 - .3 Duct mounted smoke detectors (for inspection of in-duct sensors).
 - .4 Control valves and temperature control components.
- .3 Indicate access panels on "As built" drawings and note at each location the items (i.e. equipment or valve no.) that access is being provided for.
- .4 Size access doors to provide adequate access and be commensurate with type of structure and architectural finish.
- .5 Ensure proper rating of doors in fire separations.
- .6 Provide lamacoid labels (white on black), screwed in place, on all access doors and access tiles listing items or equipment which access is being provided for.

3.18 EXPOSED WORK

- .1 Wherever any mechanical work (plumbing, drainage, hydronic and sprinkler piping, ductwork, and associated thermal insulation) is exposed in finished areas, co-ordinate the work with the Consultant prior to installation. If unsatisfactory installation results due to not following this procedure, perform remedial work to the Consultant's acceptance.
- .2 For purposes of the foregoing, finished areas do not include equipment rooms.

3.19 PIPING SYSTEM TESTS

- .1 Do not insulate piping systems until completed, perfected, and proven tight.
- .2 Should leaks develop in any part of the piping system, remove and replace defective sections, fittings and equipment.
- .3 Test piping system in sections as required by the progress of work.
- .4 Test all heating water and domestic water piping hydraulically to a minimum pressure of 1100 kPa (150 psi) or 1.5 times the normal working pressure, whichever is the greater, and prove tight for a period of 8 hours. Testing with nitrogen is also acceptable provided a pressure of 1.25 times values specified previously is used. Test natural gas piping as required by Code and Authorities Having Jurisdiction.
- .5 All plumbing, heating and cooling mains and branches are to be flushed and cleaned without fixtures and appliances connected.
- .6 All tests must be recorded. Submit recorded data to the Consultant.

3.20 PROVISION FOR PIPE EXPANSION, CONTRACTION AND BUILDING SHRINKAGE

- .1 Make provision for pipe expansion, contraction and building shrinkage with suitable anchors, offsets or expansion loops. Where space limitations do not permit the use of expansion loops or offsets, provide expansion joints properly selected for system operating pressures. Standard grooved joint fittings shall not be used for expansion/contraction\ compensating purposes.
- .2 Install piping to allow freedom of movement in all planes without imposing undue stress on any section of main piping, branch piping, equipment or structure.
- .3 Install expansion joints in accordance with manufacturer's published instructions.

3.21 PIPE GUIDES AND ANCHORS

- .1 Provide expansion compensators (including expansion loops) in the piping where required. Design and install guides and anchors in all vertical and horizontal piping that will be subject to movement of any kind due to any cause.
- .2 Provide pipe alignment guides where required, including double guides at each side of expansion loops and/or compensators, according manufacturer's published recommendations. Use at least two guides on each side of expansion joint.
- .3 Install pipe guides for expansion joints. Install manufactured or field fabricated alignment guides to allow movement in axial direction only.
- .4 Where guides are provided on cold piping, provide thermal break to prevent sweating.
- .5 Secure engineered anchors to the structure to secure pipework where required. Avoid introduction of excessive reactive forces and operating weights into the structure and onto equipment and piping. Anchors shall be in accordance with reviewed shop drawings.
- .6 Install vertical risers properly anchored and guided to maintain accurate vertical position of piping. At time of startup, clean and lubricate guides, and adjust to allow free sliding at operating conditions.

3.22 PAINTING

- .1 Paint all ferrous metal work except piping, galvanized and stainless steel ductwork, with one factory prime coat, or paint one prime coat on site.
- .2 Clean and steel brush surfaces with welds. Then prime coat all steel supports and brackets.
- .3 On uninsulated piping, steel brush and prime coat welds.
- .4 Touch-up or repaint surfaces damaged during shipment or installation and leave ready for finish painting.
- .5 Prime coat material shall conform to Canadian General Standards Board Standard No. 1-GP-48.
- .6 Finish painting will be provided by Painting Trades.

3.23 IDENTIFICATION OF MECHANICAL SERVICES

- .1 Identify all mechanical services after finish painting is complete.
- .2 Use terminology consistent:
 - .1 with the Drawings and Specifications
 - .2 with the Owner's requirements and standards.
- .3 Identify lay-in type acoustic ceilings used for access to equipment and components by a method acceptable to Consultant.
- .4 Mark valve and equipment identification on Record Drawings.
- .5 Provide typewritten master lists for each Equipment Room. Frame under glass. Insert copies in Operating and Maintenance Instruction Manuals.

3.24 IDENTIFICATION OF PIPING AND PIPELINE EQUIPMENT

- .1 Identify all automatic control devices and motor driven equipment with 3mm (1/4") lamacoid plastic plates with beveled edges having engraved white letter on black background giving the nature of equipment service and its number, i.e. "Washroom Exhaust E1", "Condenser Pump P1" Fix to equipment using sheet metal screws.
- .2 Also provide:
 - .1 12mm (1/2") lettering for motor starters and 75mm (3") lettering for equipment.
 - .2 Where equipment is locally switched (e.g. Room exhaust fans) provide identification plate at switch.
- .3 Co-ordinate with BAS Trades and obtain list of automatically operated equipment and provide warning identification on lamacoid plate for each item as follows:

- .1 "Warning: This equipment may start at any time. Do not service without disconnecting power."
- .4 Provide all major valves with brass or plated plastic numbered tags, 18mm (3/4") diameter with stamped numbers. Secure by brass chains to the valve. Valves adjacent to plumbing fixtures, convectors, unit heaters and entrance heaters need not be tagged. Prepare an approved list detailing the valve location, tag numbers and purpose. Mount one (1) copy of this list in a glazed frame where advised by the Owner and provide additional copies for the manuals.
- .5 Identify the following piping as to service and direction of flow using stencils and black lettering behind each access door, in each room, and/or every 12m (40 ft.)
 - .1 Domestic (potable) water: hot, cold, recirculation
 - .2 Hydronic piping system: chilled water supply and return, chilled glycol supply and return, heating water supply and return, heating glycol supply and return.

3.25 FLASHING AND COUNTER-FLASHING

- .1 Provide flashing for pipe openings or pre-manufactured roof curbs.
- .2 Provide counter-flashing for roof mounted mechanical equipment and for pipes and ducts passing through roof. Fit counter-flashing over flashing or curb. Pitch pockets are not acceptable.

3.26 CURBS

- .1 Ensure that curbs are provided for mechanical work where required.
- .2 Provide curbs for roof mounted equipment, around ducts passing through roof and surrounding groups of pipes and/or ducts passing through equipment room floors, kitchens and similar areas.
- .3 Select curb heights to prevent water leakage or weather penetration around the mechanical services surrounded by the curb.

3.27 METAL FRAMES AND COVERS

- .1 Covers and frames for pits and sumps shall be designed, fabricated and installed to readily permit full access to the concealed services, to resist superimposed loading, and to be gas tight where odours may be present.
- .2 Installation to ensure that covers and grates are flush with finished floors.

3.28 STEEL

- .1 Provide steel of adequate strength to support equipment and materials during all operating and test conditions.
- .2 Support suspended equipment from the bottom or from manufacturer's designated suspension points. Support tanks and similar equipment with adequate beam strength by saddles with curvature to match the equipment. Continuously support other equipment.
- .3 Provide base supports for all pipe risers. Design to distribute operating and static loads.
- .4 Fabricate steel supports in contact with water or humidity conditions from materials having approved corrosion resistance or galvanize after fabrication or brush welds clean and apply a prime coat of rust inhibiting paint.

3.29 EQUIPMENT BASES AND SUPPORTS

- .1 Unless otherwise specified or required, set all floor mounted equipment on minimum 4" (100 mm) high reinforced concrete housekeeping pads 8" (200 mm) clear of the equipment on each side and end, or a minimum of 8" (200 mm) from the centreline of equipment anchor bolts to the edge of the base, whichever is larger. Conform to the following requirements:
 - .1 supply dimensioned drawings and equipment base templates, and provide anchor bolts for proper setting and securing of equipment on pads;
 - .2 place anchor bolts during the concrete pour and be responsible for all required levelling, alignment, and grouting of the equipment;

- .3 as a minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement as per structural drawing details.
- .2 For equipment not designed for base mounting, where required, provide welded, cleaned and prime coat painted structural steel stands or supports conforming to the following requirements:
 - .1 all stands and supports, except those for small equipment, are to be designed by a structural engineer registered in the jurisdiction of the work, and stamped and signed design drawings with calculations are to be submitted as shop drawings for review;
 - .2 all steel stands are to be flange bolted to concrete housekeeping pads;
 - .3 all stands and supports are to be seismically restrained in accordance with applicable requirements.

3.30 WELDING AND BRAZING

- .1 All welding and brazing shall conform to the following codes and standards:
 - .1 Building Services Piping Code ANSI/ASME B 31.9 (latest edition)
 - .2 CSA B51 (latest edition), Boiler, Pressure Vessel and Pressure Piping Code
 - .3 ASME Boiler Code - Section IX
 - .4 All requirements of the Technical Standards and Safety Authority (TSSA)
- .2 Welding shall conform to a welding procedure which must be in accordance with TSSA requirements and include materials, weld preparation, heat treatment and welding equipment to be used.
- .3 Qualify welders according to ASME equivalent testing procedures. Do not use welders, on or off site work who are not qualified for the work. Maintain records for all qualification testing, and provide copies to the Consultant on request.
- .4 Identify work in accordance with codes and standards. Welds shall be full penetration, continuous and without defects. After deposition, each layer of weld shall be cleaned to remove slag and scale by wire brushing or grinding, then chipped where necessary to prepare for proper deposition of the next layer. The weld reinforcement shall not be less than 1/16" (1.6 mm) and not more than 1/8" (3.2 mm) above the normal surface of the joined sections. The reinforcement shall be crowned at the centre and shall merge into the base material without excessive shoulder or undercut.
- .5 Welding shall be made by machine or manual shielded metallic arc process. Direct current shall be used exclusively with the base material on the negative side of the line. Electrodes used shall be an approved all position rod type.
- .6 Provide a copy of TSSA registration and include with Maintenance Manuals.

3.31 DRIP PANS

- .1 Route piping to avoid running over critical spaces unless the piping system serves the respective area. Critical spaces shall include, but not be limited to, critical care areas, procedure rooms, recovery rooms, areas containing expensive medical or computer equipment, and food preparation areas.
- .2 Where such critical and sensitive areas cannot be avoided, plan the installation to minimize the number of joints required, and locate potential failure points in less sensitive locations. Use welded or soldered joints over critical spaces.
- .3 Provide drip pans under piping running over critical spaces.
- .4 Drip pans shall be constructed of galvanized steel or stainless steel sheet, and shall be complete with drain connections.
- .5 Slope pan to ensure positive and complete drainage to the drain connection point, and pipe the drain to a local indirect termination.
- .6 Each drip pan shall extend beyond the edge of the piping it serves by a minimum of 75 mm and shall be configured to have at least a 50 mm high lip.

- .7 Drip pans shall not obstruct access to piping protected or other services installed above.

3.32 MAINTENANCE OF EQUIPMENT PRIOR TO ACCEPTANCE

- .1 Maintain all equipment in accordance with the manufacturer's printed instructions prior to start-up, testing and commissioning.
- .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.
- .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminum tubing.
- .4 All filters shall be new upon Substantial Performance of the work. This is in addition to any spare filters specified.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

PART 2 - PRODUCTS

2.01 NIL

PART 3 - EXECUTION

3.01 GENERAL INSTRUCTIONS

- .1 Refer to Drawings for extent of demolition work. The drawings indicate the approximate locations of services as far as these are known.
- .2 Dispose, off site, of all debris in accordance with the Authorities having Jurisdiction (AHJs).
- .3 Removal and storage of salvageable items will be as directed by this Specification Section and the Owner or their representative.
- .4 At the end of each work shift, leave work in a safe condition.
- .5 Patch fire rated partitions and floors to maintain rating upon removal of mechanical services originally spanning fire rated assembly.
- .6 Demolish work into sections of practical size for removal without alteration or damage to existing building.
- .7 Unless noted otherwise include with the demolition scope all control devices and sensors, including control wiring and/ or pneumatic tubing, associated with equipment indicated as being demolished. This includes, but is not limited to:
 - .1 Space temperature and humidity sensors;
 - .2 Duct mounted temperature, flow and humidity sensors;
 - .3 Piping temperature, and flow sensors (sensing wells to remain where piping is not intended for demolition).

3.02 DISPOSAL OF MATERIALS

- .1 All materials which have not been designated for salvage from the demolition shall become the property of the Contractor. Remove all material and debris from the site as quickly as possible and dispose of legally. Burning of debris or selling of materials on the site will not be permitted.
- .2 Present to the Owner existing equipment removed but not identified for salvage on site. Acceptance of removed equipment is at the discretion of the Owner. Remove such items from site when deemed unsuitable.
- .3 Conform to requirements of municipality's Works Department regarding disposal of waste materials.
- .4 Materials prohibited from municipality waste management facilities shall be removed from site and disposed to recycling companies specializing in recyclable materials.

3.03 PROTECTION OF OWNERS PREMISES

- .1 Adhere strictly to the Owner's requirements.
- .2 Confer with the Owner concerning schedule, dust and noise control prior to commencing Demolition Work in or adjacent to existing facilities where such Demolition Work might affect either those facilities or their occupants.
- .3 Execute Demolition Work with least possible interference or disturbance to occupants, public and normal use of premises.
- .4 Provide temporary means to maintain security when security has been reduced by Demolition Work.

- .5 Only elevators, dumbwaiters, conveyors or escalators assigned for Contractor's use may be used for moving Trades and material within building. Protect walls of passenger elevators, to approval of Owner prior to use. Accept liability for damage, safety of equipment and overloading of existing equipment.
- .6 Provide temporary dust screens, barriers, warning signs in locations where renovations and alternation work is adjacent to areas which will remain functional during Demolition Work.
- .7 All mechanical systems indicated to remain shall be protected from damage.
- .8 Provide and maintain ready access to fire-fighting equipment at all times.
- .9 Provide and maintain proper and suitable fire extinguishers throughout the duration of the Demolition Work.
- .10 The drawings indicate the approximate locations of services as far as these are known. Should any service line be broken, or disrupted by Demolition Work specified under this Contract, repair service lines, and make good all damage due to the disruption or break, at no expense to the Owner. Notify the Owner immediately whenever any service line is broken or damaged.
- .11 The drawings indicate the approximate locations of services as far as these are known. Immediately advise Consultant in writing when unknown services are encountered.
- .12 Accept liability for costs incurred by the Owner in repairing and cleaning equipment, or other building finishes or services resulting from failure to comply with the requirements of these Specifications.

3.04 RESTRICTION ON USE OF PREMISES

- .1 Use only those existing entrances and stairs designated by the Owner for access to and egress from the existing buildings and various floors where work of this contract is to be carried out. No traffic through other areas of the building will be permitted without the prior consent of the Owner.
- .2 Keep stairs and corridors clear and open as required by the Ontario Fire Code ("OFC") and the Authorities Having Jurisdiction ("AHJs") for exiting purposes in case of fire, and as required for use by the Owner's personnel.
- .3 Owner will designate which toilet facilities may be used by Mechanical Division Trades.

3.05 PREPARATION

- .1 Notify the consultant a minimum of 48 hours prior to commencing Demolition Work.
- .2 Prior to commencing Demolition Work arrange to have the appropriate Trades concerned present for the disconnection of all building services.
- .3 Ensure that all existing services designated to remain are adequately protected.

3.06 INTERRUPTION OF EXISTING SERVICES

- .1 Arrange, schedule and perform Demolition Work with minimum disturbance to existing facilities and services.
- .2 Submit a complete schedule of service interruptions and changeovers with approximate dates required, durations and times of day, for approval before proceeding.
- .3 Notify Owner in writing at least 72 hours in advance of planned interruption to existing services.
- .4 Interruption of service must occur at the times and for the duration stipulated by the Owner.
- .5 Keep service interruption duration to an absolute minimum. Carry out all preparatory Work, measurements, performance evaluation, and similar, without interruption of existing services.
- .6 If the Owner requires service interruptions during the night or on weekends, include any premium time in the Bid Price. No extra charges will be allowed at a later date for failure to include for premium time.

3.07 SALVAGED ITEMS

- .1 The following items included in the demolition scope are to be turned over to the Owner:
 - .1 None

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with requirements of Section 20 05 05 Mechanical Demolition.

1.02 WORK INCLUDED

- .1 Planning and phasing of construction activities that allow for the continued operation of the facility, or designated areas of the facility, during the construction period, including, but not necessarily limited to:
 - .1 Limitations on access to areas of the site,
 - .2 Limitations on use of the site,
 - .3 Coordination with site personnel,
 - .4 Maintenance of identified existing mechanical services during construction, or construction related activities, under control of the Contractor.

1.03 SUBMITTALS

- .1 Submit a Work Plan identifying how existing mechanical services identified to be maintained during construction activities are intended to continue in operation unless approved as part of a pre-planned scheduled service disruption. The Work Plan will address the following:
 - .1 Services being disrupted,
 - .2 Anticipated start of disruption, length of disruption, and date when mechanical services are anticipated to be re-established,
 - .3 Mechanical services in the operational areas of the facility outside of the construction site that will be affected during the service disruption,
 - .4 How the mechanical service, or portion of the mechanical service, will be maintained during construction activities, or construction related activities, under control of the Contractor,
 - .5 The Contractor's plan for remedial work to reestablish any required mechanical services to be maintained, but disrupted because of construction related activities, regardless of the effort to maintain the mechanical services intended by the Work Plan.
- .2 Carefully schedule all disruption and/or shutdowns and ensure that the duration of same is kept to the absolute minimum.
- .3 The Contractor shall not execute any work on site until the Work Plan has been submitted and reviewed by the Owner.

1.04 WORK IN EXISTING BUILDING

- .1 Areas of the facility identified in the Documents shall remain open and in operation during construction, or construction related activities under the control of the Contractor.
- .2 The existing building is to remain online and operational unless a service disruption is required to complete the work, and only then at a time and duration agreed to by the Owner. Where existing services such as water, drainage, fire protection, natural gas, heating, cooling, exhaust, make-up (ventilation) air, stand-alone controls, the Building Automation System (BAS) elements, and other similar mechanical services are required to be maintained during construction, the Contractor shall coordinate any required service shut-downs with the Owner as identified in the Work Plan and carry out the work at a time and in a manner acceptable to them.
- .3 Where disruption to life safety systems are required, provide a Fire Watch in accordance with Section 20 01 10 during the service shut down period and ensure that all systems are reactivated prior to leaving site at the end of each working day.

- .4 Should any temporary connections be required to maintain services during work in the existing building, supply and install all necessary material and equipment and provide all labour at no extra cost. Should any existing system be damaged, make full repairs, without additional cost, to the satisfaction of the Consultant.
- .5 Refer to Owner's General Requirements and Division 01 for phasing and staging of work and adhere to those requirements. Comply with instructions regarding working hours to maintain the building in operation.
- .6 The drawings indicating items of equipment to be deleted or relocated have been prepared as a guideline for the Contractor but shall not be construed as indicating every item of equipment or ancillary device. Be responsible for determining site conditions by personal examination prior to any service shutdown.
- .7 Where existing services mounted on, and/or concealed behind, existing finishes become exposed during the work and where these services are required to remain but will no longer be concealed behind or mounted on new finishes as part of the work, identify the services to the Consultant. Co-ordinate new service locations or means to conceal these services with the Consultant.

PART 2 - PRODUCTS

2.01 NIL

PART 3 - EXECUTION

3.01 FIRE PROTECTION SERVICES TO BE MAINTAINED

- .1 During construction the following Fire Protection Services are to be maintained:
 - .1 Fire extinguishers inside the wash bays and services are to remain in place.

3.02 PLUMBING AND DRAINAGE SERVICES TO BE MAINTAINED

- .1 During construction the following Plumbing and Drainage Services are to be maintained:
 - .1 Potable water supply to the building, including UV filtration and water softening equipment to maintain functionality of the wash bays and service bays is to remain operational,
 - .2 Floor drains and below grade sanitary drainage serving the wash bays and service bays, and related trap seal primer and venting systems are to remain operational,
 - .3 Wash bay and service bay roof drainage is to remain operational.
 - .4 Natural gas service to radiant heating system is to remain operational.
 - .5 Air compressor serving compressed air distribution piping in wash bay and service bay to remain operational.

3.03 HVAC SERVICES TO BE MAINTAINED

- .1 During construction the following Heating, Ventilation and Air-Conditioning (HVAC) Services are to be maintained:
 - .1 Wash bay and service bay exhaust fans are to remain operational.
 - .2 Wash bay and service bay make-up air intake louvers and dampers are to remain operational.
 - .3 Natural gas radiant heating serving the wash bays and service bays are to remain operational.
- .2 Where natural gas radiant heating in the wash bays and service bays cannot be maintained due to scheduled demolition of other services, provide temporary propane heaters in the wash bays and service bays in lieu of existing radiant heaters.

3.04 CONTROLS AND BAS SERVICES TO BE MAINTAINED

- .1 During construction the following Controls and Building Automation System (BAS) Services are to be maintained:
 - .1 Controls related to the wash bay and service bay exhaust fans, and make-up air dampers.

- .2 Controls related to the wash bay and service bay space heating.
- .3 Remote BAS monitoring and control of the following buildings on site, but unrelated to the construction:
 - .1 Existing salt storage building.
 - .2 Grey water system control panel monitoring and controlling storage tank and pumps adjacent to salt storage building.
 - .3 Existing sheds (four total, refer to site plan for location)

END OF SECTION 20 05 14

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 SCOPE OF WORK

- .1 Provision of electric heat tracing systems and equipment heating cables, components and controls to prevent pipelines from freezing as described in this Section.
- .1 Coordinate with the Electrical Trades all systems, equipment and devices.

1.03 QUALITY ASSURANCE

- .1 Electrical heat tracing work shall be performed by a qualified licensed electrician.
- .2 Unless stated otherwise, all electric heat tracing products, materials and equipment shall be ULC listed and ETL approved.

1.04 REFERENCE CODES AND STANDARDS

- .1 Comply with applicable Codes and Standards including the following:
 - .1 Requirements of the Authorities Having Jurisdiction ("AHJs").
 - .2 The Ontario Building Code ("OBC").
 - .3 The Ontario Electrical Safety Code ("OESC")
 - .4 Requirements of the Owner's Insurer.

1.05 SUBMITTALS

- .1 Submit fire protection system shop drawings to the regulatory authority for review and approval prior to submitting to the Design Consultant. Conform to the following requirements:
 - .1 submit shop drawings for all products specified.

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Trade Contractor is to review all discrepancies and verify the locations of all existing services that are being extended, and the routing of new services.
- .2 Report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Trade Contractor.
- .3 Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 ELECTRIC HEATING CABLE

- .1 The specifications are based on Raychem XL-Trace System.
- .2 Provide self-regulating heating cable consisting of two (2) 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field.
- .3 The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket with a braid of tinned-copper and an outer jacket of modified polyolefin (CR) as required by the electrical code.

- .4 Provide heating cable with self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40°F pipe temperature operation to 150°F pipe temperature operation.
- .5 The heating cable shall operate on line voltages of 120 and/or 208 volts without the use of transformers.
- .6 The heating cable shall be sized according to the table below. The required heating cable output rating is in watts per foot at 50°F. Heating cable selection is based on 1" fiberglass insulation on metal piping.

Pipe Size (in.)	Minimum Ambient Conditions (- 10°F)
3 in or less	5 watts
4 in	5 watts
6 in	8 watts
8 in	2 strips – 5 watts
12 in to 14 in	2 strips – 8 watts

- .7 Provide power connection, end seal, splice and feed kit components to be applied in the field.
- .8 Heating cable circuit shall be protected by a ground fault device for equipment protection. Coordinate breaker requirements with Division 26.

2.02 SYSTEM CONTROL

- .1 The system shall be controlled by a line sensing thermostat AMC-1A set at 40°F either directly or through an appropriate contactor.

2.03 ELECTRIC HEAT TRACING FOR FIRE PROTECTION SYSTEMS

- .1 Electric heat tracing used for fire protection system piping shall include supervision at the building fire alarm system for the following:
 - .1 Ground fault
 - .2 Low system temperature
 - .3 High system temperature
 - .4 Temperature sensor failure
 - .5 Primary controller failure
 - .6 Electrical continuity
 - .7 Loss of incoming supply voltage
 - .8 Engagement of secondary controller

PART 3 - EXECUTION

3.01 GENERAL

- .1 All wiring and conduit installation shall conform to governing Codes and Standards and shall be inspected, as required, by the Authorities Having Jurisdiction ("AHJ's). Make any corrections to the Work to comply with the requirements of the AHJ's in order to obtain approval for the Work.
- .2 Install all wire and conduit in a neat and secure manner in such a way that it is protected from damage, is not in conflict with mechanical or architectural components and allows for future changes and additions.
- .3 Provide wiring for electrical heat tracing systems to achieve a fully operational system as intended by the design.
- .4 Provide all required interlock connections, relays and control wiring.
- .5 Provide complete wiring diagrams of all circuits.

- .6 Identify all conduits, raceways, and junction boxes using colour bands. Colouring scheme shall be Owner's standard.
- .7 Identify system voltage, phase, neutral and grounding of all junction boxes, conduits and wiring.

3.02 INSTALLATION

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- .2 Prior to installation of heating cable system, verify that all piping which will be heat trace has passed all hydrostatic/pressure test and is signed off by the Consultant.
- .3 Secure the heating cable to piping with cable ties or fiberglass tape.
- .4 Prior to installing heating cable on the piping an insulation resistance test shall be performed by the installing contractor to ensure integrity of heating cable as describe in the installation & maintenance manual.
- .5 All heating cable ends shall be protected from moisture ingress until cable is terminated.
- .6 All heat tracing components including power connections, splices, tees, crosses or end seal must be installed above grade and protected from abuse or damage; electrical connections are not permitted to be installed below grade.
- .7 Contractor to furnish & install a 1" plastic conduit to six (6) o'clock position on the below ground water piping as a raceway for the heating cable to the electoral heat traced piping below grade. Conduit sweep shall be clamped to the piping as indicated on the drawings.
- .8 Heating Cable shall be installed in the six (6) o'clock position on all of the below ground, water piping.
- .9 Contractor to furnish & install ¾" plastic conduit from controller to the below ground, hydronic piping as a raceway for the temperature sensor. Conduit shall be strapped to the twelve (12) o'clock position/top of the water piping, extend a distance of 2'-0" on top of the pipe and sealed with a closed end cap as indicated on drawings.
- .10 Temperature sensor shall be installed inside of ¾" plastic conduit and pushed all the way to the closed end. Contractor to wire temperature sensor to C910-485 controller and be responsible for extended temperature sensor wiring as required by the site conditions.
- .11 Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.
- .12 Apply "Electric Traced" signs to the outside of the thermal insulation.
- .13 For heat tracing for fire protection piping, all products shall be ULC listed and FM approved meeting the requirements of applicable NFPA Standards.

3.03 TESTS

- .1 After installation and before and after installing the thermal insulation, subject heating cable testing using a 2500 Vdc Megger. Minimum insulation resistance shall be 20 to 1000 megohms regardless of length.

3.04 PIPING SYSTEMS WHICH REQUIRE HEAT TRACING AND INSULATION

- .1 Unless noted otherwise, provide electric heat tracing for piping subject to freezing. Piping located in an unheated or partially heated parking garage is considered as area subject to freezing.
- .2 Refer to the following table for piping systems which require heat tracing.

Piping System	Heat Trace	Insulation
Fire Protection – Sprinkler and Standpipe Systems:		
Drum Drips	Yes ⁽¹⁾	Yes
Drainage Systems:		
Sanitary	No ⁽²⁾	Yes
Notes:		
.1 Heat tracing used for fire protection system to be UL and ULC listed and FM approved meeting the requirements of NFPA 13 and 14 and the Owner's Insurer.		
.2 Sanitary P-traps, and sanitary drainage piping 10 ft (3m) downstream of P-trap, are required to be heat traced and insulated in unheated spaces.		

END OF SECTION

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- 3.01 VIBRATION ISOLATION INSTALLATION**

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 10 50 Basic Materials and Methods.

1.02 SCOPE OF WORK

- .1 Supply labour and materials required to isolate motor driven mechanical equipment as indicated on the drawings and specified herein, and guarantee the function of the materials and equipment supplied.
- .2 Supply labour and materials required to isolate piping systems connected to motor driven equipment.

1.03 SUBMITTALS

- .1 Submit shop drawings for all Vibration Isolation products Specified in this section of the Specifications.

1.04 QUALITY CONTROL

- .1 All vibration isolators and bases shall be supplied by an approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.
- .2 Provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The drawings shall bear the stamp and signature of the responsible supplier's technical representative.
- .3 The work shall be carried out in accordance with the specification and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

1.05 VIBRATION ISOLATION GENERAL REQUIREMENTS

- .1 All vibration isolators shall have either known undeflected heights or other markings so that after adjustment, when carrying their load, the deflection under load can be verified thus determining the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- .2 All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and shall be linear over a deflection range of 50 percent above the design deflection.
- .3 The ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 2.0.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATION

- .1 General:
 - .1 The static deflection of isolators shall be given in the equipment schedule and as specified.
 - .2 Vibration isolator sizes and layout shall be determined by the vibration isolator supplier.
 - .3 All mechanical equipment not specifically identified in this specification that contains rotating or vibrating elements shall be installed on Type P1 isolators.
 - .4 Elastomeric elements that will be exposed to temperatures below freezing shall be fabricated from natural rubber instead of neoprene.
 - .5 All isolators to be installed outdoors or exposed to weather shall be hot dipped galvanized and shall be furnished with neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.

- .6 Acceptable Manufacturer (All vibration isolators) (as listed or equal): Mason, Vibro-Acoustics, Vibron, Amber Booth
- .7 Model numbers for Mason isolators are indicated for reference purposes.
- .2 Elastomeric Pads
 - .1 Type P1 - neoprene waffle or ribbed; 5/16" (9 mm) minimum thick; 50 durometer; maximum loading 50 psi (350 kPa). Mason type W
 - .2 Type P2 - rubber waffle or ribbed; 5/16" (9 mm) minimum thick; 30 durometer natural rubber; maximum loading 60 psi (415 kPa). Mason type W.
 - .3 Type P3 - neoprene-steel-neoprene; 5/16" (9 mm) minimum thick neoprene bonded to 16 gage (1.71 mm) steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers. Mason type WSW.
 - .4 Type P4 - rubber-steel-rubber; 5/16" (9 mm) minimum thick rubber bonded to 16 gage (1.71 mm) steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers. Mason type WSW
 - .5 Pads to be selected for 15% strain.
- .3 Elastomeric Mounts:
 - .1 Type M1 - color coded; neoprene in shear; laterally stable maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces. All metal surfaces to be covered with neoprene. Mounts shall have leveling bolts rigidly secured to the equipment. Mason type ND.
 - .2 Pads to be selected for 15% strain.
- .4 Isolator Springs:
 - .1 Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with leveling devices.
 - .2 Cadmium plate for outdoor and internal air handling installations.
 - .3 Color code springs. The spring diameter shall be not less than 80% of the compressed height of the spring.
 - .4 Unless otherwise specified, the minimum static deflection for equipment mounted on grade slabs shall be 1" (25 mm) and the minimum static deflection for equipment mounted above the lowest level shall be 2" (50 mm).
 - .5 Two isolation pads sandwiching a 16 gage (1.71 mm) steel plate shall be bonded to the isolator base plate.
 - .6 Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If the base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve shall be installed under the bolt head between the steel washer and the base plate.
- .5 Spring Mounts:
 - .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
 - .2 Type M2 - stable open spring: support on bonded 1/4" (6 mm) minimum thick ribbed neoprene or rubber friction and acoustic pad. Mason type SLF.
 - .3 Type M3 - stable open spring: 1/4" (6 mm) minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; internal adjustment; equipment bolting not necessary. Mason type SLF.
 - .4 Type M4 - restrained stable open spring: supported on bonded 1/4" (6 mm) minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates. Minimum clearance of 1" (25 mm) shall be maintained around restraining boots and between the housing and the spring so as not to interfere with the spring operation. Limit stops shall be out of contact during normal operation, backed away from

- contact by at least 1/2" (12 mm); a neoprene washer shall be installed beneath the bolt head/washer used to restrain the isolator. Mason type SLR.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 51 lbs (23 kg) maximum.
 - .6 Spring Hangers:
 - .1 Color coded springs, rust resistant, painted box type hangers. Swivel arrangement to permit hanger box or rod to move through a 30° arc without metal to metal contact.
 - .2 Unless specified otherwise, the static deflection shall be 3/8" (9 mm), with a strain not exceeding 15%, and spring hangers to have minimum static deflection of 2" (50 mm).
 - .3 A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/8" (19 mm) larger than the diameter of the hanger rod.
 - .4 Type H1 - neoprene - in-shear. Mason type HD
 - .5 Type H2 - stable spring, elastomeric washer. Mason type 30
 - .6 Type H3 - stable spring, elastomeric element. Mason type 30N
 - .7 Riser Guide:
 - .1 For vertical isolated piping, riser guides shall be M-1 type isolators bolted to the vertical edge of a 90 degree steel angle. The angle shall allow the pipe to move axially but shall limit lateral movement to approximately +/- 1" (25 mm).
 - .8 Inertia Base Forms
 - .1 Type B1 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; provide metal pans integrally welded on sizes up to 8 feet (2400 mm) on smallest dimension, bolted on sizes over 8 feet (2400 mm) on smallest dimension; spring mounted units carried by gusseted height saving brackets welded to frame; and clear housekeeping pads by 2" (50 mm) minimum.
 - .2 Mechanical Contractor to provide concrete in accordance with section 20 05 10.
 - .3 Minimum thickness of isolation base forms to be in accordance with the following schedule.

Motor Size (HP)	Minimum Thickness (in.)
3 - 9	6
10 - 24	8
25 - 74	10

PART 3 - EXECUTION

3.01 VIBRATION ISOLATION INSTALLATION

- .1 Provide vibration isolation for new equipment as noted in the specification, listed in the schedule and shown on the drawings.
- .2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility.
- .4 Ensure that piping and ducting passage through walls and floors do not transmit vibrations. A minimum of 1" (25 mm) clearance shall be allowed around the entire perimeter of the penetration. The clearance shall be packed with fibreglass and sealed with non-hardening mastic on both sides.

- .5 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 1" (25 mm) minimum static deflection as follows:
 - .1 Up to NPS 4: first 3 points of support.
 - .2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 2" (50 mm).
- .6 Unless specified otherwise, isolators indoors need not be bolted to the floor. Where isolation is bolted to floor avoid short circuiting of sound pads by using vibration isolation rubber washers.
- .7 Provide suitable supports for all equipment which does not have a frame with adequate rigidity.
- .8 All steel bases shall clear the sub-bases by at least 2" (50 mm). All bases shall be blocked and shimmed level so that all ductwork and piping connections can be made to a rigid system, at operating level, before the isolation adjustment is made. The clearance shall be checked by the contractor to ensure that no scraps have been left to short circuit the vibration isolators.
- .9 There shall be a minimum of 4" (100 mm) clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.
- .10 Piping, ductwork, conduit or mechanical equipment shall not be hung from or supported on other equipment, pipes or ductwork installed on vibration isolators. It shall be supported on or suspended from building structure.
- .11 Equipment connected to fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Equipment should be blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims, and the Contractor shall confirm that the isolators for the fluid-filled pipes, pumps and other elements deflect the specified amounts and no more.
- .12 All wiring connections to mechanical equipment on isolators shall be made in a 360-degree loop: minimum conduit length: 3-ft (1 m). Cut any ties used to install this loop prior to adjusting the isolators.
- .13 Isolation Within Mechanical Room:
 - .1 Within the mechanical rooms, all equipment, piping and ductwork below DI department shall be suspended, supported and guided within the mechanical room by means or appropriate spring vibration isolators as described below and in the schedule. This includes ductwork, domestic water, heating, steam and chilled water/glycol pipes, etc. The only exclusion is fire protection piping. Pipes shall be supported by Type M3 or hung from the structure on Type H3 hangers (see Item 3 below).
 - .2 Piping in the mechanical equipment room that is connected only to machinery installed on neoprene isolators shall be either supported from the floor on Type M1 mounts or suspended from the structure on Type H1 hangers (see Item 3 below).
 - .3 Areas where only floor supports and spring mounts must be used or areas where spring hangers can be used are identified on the attached sketches.
- .14 Where a pipe run connects multiple items of equipment in the mechanical from the pipe isolators for the entire run shall be chosen to suit the connected equipment of greatest static deflection.

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 SCOPE OF WORK

- .1 Electrical materials, equipment and installation procedures shall conform to Ontario Electrical Safety Code as amended to date.
- .2 Provide all required motors, starters, motor control centres, contactors, disconnect switches, and control devices for the Mechanical Division of the Work.
- .3 Provide electric power wiring in conduit for equipment (connection of motors through starters and disconnects) provided as part of the Work.
- .4 Provide motor control wiring in conduit (at any required voltage) between starter panels and control components to achieve all performance requirements specified.
- .5 Provide all required power, control and communication wiring in conduits for items supplied by equipment manufacturers such as high level alarms, low water cut-offs, anti-vibration lock-outs, flow switches, remote and local temperature and humidity sensors, sump pump alternators, level controllers, water treatment equipment, and control wiring between starters and control panels.
- .6 Provide all required power, control and communication wiring in conduit for interface panels and sensors.
- .7 Provide all required power, control and communication wiring in conduit required for project. All wiring in connection with the control system shall be provided by the BAS Trades.
- .8 Provide control and communication wiring between Cooling Tower VFD and Cooling Plant Control System.
- .9 Provide control and communication wiring between Chillers and Cooling Plant Control System.
- .10 Provide control and communication wiring between Boilers and Boiler Sequencing Panel.
- .11 Provide power, control and communication wiring in conduit between cooling tower level control sensor and make-up water automatic control valve.
- .12 Provide protected (fire rated) control and communication wiring between fire pump automatic transfer switch (ATS) and emergency power generator control panel.
- .13 Coordinate with the Electrical Trades all systems, equipment and devices provided for the Mechanical Division of the Work.

1.03 REFERENCE CODES AND STANDARDS

- .1 Comply with applicable Codes and Standards including the following:
 - .1 Requirements of the Authorities Having Jurisdiction ("AHJs").
 - .2 The Ontario Building Code ("OBC").
 - .3 The Ontario Electrical Safety Code ("OESC")
 - .4 CAN/ULC-S524 - "Standard for the Installation of Fire Alarm Systems"
 - .5 Requirements of the Owner's Insurer.

1.04 SUBMITTALS

- .1 Submit shop drawings for all Motors, Motor Starters, and Motor Control Centers ("MCCs").
- .2 Submit a colour code for input/output point wiring, communication buses, and power wiring.

PART 2 - PRODUCTS

2.01 ELECTRIC MOTORS

- .1 CSA labelled, and except where specifically noted.
- .2 Unless noted otherwise, all motors ½ HP rated capacity and smaller shall be 120 volt, single phase, 60 cycles.
- .3 Unless noted otherwise, all motors ¾ HP up to and including 1½ HP rated capacity shall be 208 volt, 3 phase, 60 cycles.
- .4 Unless noted otherwise, all motors 2 HP rated capacity and larger shall be 600 volt, 3 phase, 60 cycles.
- .5 Refer Mechanical Equipment Schedules for exact details. Motors to meet NEMA standards for maximum sound level ratings under full load. Service factor on all motors to be 1.15.
- .6 Motor bearings: to be permanently lubricated ball type for motors up to and including 5 HP. Bearings for all motors over 5 HP to be self-aligning greaseable ball bearings sized to provide life of at least 50,000 hours L-10 life under belt driven service.
- .7 Single Phase Motors: Provide permanent split capacitor type.
- .8 Motors 20 HP and larger provide thermistor over temperature protection for each winding, wire in series, with leads terminated in the motor junction box.
- .9 Unless noted otherwise, all motors over 1/3 HP to be Open Drip Proof (“ODP”).
- .10 All motors over 1 HP to be high efficiency type with ratings based on statistically valid Quality Control procedures conforming to ANSI/IEEE 112 (Ref. 10), Test Method B (dynamometer), using NEMA MG1 (MG1-12.54 and MG1-12.55) (Ref.11), and conforming to efficiency ratings as defined in Table 10.4.1.A (a) under SB-10 of Ontario Building Code. Motors to be approved under the Canadian Electrical Safety Code.
- .11 Motors used in applications where Variable Frequency Drives (VFDs) are employed shall be complete with:
 - .1 motor winding insulation suitable for the intended application, and
 - .2 motor bearing protection rings (motor bearing grounding rings), to redirect stray shaft currents to the motor frame bypassing the motor bearings.
- .12 Acceptable electric motor manufacturers: WEG, US Motors, Westinghouse, General Electric, Baldor-Reliance, Brook-Crompton, Marathon

2.02 MOTOR STARTERS

- .1 Provide combination starters for all motors that are not already controlled by variable frequency drive (“VFD”), or have been included as an integral part of manufacturer’s packaged equipment.
- .2 Motor starters to be capable of starting associated motors under imposed loads. Confirm starter voltage matches motor prior to ordering.
- .3 Unless noted otherwise, all motor starters shall be complete with the following:
 - .1 Surface or recessed enclosure to suit application;
 - .2 Hand-Off-Auto (HOA) switch capable of receiving remote enabling signal from Building Automation System (BAS) in the Auto position;
 - .3 LED pilot lights;
 - .4 Integral control power transformer;
 - .5 Sufficient control terminal contacts, Normally Open (NO) and Normally Closed (NC), to achieve requirements outlined in the Control Sequences;
 - .6 Minimum two auxiliary contacts (1 x NO, 1 x NC) in addition to control terminal contacts described above;
 - .7 Reset push button;
 - .8 Capacity to apply physical lock-out capability.

- .4 In addition to the above, and unless noted otherwise, starters for fan motors shall be complete with the following:
 - .1 Fire Alarm Emergency Shut-down input to disable the starter from energizing the motor in either Hand or Auto mode.
 - .2 Firefighter's override operation that, when activated, will take priority over the Fire Alarm Emergency Shut-down and energize the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or auto.
- .5 Unless otherwise specified, starters for 1-phase motors are to be 115 volt, thermal overload protected manual starting switches.
- .6 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with overload relay per phase, and accessories in accordance with motor starter schedule.
- .7 Unless otherwise specified, starters for 3-phase motors 50 HP to 150 HP are to be reduced voltage, non-reversing, auto-transformer type starters each complete with one overload relay per phase, through door disconnect, and accessories in accordance with motor starter schedule.
- .8 Unless otherwise specified, starters for 3-phase motors 150 HP and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters each complete with one overload relay per phase, through door disconnect, and accessories in accordance with motor starter schedule.
- .9 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with adjustable 60 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .10 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with adjustable 60 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .11 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with adjustable 60 second time delay to allow fan(s) to coast down to stop before being operated in reverse rotation.
- .12 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:
 - .1 enclosures located in sprinklered areas – Type 2;
 - .2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;
 - .3 enclosures inside the building in areas subject – Type 3R, constructed of stainless steel;
 - .4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
 - .5 enclosures except as noted above – Type 1;
 - .6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.
- .13 Fuses are to be, unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.
- .14 Acceptable manufacturers are:
 - .1 Rockwell Automation Inc. - Allen-Bradley;
 - .2 Eaton;
 - .3 Siemens Canada;
 - .4 Schneider Electric.

2.03 WIRING

- .1 "RW90" single copper conductors to CSA C22.2 No. 38, 90 degrees C. X-link polyethylene insulated, colour coded.
- .2 "T90 Nylon", single copper conductor to CSA C22.2 No. 75, 600 volts, 90 degrees C rated, PVC insulated, nylon covered.
- .3 "RWU90" single copper conductor to CSA C22.2 No. 38, 1000 volts, maximum 90°C conductor temperature, -40°C minimum installation temperature, extra thickness X-link polyethylene (XLPE) insulation suitable for wet and buried installations, colour coded.
- .4 "TWU" single copper conductor to CSA C22.2 No. 75, colour coded, -40 °C rated, PVC insulated.
- .5 "AC-90" flexible armoured cable to CSA C22.2 No. 51 (R2004), with "RW-90" conductors and bare copper ground conductor.
- .6 "MI" two (2) hour fire rated, specifically ULC listed and labelled as fire resistive cabling, copper sheathed, copper conductor, mineral insulated cable.
- .7 Wiring Connectors:
 - .1 Armoured cable connectors to be proper squeeze type connectors and plastic anti-short bushings at terminations.
 - .2 Connectors for wire in conduit to be minimum 600 volts rated pressure type connectors.
 - .3 Connectors for main feeders to be two hole, long barrel, double crimp compression lugs.
 - .4 Lugs shall be copper.

2.04 CONDUIT

- .1 EMT (galvanized electrical metallic tubing) to CSA C22.2 No. 83. Install in climate controlled areas within ceiling spaces, wall spaces or surface mounted in non-finished areas.
- .2 Rigid galvanized steel to CSA C22.2 No. 45. Install in non-climate controlled areas, surface mounted, at heights subject to
- .3 Aluminum flex or galvanized steel liquid-tight metallic conduit to CSA C22.2 No. 56.
- .4 Rigid plastic conduit (PVC).

2.05 PULLBOXES AND JUNCTION BOXES

- .1 Galvanized or prime coat plated steel, suitable in all respects for the application and complete with screw-on or hinged covers as required, and connectors suitable for connected conduit.
- .2 Threaded cast Feraloy outlet boxes of an exact type to suit the application, each complete with screw-on gasketed cover.
- .3 Rigid plastic (PVC), junction boxes, and access fittings with solvent weld type joints and screw-on PVC covers.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 All wiring and conduit installation shall conform to governing Codes and Standards and shall be inspected, as required, by the Authorities Having Jurisdiction (AHJ's). Make any corrections to the Work to comply with the requirements of the AHJ's in order to obtain approval for the Work.
- .2 Install equipment, conduit and cables in a workmanlike manner to present a neat appearance to function properly to the satisfaction of the Consultant.
- .3 Replace work unsatisfactory to the Authorities Having Jurisdiction (AHJ's) and/or the Consultant without extra cost.
- .4 Protect from damage all equipment delivered to the site and during installation. Any damage or marking of finished surfaces shall be made good to the satisfaction of the Consultant.

- .5 Install all wire and conduit in a neat and secure manner in such a way that it is protected from damage, is not in conflict with mechanical or architectural components and allows for future changes and additions.
- .6 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement with due allowance therefore.
- .7 Make provision to accommodate future plant and equipment indicated on drawings.
- .8 Install runs parallel and perpendicular to building lines, in chases, behind furring or above ceilings, where such concealment is possible. In areas where systems are to be exposed install neatly and group to present a tidy appearance.
- .9 Provide power wiring for mechanical equipment, controls and where ever required to achieve a fully operational system as intended by the design.
- .10 Provide control wiring for all equipment provided or supplied as part of the Mechanical Division of the Work.
- .11 Provide all interlock connections and relays.
- .12 Provide complete wiring diagrams of all controls and pilot circuits.
- .13 Identify all conduits, raceways, pull boxes, and junction boxes using colour bands. Colouring scheme shall be Owner's standard.
- .14 Identify system voltage, phase, neutral and grounding of all pull boxes, junction boxes, conduits and wiring.

3.02 INSTALLATION OF ELECTRIC WIRING

- .1 Provide all required wiring and conductors unless otherwise specified or required, wiring from panel boards to wiring devices shall be sized for a 2% voltage drop. Bus bars, cables and wires shall be copper.
- .2 Where allowed, exposed wire shall consist of a minimum FT6 rated, Teflon covered cable and limited to distances as specified by the applicable Codes within individual fire compartment areas.
- .3 Ceiling space return air plenums shall contain no exposed wiring of any type.
- .4 Wiring joints shall contain no more than three wires of gauges within one size range apart. Mechanically crimp all joints. The use of "marrett" type connectors are restricted for joining two wires maximum of equal AWG and type only.
- .5 Cable ties shall be used to secure wire at equal distances and neatly trimmed according to manufacturers' recommendations. Black colour ties are required in non-conditioned areas of the building.
- .6 Separate all wiring for systems of different voltages and from different sources and do not run in common raceways. Maintain adequate shielding and separation between wiring for power and communication systems to prevent interference.
- .7 No two wires within common conduit systems shall be of the same colour unless they are similar, i.e. Whites for neutral power.
- .8 Use wiring methods, materials and devices that result in a safe, reliable and flexible electrical power, communication, data, and life safety system.
- .9 Colour code conductors throughout to identify phases, neutrals and ground by means of self-laminating coloured tape, coloured conductor insulation;
- .10 All control wiring must be identified with self-sticking wire markers, indicating I/O channels at panels, pull boxes, junction boxes, equipment and similar locations.
- .11 Install individual ground conductor in each conduit and/or raceway.
- .12 Provide Pyrotenax "MI" fire rated cable in accordance with OBC for power wiring and control wiring connected to designated Life Safety equipment. Wiring located only within the fire compartment where the equipment is located need not be fire rated.

- .13 Provide power, lighting, Building Automation System (BAS), high voltage distribution and other electrical wiring systems with unique colours in accordance with the Owner's colouring scheme. Major colour to be 100 mm wide and minor colour to be 50 mm wide.
- .14 Upon completion of the installation and prior to energization of components and systems, perform a complete inspection and testing to verify phase and polarity match of feeders with equipment and the tightness of power wiring terminations.

3.03 INSTALLATION OF CONDUIT

- .1 Install all wiring in conduit conform to the requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Install conduit and conductors concealed in all finished areas, and concealed to the degree made possible by finishes in partially finished and unfinished areas. Conduit may be exposed in unfinished areas such as Electrical and Mechanical Rooms.
- .3 All wiring within mechanical and equipment rooms shall be contained in thin wall electric metallic tubing ("EMT") conduit. The wiring shall not change colour, gauge, type (Solid/Stranded), or contain splices within the conduit pipe. All splicing shall occur at proper junction boxes. Maintain 20% spare capacity within conduit pipes for future wire and install nylon pull strings, secured at both ends, in all conduit.
- .4 Where conduit and/or conductors are exposed, arrange same to avoid interference with other work and parallel to the building lines. Where horizontal conduits and/or conductors are exposed, install as high as possible. Do not install conduit and/or conductors within 150 mm of "hot" pipes or equipment unless the conduit and/or conductors are associated with the equipment.
- .5 Provide conduit for all conductors except armoured cable and copper sheathed mineral insulated conductors, and except where cable tray, duct or similar raceway materials are provided. Unless otherwise specified or required, conduit shall be as follows:
 - .1 for feeders exceeding 208V (except concrete encasement), main distribution wiring in electrical, mechanical or other service rooms and for concealed conduit in exterior walls – rigid galvanized steel;
 - .2 for exposed conduit outside the building to surface mounted "FS" boxes and for semi-exterior areas such as loading docks – rigid galvanized steel;
 - .3 for exposed conduit mounted at a height of less than 1200 mm in electrical, mechanical or other service areas – rigid galvanized steel;
 - .4 for short branch circuit connectors to motorized equipment (minimum length 450 mm, maximum length 600 mm with 180° loop); galvanized steel flexible liquid-tight conduit;
 - .5 at points, where conductors cross building expansion joints – galvanized steel flexible conduit;
 - .6 in climate controlled areas, for conduit larger than 50 mm diameter containing distribution conductors or communication system conductors (fire alarm, telephone, etc.) except as noted above – EMT with separate insulated ground conductor;
 - .7 for conduit embedded in concrete or for low voltage conductors run underground – rigid PVC;
 - .8 for conductors in climate controlled areas and unless otherwise specified above – EMT.
- .6 Minimum EMT conduit size is 20mm (3/4").
- .7 Install low voltage wiring (unless otherwise required by Authorities Having Jurisdiction) in EMT with steel couplings and connectors.
- .8 Use rain tight connectors for surface mounted conduits.
- .9 Armoured cable ("BX") may be used for final connections from junction boxes to:
 - .1 motorized terminal devices suspended above ceilings;
 - .2 to vibrating equipment, such as transformers and motors.

- .10 The maximum length of any individual piece of BX cable is 3.0 metres.
- .11 Minimum flexible conduit size is 21mm (3/4") and maximum length of any flexible conduit run is 3.0 metres.
- .12 Install approved fire stopping to maintain all fire separations and as required by the Authorities Having Jurisdiction.
- .13 Vertical conduits and other raceways shall be curbed to prevent the flow of water between floors and to prevent water flowing down the outside of the conduit and raceways.
- .14 Provide a separate ground conductor in all plastic conduit.

3.04 INSTALLATION OF PULLBOXES AND JUNCTION BOXES

- .1 Provide junction boxes wherever required. All pull boxes and junction boxes must be accessible after the work is completed.
- .2 Provide pullboxes in conduit systems wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30 m in length, or with more than two (2) 90° bends shall be equipped with a pullbox installed at a convenient and suitable intermediate accessible location.
- .3 Accurately locate and identify all concealed pullboxes and junction boxes on "as-built" record drawings. Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by spray painting the outside of the covers with colour coded identification. In addition to painting miscellaneous signal boxes, clearly identify the specific system in which the box is installed.
- .4 Cover boxes in fire walls with aluminium tape and seal with caulking.
- .5 Unless otherwise specified boxes shall be as follows:
 - .1 boxes in rigid conduit and EMT in climate controlled areas shall be stamped galvanized or prime coated steel;
 - .2 boxes in non-climate controlled areas connected to rigid conduit and boxes in perimeter walls where insulation and vapour barrier is present shall be "Condulet" cast gasketed boxes;
 - .3 boxes in plastic conduit shall be rigid PVC plastic boxes.
- .6 Colour-code all junction boxes using coloured duct tape on the cover. Neatly identify the relevant system and circuit ID using permanent marker pen. Identify parallel conduit runs at common locations.

3.05 DOCUMENTATION AND SYSTEMS ACCEPTANCE

- .1 Provide Operating and Maintenance (O&M) Manuals in accordance with Section 20 01 10, and the following:
 - .1 A set of as-built drawings including complete wiring and connections diagrams
 - .2 Letters of Owner's Instructions
 - .3 Final ESA Certificate
 - .4 Representative certificates for:
 - .1 Building Automation System (BAS)
 - .2 Fire Alarm System as integral part of Fire Protection System detection and control system
- .2 Ensure that O&M Manuals are specific and apply to the models and types of equipment provided.
- .3 Ensure the Work has met requirements outlined in the Article entitled 'Completion' found in Section 20 01 10.

END OF SECTION

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- 3.01 INSTALLATION OF VARRIABLE FREQUENCY DRIVES**

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements and all Documents referenced therein.

1.02 SCOPE OF WORK

- .1 Provide all required Variable Frequency Drives ("VFDs") for motorized equipment requiring varying speed control as noted on the equipment schedules and/or on the control schematics.

1.03 SUBMITTALS

- .1 Submit shop drawings for all VFDs.

PART 2 - PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

- .1 VFDs to be rated to operate from 3 phase input voltage of 208 or 600 volts \pm 10%, as indicated in the Documents, and frequency range from 48 to 63 Hz. In addition, a tolerated voltage window to allow system to operate from a line of +30% to -35% nominal voltage. System to incorporate circuitry that allows drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
- .2 VFDs to employ a full wave rectifier to prevent input line notching and operate at a minimum fundamental input power factor of 0.97 at all speeds and loads.
- .3 VFDs efficiency to be 97% or better at full speed and load.
- .4 Output voltage and current ratings to match adjustable frequency operating requirements of standard 3ph, 60Hz, NEMA design B inverter-duty motors in compliance with NEMA-MG1, Part 31 Standard. Overload current capacity for variable torque overload capacity to be 110% of rated current for 1 minute out of 10 minutes and 130% for 2 seconds. Output frequency to be adjustable between 0 and 500 Hz.
- .5 Open loop static speed regulation to be 0.1% to 0.3% (10% of motor slip). Dynamic speed accuracy to be 4%-sec. or better open loop.
- .6 When a suitable motor is used, drive provides breakaway torque equal to 200% of rated motor torque. Torque response time to be 5 ms or less.
- .7 Enclosures:
 - .1 in climate controlled areas – minimum NEMA 12;
 - .2 in non-climate controlled areas – minimum NEMA 3R.
 - .3 outdoor installations – minimum NEMA 4X
- .8 Harmonic Filters and Reactors:
 - .1 VFDs to include internal 5% impedance AC line reactor (or equivalent 5% impedance dual positive and negative DC bus reactors) provided as a standard to reduce input current harmonic content and provide isolation from power line transients and to reduce RFI emissions.
 - .2 VFDs serving motors sized 18 kw (25 HP) or more to be provided with harmonic filters to limit harmonics distortion produced by each drive to following maximum levels as measured on input side of drive:
 - .1 Total harmonic distortion (voltage) – 5%;
 - .2 Total harmonic distortion (current) – 10%.
 - .3 Harmonic filter shall have the following features:
 - .1 passive inductor/capacitor network;

- .2 all Harmonic filters be provided with a capacitor contactor that allows the capacitors to be removed from the circuit if the VFD is operating below 40% speed;
 - .3 full load efficiency of harmonic mitigation equipment / VFD combination to be greater than 96%;
 - .4 copper wiring;
 - .5 220°C system insulation class and temperature rise of 130°C;
 - .6 anti-vibration pads between reactor or transformer core and enclosure;
 - .7 ventilated, sprinkler proof NEMA-3R enclosure.
 - .8 where VDFs with bypass features are provided, harmonic filters shall be wired to be bypassed when the VFD is in the bypass mode.
 - .9 manufactured and tested in accordance with latest applicable standards of ULC, CSA and NEMA;
 - .10 treat characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.);
- .9 Controls And Adjustment Functions
- .1 Include for following:
 - .1 programmable critical frequency lockout ranges to prevent VFD from operating load continuously at an unstable speed;
 - .2 proportional integral derivative (PID) speed loop regulators with an auto tune function as well as manual adjustments; PID setpoint controllers to allow pressure or flow signals to be connected to VFD, using microprocessor in VFD for closed loop control; includes 250 ma of 24 VDC auxiliary power and capability of loop powering a transmitter supplied by others; two parameter sets for first PID that allow sets to be switched via a digital input, serial communications or from keypad for night setback, summer/winter setpoints, etc; independent, second PID loop that can utilize second analogue input and modulate analogue outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.); setpoints, process variables, etc. to be accessible from serial communication network;
 - .3 programmable analogue inputs that accept current or voltage signals;
 - .4 programmable analogue outputs (0-20ma or 4-20 ma), that may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data;
 - .5 programmable digital inputs;
 - .6 programmable digital Form-C relay contact outputs for programmable on and off delay times and adjustable hysteresis; rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS;
 - .7 run permissive circuit - for damper or valve control; dry contact closure that will signal damper to open (VFD motor does not operate); when damper is fully open, a normally open dry contact (end-switch) closes; closed end-switch is wired to a VFD digital input and allows motor operation; two separate safety interlock inputs, when either is opened, motor to coast to stop, and damper to close;
 - .8 two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps;
 - .9 firefighter's override input - upon receipt of a contact closure from fireman's control station, VFD operates in one of two modes: operate at a programmed predetermined fixed speed or operate in a specific firefighter's override PID algorithm that automatically adjusts motor speed based on override set point and

feedback; mode overrides all other inputs (analogue/digital, serial communication and keypad commands), except customer defined safety run interlock, and forces motor to run in one of the two modes; "Override Mode" to be displayed on control panel; upon removal of override signal, VFD resumes normal operation.

.10 Operator Control Panel

- .1 front mounted plug-in operator control panel consisting of keypad, multi-line backlit LCD display for programming and fault diagnostics;
- .2 keys (switches) for HAND, OFF, AUTO, and manual speed control INCREASE/DECREASE;
- .3 menu navigation and parameter selection keys for custom programming;
- .4 HELP key for assistance with programming and troubleshooting;
- .5 date and time clock - clock to have a battery backup with 10 years minimum life span; clock to be used to date and time stamp faults and record operating parameters at time of fault; if battery fails VFD I automatically reverts to hours of operation since initial power up; clock also to be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays; VFD to have a digital input that allows an override to time clock (when in off mode) for a programmable time frame; four (4) separate, independent timer functions that have both weekday and weekend settings;
- .6 parameter names, fault messages, warnings and other information to be displayed in complete words or standard abbreviations to allow user to understand what is being displayed without use of a manual or cross reference table, as follows:
 - .1 "HAND" position to start drive and modify reference frequency by use of INCREASE/DECREASE keys;
 - .2 "OFF" position stops drive;
 - .3 "AUTO" position allows drive to be started or stopped using whichever remote start/stop command configured; drive speed controlled by external speed reference input or by PID controller.
 - .4 applicable operating values to be capable of being displayed in engineering (user) units; operating displayed include:
 - .1 Output Frequency;
 - .2 Motor Speed (RPM, %, or Engineering units);
 - .3 Motor Current;
 - .4 Drive Temperature;
 - .5 DC Bus Voltage;
 - .6 Output Voltage.

.11 Protective Functions:

- .1 For each programmed warning and fault protection function, keypad displays a message in complete words or standard abbreviations. Three most recent fault messages and times are stored in drive's fault history.
- .2 VFDs include metal oxide varistors (MOV's) for phase to phase and phase to ground line voltage transient protection.
- .3 Short circuit current rating of the entire VFD assembly (VFD and bypass, when provided), 100,000 amps to be provided per UL 508C without relying on line fuses.
- .4 Ground fault protection, motor phase loss protection and phase unbalance protection to be provided. Single phase protection to be provided on input and output.
- .5 VFDs to provide electronic motor overload protection qualified per UL 508C.

- .6 Protection to be provided for AC line or DC bus overvoltage at 130% of maximum rated or under-voltage at 65% of minimum rated.
- .7 Stall protection to be programmable to provide a warning or stop VFD after motor has operated above a programmable torque level for a programmed time limit.
- .8 Underload protection to be programmable to provide a warning or stop VFD after motor has operated below a selected underload curve for a programmed time limit.
- .9 Over-temperature protection to provide a warning if power module temperature is less than 5C below over-temperature trip level.
- .10 Input terminal to be provided for connecting a motor thermister (PTC type) to drive's protective monitoring circuitry. An input to also be programmable to monitor an external relay or switch contact.
- .11 VFDs through 56 kW (75HP) to be protected from damage from input and output power miss-wiring. VFD to sense this condition and display an alarm on control panel.
- .12 EMI / RFI filters to be provided as per standard EN 61800-3.
- .13 Automatic reset feature to automatically reset selected faults and attempt to restart drive based on control parameters such as adjustable time delays, number of restart attempts and duration of restart attempts. Faults include following:
 - .1 Overcurrent;
 - .2 Overvoltage;
 - .3 Under-voltage;
 - .4 Analogue input signal reference loss;
 - .5 External fault.
- .14 Additional built-in protection circuits include:
 - .1 Overcurrent trip limit;
 - .2 Under-voltage trip limit;
 - .3 Microprocessor fault;
 - .4 Keypad control panel loss;
 - .5 Serial communication loss;
 - .6 External fault interlock inputs;
 - .7 Adjustable output frequency and motor speed limits;
 - .8 Pass code parameter change protection;
 - .9 Keypad operator control lockout.
- .12 VFD Bypass
 - .1 Provide a complete factory wired and tested bypass system consisting of an output contactor and bypass contactor, service (isolation) switch and VFD input fuses are required. Bypass designs, which have no VFD only fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted.
 - .2 The bypass enclosure door and VFD enclosure must be interlocked such that input power is turned off before either enclosure can be opened. The VFD and Bypass as a package shall have a cUL listed short circuit rating of 100,000 amps and shall be indicated on the data label.
 - .3 Door interlocked padlockable disconnect switch that will disconnect all input power from the drive and all internally mounted options.

- .4 Bypasses shall be either electromechanical or electronic; electromechanical bypass shall utilize three (3) contactor bypass circuits (relays and contactors) to switch and to identify status; electronic bypasses shall meet the requirements of the following paragraphs:
- .5 The following operators shall be provided:
 - .1 Bypass Hand-Off-Auto (H-O-A);
 - .2 Drive mode selector and light;
 - .3 Bypass mode selector and light;
 - .4 Bypass fault reset
 - .5 Bypass LDC display, 2 lines, for programming and status / fault / warning indications
- .6 Motor protection from single phase power conditions - The Bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in Bypass mode are not acceptable.
- .7 The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage as a minimum. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
- .8 The Bypass system shall NOT depend on the VFD for bypass operation. The bypass shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the enclosure for repair / replacement.
- .9 Serial communications – the bypass and VFD shall be capable of being monitored and or controlled via serial communications. Provide communications protocols as required to communicate with selected Building Automation System in the bypass controller.
- .10 BACnet Serial communication bypass capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, bypass current (in amps), bypass kilowatt hours (resettable), bypass operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relays output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional bypass status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, and bypass selected. The DDC system shall also be able to monitor if the motor is running under load in both VFD and bypass (proof of flow) in the VFD mode over serial communications or Form-C relay output. A minimum of 40 field parameters shall be capable of being monitored in the bypass mode.
- .11 Run permissive circuit - there shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, time-clock control, or serial communications) the VFD and bypass shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD system input and allows motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.
- .12 The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor operation shall be indicated on the Bypass LCD display as well as over the serial communications protocol.
- .13 The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. This will allow VAV boxes to be driven open

- before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
- .14 The bypass control shall be programmable for manual or automatic transfer to bypass. The user shall be able to select via keypad programming which drive faults will generate an automatic transfer to bypass and which faults require a manual transfer to bypass.
- .15 There shall be an adjustable motor current sensing circuit for the bypass and VFD mode to provide proof of flow indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and on a relay output contact closure.
- .16 The bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs.
- .17 The relay outputs from the bypass shall be programmable for any of the following indications:
- .1 System started;
 - .2 System running;
 - .3 Bypass override enabled;
 - .4 Drive fault;
 - .5 Bypass fault;
 - .6 Bypass hand-Off-Auto (H-O-A) position;
 - .7 Motor proof of flow (broken belt);
 - .8 Overload;
 - .9 Bypass selected;
 - .10 Bypass run;
 - .11 System started (damper opening);
 - .12 Bypass alarm;
 - .13 Over temperature
- .18 The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.
- .19 Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
- .20 The user shall be able to select the text to be displayed on the keypad when the safety opens.
- .13 Acceptable Manufacturers:
- .1 Danfoss
 - .2 ABB
 - .3 Eaton/ Cutler-Hammer
 - .4 Rockwell Automation/ Allen-Bradley
 - .5 Johnson Controls
 - .6 Siemens
 - .7 Toshiba
 - .8 Hitachi

PART 3 - EXECUTION

3.01 INSTALLATION OF VARIABLE FREQUENCY DRIVES

- .1 VFD installation shall conform to all governing Codes and Standards and shall be inspected, as required, by the Authorities Having Jurisdiction ("AHJ's). Make any corrections to the Work to comply with the requirements of the AHJ's in order to obtain approval for the Work.
- .2 Meet Manufacturer's installation instructions.
- .3 Arrange for the manufacturers technical representative to inspect the installation of each drive and to commission operation with start-up and testing procedures. Provide coordination of control sequences for start-up and testing.
- .4 Properly ground the electrical system as per manufacturer's instructions.
- .5 Provide a separate steel conduit/shielded wiring for all supply, line load and control wiring.
- .6 Install the drive not more than 10m (30ft.) from the motor. The length of wiring connection shall not exceed 10m (30ft.). Provide support for the variable frequency drive in the vicinity of the motor as required.
- .7 Start-up Service:
 - .1 The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory trained certified technician. The commissioning personnel shall be the same personnel that will provide service and warranty repairs at the customer's site.
 - .2 The manufacturer shall provide four hours of customer operator training on operation and service diagnostics at the time of equipment commissioning.
 - .3 Drive manufacturer shall provide as much assistance is required to the air balance contractor to set the drives to provide the specified air flow.

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- 3.04 HYDRONIC SYSTEM BALANCING**
- 3.05 DOMESTIC WATER SYSTEMS**
- 3.06 REPORTS**

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements and all Documents referenced therein.

1.02 GENERAL INSTRUCTIONS

- .1 Testing Adjusting and Balancing ("TAB"): means to test, adjust and balance all systems, including equipment, to perform in accordance with Contract Documents.
- .2 Follow start-up procedures as recommended by Manufacturer.
- .3 Special start-up procedures may be specified elsewhere.

1.03 SITE INSPECTIONS AND SUBSEQUENT MEETINGS

- .1 Schedule once a month, site visits to correspond with the weekly site meeting.
- .2 After each site visit submit a written report to the Construction Manager and Mechanical Consultant.
- .3 Site visits shall commence at the start of the air distribution work and be spread over the construction period up to the start of the balance of the work.
- .4 If work requiring correction is discovered during an inspection, be sure that the required correction work is clearly indicated in the report.
- .5 In addition to site meetings and inspections specified above, attend, when requested by the Consultant, at the TAB Contractor's expense any other meetings where the TAB Contractor's presence is required.

1.04 ASSISTANCE FROM MECHANICAL TRADE CONTRACTOR

- .1 The Mechanical Trades, and their Sub-trades, shall provide the TAB Trades all of the assistance required to complete the TAB Trade's scope of Work. This shall include but not be limited to:
 - .1 Provision of all required shop drawings and fan and pump curves.
 - .2 Provision of all required test ports.
 - .3 Provision of all required specialty Trades (Sheet Metal Trades, Plumbing Trades, Building Automation (BAS) Trades, and similar) as may be necessary to complete TAB Work.
 - .4 All assistance required to balance variable speed systems in accordance with the design.

1.05 QUALIFICATIONS

- .1 The TAB agency shall be a current member in good standing with either the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) or National Building Comfort Testing Association (NBCTA).

1.06 REFERENCE STANDARDS

- .1 Perform TAB Work for complete mechanical systems over entire operating range in accordance with most stringent conditions of selected standard:
 - .1 AABC (Associated Air Balance Council).
 - .2 ASHRAE (American Society of Heating Refrigerating & Air Conditioning Engineers).
 - .3 NABC (National Air Balance Council).
 - .4 SMACNA (Sheet Metal & Air Conditioning Contractors National Association).
 - .5 Specifications herein or elsewhere in the Contract Documents.
- .2 If these Contract Documents set forth more stringent requirements than the Reference Standards, these Contract Documents shall prevail.

1.07 SCOPE OF WORK

- .1 Provide all labour, materials, products, equipment and services to test, adjust and balance all air and hydronic systems to verify conformance to specified quantities and to the design intent of the mechanical system.
- .2 The following systems and or equipment are included in the Scope of Work:
 - .1 Air Systems:
 - .1 Air Handling Units
 - .2 Return Fans
 - .3 Exhaust Fans
 - .4 Supply Fans
 - .5 Transfer Air Fans
 - .6 Zone Branch and Main Ducts
 - .7 Diffusers, Registers and Grilles
 - .8 Coils (Air Temperatures and Flow)
 - .2 Hydronic Systems:
 - .1 Heat Pumps
 - .2 Chillers
 - .3 Cooling Towers
 - .4 Pumps
 - .5 System Mains and Branches
 - .6 Heat Exchangers
 - .7 Chilled Water and Heating Coils (Water Temperature and Flow)
 - .8 Reheat Coils in Terminal Units
 - .3 Potable Water Systems:
 - .1 Domestic Booster Pumps
 - .2 Domestic Hot Water Recirculation
 - .3 Domestic Hot Water Heaters
 - .4 Pressure Reducing Stations

1.08 FINAL BALANCING

- .1 Start final TAB Work only when:
 - .1 building exterior envelope is complete and closed in;
 - .2 rooms requiring a relative differential relative pressure performance have doors, windows, and finishes complete, and sealing and caulking of any room envelope penetrations is complete;
 - .3 permanent power is available;
 - .4 construction of mechanical systems is essentially completed.

1.09 RELATIVE DIFFERENTIAL PRESSURE BALANCING

- .1 The TAB contractor shall ensure that each room (noted with relative pressure required) shall have the noted pressures. The final balanced condition of each area, zone and room as shown and indicated in the project drawings shall include testing and adjusting of pressure conditions and dynamic balancing of air flow to achieve the specified and indicated values.
- .2 TAB contractor shall adjust the system(s) as required to maintain room pressurization. The TAB contractor shall install, where required, new sheaves and belts to facilitate these adjustments to place the operating position of the fan in an efficient operating position.

- .3 TAB Contractor shall adjust the outside air, return air and exhaust air dampers to provide the correct amount of outside air to maintain system pressurization.

1.10 ACCURACY

- .1 The accuracy of measurements shall be in accordance with AABC or NEBB Standards or +5%, whichever is more stringent.
- .2 Instrument calibration shall be in accordance with referenced standards and shall have been completed within three (3) months of commencement of TAB Work.

1.11 SUBMITTALS

- .1 Submit shop Testing Adjusting and Balancing ("TAB") Reports to the Consultant for review.
- .2 All reports shall include instrument calibration certificates, a report summary and remarks section explaining the rationale for how the system was configured for testing, and a listing of any deficiencies.
- .3 Format to be in accordance with referenced standard listed above, but using design drawing units.
- .4 Reports shall be indexed as follows:
 - .1 Air Systems:
 - .1 Summary
 - .2 Procedure
 - .3 Instrumentation
 - .4 Drawings
 - .5 Equipment/Component Summary
 - .6 Fan data sheets
 - .7 Fan curves
 - .8 Air handling unit profile data
 - .9 Traverse data and schedule
 - .10 Outlets data summary and schematic (per system)
 - .11 Relative Space Pressurization
 - .12 Fume hood
 - .2 Hydronic Systems:
 - .1 Summary
 - .2 Procedure
 - .3 Instrumentation
 - .4 Drawings
 - .5 Equipment/Component Summary
 - .6 Pump data sheets
 - .7 Pump curves
 - .8 Pump profile data
 - .9 Balancing valve summary and schematic (per system)
 - .10 Coils (heating and cooling) per system.
- .5 Produce "as-constructed" full system schematics and floor plans identifying the location where all measurements were taken and the resulting flows that were obtained. Use as-built drawings for reference.

- .6 Submit two (2) copies of preliminary TAB reports, each in "D" ring binders, complete with index tabs for verification and approval of Consultant.
- .7 Submit two (2) hard copies of final TAB reports each in "D" ring binders, and one (1) copy of final TAB report on a USB memory stick after approval by the Consultant.
- .8 Obtain the shop drawing for each fan system. Mark the actual operating point on the fan curve for each fan. Include the fan curves for each fan in the balancing report.
- .9 Obtain the shop drawing for each pump system. On the pump curve for each pump mark the actual operating point on the curve. Include the pump curves with superimposed power draw, rpm and impeller size.

1.12 VERIFICATION

- .1 Reported measurements shall be subject to verification by Consultant. Provide instrumentation and manpower to verify results of up to 30% of all reported measurements. Number and location of verified measurements to be at discretion of the Consultant.
- .2 A measured flow deviation of more than 10% between the verification reading and the reported data shall be considered a failure of the verification procedure.
- .3 A failure of more than 10% of the selected verification readings shall result in the rejection of the report as unacceptable.
- .4 Should the report be rejected, the TAB Trades shall rebalance all systems, submit new certified reports and make a re-inspection at no additional cost to the Owner.
- .5 Bear costs to repeat TAB Work, as required, to the satisfaction of the Consultant.

1.13 SETTINGS

- .1 Lock and permanently mark settings as required by reference Standards.

1.14 TAB COMPLETION

- .1 TAB to be considered complete only when final reports have 'Reviewed' status from Consultant.
- .2 Confirm that all flow stations are providing accurate measurements as described in the Design Documents.

1.15 AIR MOVING

- .1 General:
 - .1 Measurements as required by Systems referenced standards.
 - .2 Due to the extent of the hard ceilings some areas will be required to be pre-balanced prior to the installation of the drywall ceilings.
 - .3 Provide face velocity test and smoke test for fume hoods according to ASHRAE 110.
 - .4 Mechanical Contractor to provide all required parts, belts and adjustments for all systems as deemed necessary to complete the required balancing.
- .2 Measurements:
 - .1 Air velocity.
 - .2 Static pressure.
 - .3 Velocity pressure.
 - .4 Temperature:
 - .1 Dry bulb;
 - .2 Wet bulb;
 - .3 Dew Point (where relevant to control sequences).
 - .5 Cross sectional area.
 - .6 RPM.

- .3 Electrical power:
 - .1 Voltage
 - .2 Current draw.
- .4 Location of Equipment Measurements:
 - .1 Inlet and outlet of each:
 - .1 Fan
 - .2 Coil
 - .3 Filter
 - .4 Damper
 - .5 Flow Station
 - .6 Other auxiliary equipment
- .5 Location of System Measurements:
 - .1 Main ducts.
 - .2 Main branch ducts.
 - .3 Sub-branch ducts.
 - .4 Each supply, exhaust and return air inlet and discharge.
 - .5 Other auxiliary equipment.
 - .6 All areas served by system.
 - .7 Before and after the silencers.

1.16 HYDRONIC SYSTEMS

- .1 Provide Hydronic Systems TAB measurements as required by referenced standards, including, but not limited to, the following requirements:
- .2 Measurements:
 - .1 Flow
 - .2 Pressure
 - .3 Temperature
 - .4 Specific gravity
 - .5 RPM
 - .6 Electrical power:
 - .1 Voltage.
 - .2 Current draw.
- .3 Location of equipment measurements:
 - .1 Inlet and outlet of each:
 - .1 Coil
 - .2 Chiller
 - .3 Heat Pump
 - .4 Pump
 - .5 Heat Exchanger
- .4 Heating and Cooling System:
 - .1 Flow and set point at each circuit balancing valve.

- .2 Pump
- .3 Balancing valves.
- .4 Control valves.
- .5 Balancing Pumps:
 - .1 For constant volume systems the TAB Trades shall open the main balancing valves in the system and measure the flow for each pump system with the system running at its maximum capacity.
 - .2 The TAB Trades shall submit a preliminary report indicating the operating point for each pump.
 - .3 For variable volume systems the TAB Trades shall adjust the variable frequency drive to provide the correct flow to the system. The TAB Contractor shall identify the speed that the variable frequency drive is set at to achieve this flow rate on the balancing report.

PART 2 - PRODUCTS

2.01 NIL

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- .1 Costs to perform Testing, Adjusting and Balancing (TAB) work for air and hydronic systems to be included in the Tender for the Mechanical Work.
- .2 TAB Work shall be carried out by an independent balancing firm specializing in air and water balancing, acceptable to the Consultant, to undertake this work as follows:
 - .1 Provide personnel to review working drawings, make site visits, prepare reports and take responsibility for measuring and adjusting all air supply, exhaust, return and transfer systems and water and other fluid pumping systems operate in accordance with specified requirements with tolerance of +/- 5%
 - .2 Review and check working drawings to ensure that modifications, if required, are implemented prior to execution of work.
 - .3 Provide inspections during the course of construction and issue reports making whatever recommendations are necessary in the interests of achieving specified pumping, heat transfer and air balance.
 - .4 When the work is sufficiently completed, inspect, check and test all pump and fan systems. Also cooperate with the BAS Subcontractor to achieve required air quantities where devices such as modulating dampers and hydronic valves are installed.
 - .5 Provide assistance to the Consultant for on-site spot verification of air and water balance report.
- .3 TAB shall be conducted in the presence of the Commissioning Authority and/or the Owner's Project Manager, or designated representative.
- .4 The TAB Trades shall confirm that the flow stations provided in the supply, return and exhaust air ductwork are measuring accurate readings. The variable speed drive shall be adjusted to allow for measurements at 50%, 75% and 100% flow. The flow displayed by the flow stations shall be confirmed to be accurate. Provide in the balancing report the results of the three point calibration.
- .5 Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levers, and similar controls and devices shall be physically marked to show final settings.

3.02 PREBALANCING

- .1 The TAB Trades shall preset the balancing dampers prior to the installation of the drywall ceilings by either running the air handling unit at 100 % outside air (if unit is available) or providing a portable fan to provide supply air at the required static pressure.

- .2 Once the system has been prebalanced the balancing dampers that will be located above the drywall ceilings shall be securely locked in place.
- .3 System air flows shall be confirmed once the space has been completed.

3.03 AIR BALANCING

- .1 Perform air balancing in accordance with current NBCTA, NEBB or AACB procedural standards by adjusting fan speed. Use damper throttling only in systems where fan motor is less than 1 HP or where throttling results in no greater than one (1) additional fan HP over a reduced RPM condition.
- .2 Where ductwork is subject to static pressure in excess of 75mm.wg (3 in.wg), leak test 25% minimum of total installed duct area of all representative sections of the total system. All testing to conform to requirements of HVAC Duct Leakage Test Manual, 1985, Sections 5 and 6 and tested duct leakage class at a test pressure equal to the design duct pressure class rating to be equal to or less than leakage Class 6 as defined in 4.1 of Ref. 35.
- .3 Provide Dial 1000 or Dial 2000 or acceptable alternative, duct pilot tube test opening enclosures for installation by the Sheet Metal Trades. Provide all required test opening locations and installation instructions to the Sheet Metal Trades.
- .4 The TAB Contractor shall confirm that the flow stations provided in the supply, return and exhaust air ductwork are measuring accurate readings. The variable speed drive shall be adjusted to allow for measurements at 50%, 75% and 100% flow. The flow displayed by the flow stations shall be confirmed to be accurate. Provide in the balancing report the results of the three point calibration.
- .5 After inspection and tests, report all required replacement of sheaves and belts and all required adjustments and ductwork modifications to achieve system performance as specified.
- .6 Fans and Air Handling Systems
 - .1 Verify that all ductwork, dampers, grilles, registers and diffusers have been installed per design.
 - .2 Balance air handling systems at minimum outdoor air quantities. On completion of TAB procedures, retest at maximum outdoor air quantities.
 - .3 Test and adjust fan RPM to achieve design flow.
 - .4 Test and record motor voltage and amperage. Compare data with nameplate limits.
 - .5 Perform pitot tube traverse at all main and branch ducts. Compare traverse total with measured outlet total to determine actual duct leakage.
 - .6 Test and adjust minimum outdoor and relief air volumes.
 - .7 Test and record system static pressure profile of each air handling system at minimum outdoor air volume. Note coil (i.e. wet or dry) and filter condition of time of testing.
 - .8 Test and record entering and leaving air conditions for each heat transfer coil and device. Simulate conditions to achieve winter or summer design parameters.
 - .9 Test and record settings of motor thermal overload devices. Adjust settings where required.
- .7 Air Distribution and Terminals
 - .1 Adjust duct distribution to obtain specified air quantities. At least one zone balancing damper shall be completely open. Multi diffuser or grille branch ducts shall have at least one volume damper completely open.
 - .2 Test and adjust each air terminal to obtain specified flow. Adjust deflectors and pattern controllers to eliminate drafts.

3.04 HYDRONIC SYSTEM BALANCING

- .1 Perform hydronic system balancing by minor throttling for pumps that are less than 7.45 kW (10 HP) provided this results in a power draw of no greater than 10% of that required if the impeller were trimmed. For pumps greater than 7.45 kW (10 HP), the same limit applies but in no case is it to exceed 2.23 kW (3 HP). In either case where these limits are exceeded by throttling, the impeller is to be trimmed or replaced.

- .2 Make adjustments to achieve specified flows through heat exchangers, cooling towers, chillers and coils. Also report all pump data such as suction, and discharge pressure, current draw at tested voltage and starter OL heater sizes and pump motor nameplate ratings.
- .3 Provide pump curves indicating the operating point with superimposed power draw, RPM, impeller size, etc.
- .4 Instruct piping system installers on proper locations of flow measurement ports.
- .5 Report any required pump impeller adjustments to achieve specified performance.
- .6 Hydronic Pumps
 - .1 Test and adjust pumps to achieve design flows. Pumps shall be free of cavitation and vibration.
 - .2 Confirm individual pump impeller size by dead head testing.
 - .3 Plot, on the manufacturer's performance curve, the final operating point. Where pump balancing valves are used to obtain specified water flow, indicate balancing valve final position and recommend impeller size change where applicable.
 - .4 Test and record motor voltage and amperage. Compare data with nameplate limits.
 - .5 Test and record system operating pressure at strainer inlet, pump inlet and pump discharge.
 - .6 Test and record settings of motor thermal overload devices. Adjust settings where required.
- .7 Hydronic Equipment
 - .1 Test and adjust water flow to devices such as coils, and heat exchangers to obtain the specified flow. Compare actual equipment water side pressure drops with manufacturer's published data.
 - .2 Where equipment is used in heat transfer (i.e. Air and Water Coils), measure entering and leaving liquid and gas conditions and compare to manufacturer's published data.
 - .3 Where possible, simulate design conditions for testing. If simulation is not practical, perform seasonal testing when design conditions can be achieved.
- .8 Hydronic Piping and Distribution
 - .1 Adjust water flow in distribution system to obtain specified flows.
 - .2 Test and record flow and differential pressure systems to establish references for satisfactory operation.
 - .3 Test and adjust system feeders to ensure adequate system static pressure is available under all operating conditions.
 - .4 Test and adjust hydronic terminals to obtain specified flow.

3.05 DOMESTIC WATER SYSTEMS

- .1 Domestic Water Booster System
 - .1 Confirm individual domestic water booster pump impeller size by dead head testing.
 - .2 Test motor voltage and amperage and compare readings against nameplate limits.
 - .3 In multiple pump sets, confirm each individual pump is equally loaded under various pump on and off configurations.
 - .4 Confirm settings of each pressure regulating valve assembly.
 - .5 Confirm design supply water pressure is achieved at all potable water supply branches.
- .2 Domestic Hot Water Recirculation
 - .1 Test and adjust domestic hot water circulation pump to obtain specified capacity.
 - .2 Confirm individual pump impeller size by dead head testing.
 - .3 Test motor voltage and amperage and compare readings against nameplate limits.

- .4 Test and adjust distribution to obtain specified flow through each domestic hot water recirculation branch.

3.06 REPORTS

- .1 General
 - .1 Summarize all testing into logical sections, tabulated and summarized.
 - .2 Identify system terminals and distribution on legible plan or schematic drawings depicting actual system arrangement. Label pitot tube traverse locations, terminal identification and equipment identification in a manner consistent with the contract documents.
- .2 After deficient air distribution system items have been rectified, retest and issue a final report and certificate covering the following:
 - .1 Specified and achieved total air quantities per system supported by curves for all fans over 150 l/s (300 cfm) capacity.
 - .2 Specified and achieved individual air quantities per outlet with supporting schematic diagrams showing test points. On variable air volume distribution systems adjust each VAV terminal for specified minimum and maximum flows. Balancing downstream from the VAV terminals is also required as part of the Work.
 - .3 Nameplate and actual motor loading in amperes at actual voltage and installed overload heater size and manufacturer.
 - .4 Specified and actual fan total static pressures with breakdown showing inlet and discharge pressures with data shown on fan curves.
 - .5 Shelve and belt sizes and quantities per unit.
- .3 After hydronic system adjustments, retest systems and issue final report confirming systems are operating in compliance with design.
- .4 Report Verification
 - .1 Cooperate with the Commissioning Agent in field verification of the final reported valves.
 - .2 Specific and random verifications will be performed using the same procedures used in preparation of the reports.
 - .3 Sufficient verifications will be performed to satisfy the Commissioning Agent that the reports accurately represent the actual system conditions.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with the requirements of Section 20 05 05 Mechanical Demolition

1.02 SCOPE OF WORK

- .1 Demolition and removal of existing duct, pipe and equipment insulation.
- .2 Generally ductwork, casings and plenums to be insulated shall include, but not limited to, the following:
 - .1 all fresh air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to the first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and the fresh air is not tempered, then the fresh air ductwork system complete;
 - .2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated;
 - .3 supply air ductwork outward from fans, except for supply ductwork exposed in the area it serves;
 - .4 exhaust discharge ductwork for a distance of 10 ft. (3m) downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 10 ft. (3m) distance;
 - .5 ductwork outside building, and any other ductwork, casings, plenums or sections required to be insulated;
 - .6 Refer to Ductwork Thickness Tables herein and Part 3 of these Specifications for additional requirements.
- .3 Finishes for Ductwork Insulation shall include, but not limited to, the following:
 - .1 PVC: Unless otherwise specified or required, jacket all exposed duct insulation other than calcium silicate, exposed mineral fibre duct, plenum and casing insulation, and mineral fibre equipment insulation and flexible elastomeric where inside the building with white sheet PVC and PVC fitting covers;
 - .2 Canvas: Unless otherwise specified or required, jacket all exposed calcium silicate insulation, exposed mineral fibre duct, plenum and casing insulation, and mineral fibre equipment insulation with canvas;
 - .3 Metal: Unless otherwise specified or required, jacket all pipe insulation outside the building with metal;
 - .4 Protective Coatings: Unless otherwise specified or required, apply a protective coating to all flexible elastomeric insulation. Apply one (1) coat where inside the building and two (2) coats where outside the building.

1.03 REFERENCES

- .1 Material and method of application to comply with or be tested in accordance with following Standards:
 - .1 Thermal Insulation Association of Canada (TIAC) National Insulation Standard, excluding section 12
 - .2 NFPA 90-A Installation of Air-Conditioning and Ventilating Systems
 - .3 ASHRAE/IES 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
 - .4 NFPA 255 Test of Surface Burning Characteristics of Building Materials

- .5 CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering, and Miscellaneous Materials and Assemblies
- .6 ASTM C411 Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation
- .7 ASTM C518 Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flo Meter Apparatus
- .8 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
- .9 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- .10 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation
- .11 ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
- .12 ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
- .13 ASTM C1055 Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries
- .14 ASTM C1126 (Gr.1) Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation
- .15 CGSB 51-GP-52MA Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.
- .16 CGSB 51.53-95 Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts.

1.04 DEFINITIONS

- .1 In this Section;
 - .1 "Ambient": as applied to temperatures means outdoor design temperature.
 - .2 "Concealed": as applied to mechanical services and equipment located in space above opaque suspended ceilings, and within trenches not in boiler rooms, pipe and/or duct shafts, and non-accessible chases and furred spaces.
 - .3 "Ductwork": as applied to this section includes ducts, fans, supply unit casings, and plenums.
 - .4 "Exposed": as applied to remainder of mechanical services and equipment which are not "concealed" as defined above. For greater certainty, the following locations are Exposed:
 - .5 Services in tunnels,
 - .6 Services in space beneath raised floors,
 - .7 Trenches located in boiler rooms,
 - .8 Outdoors.
 - .9 "Conditioned air": air supplied from air handling units which heats, cools, dehumidifies, or humidifies the air.
 - .10 "Unconditioned space": rooms or spaces that are not supplied with conditioned air, including ceiling spaces which are not part of a ceiling return plenum system
 - .11 "Outdoor": mechanical services and equipment located outside of the building envelope including services located beneath overhangs and soffits, and exposed to any outdoor condition including temperature, sun exposure, or precipitation.
 - .12 "Mastic": heavy-consistency waterproof compound for outdoor applications used in conjunction with reinforcing fabric that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish to insulation.

- .13 "Coating": light-consistency compound for indoor applications used in conjunction with reinforcing fabric, to provide either a breathable or vapour barrier finish to insulation.
- .14 "Finish Jacket": final finish protective layer for insulation, including lagging fabric, PVC, metal, and adhesive films; that provides weather-protective finish depending on application.
- .15 "Service temperature": for purpose of ductwork temperature, is equal to the design operating temperature.

1.05 QUALITY ASSURANCE

- .1 Qualifications: Execute work of this section only by skilled tradesmen regularly employed in the application of insulation to piping, ductwork, and equipment for building fire protection, plumbing and drainage, heating, cooling, and ventilating systems.
- .2 Insulation, self-adhesive tape, adhesives and any insulation finishes to be ULC labelled and listed for flame spread rating of less than 25 and smoke development classification of less than 50.
- .3 Acceptable Manufacturers:
 - .1 Insulation: Fiberglas Canada Inc., Knauf Fiber Glass, Manson, Roxul.
 - .2 Tape: Avery Dennison, Mactac, Tuck, Compac.
 - .3 Canvas: Fattal Thermocanvas, Alpa-Maritex 3451-RW, Clairmont Diplag 60.
 - .4 Lagging adhesive: Childers CP.50A-HV2, Fosters 30-36 asbestos free.

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

1.07 VOC REQUIREMENTS

- .1 All adhesives, sealants, paints and coatings used on or inside of building weatherproofing layer shall have a VOC content that is less than the content limits defined in LEED Product Requirements.

PART 2 - PRODUCTS

2.01 DUCTWORK INSULATION SELECTION

- .1 Insulate Hot Ductwork where surface temperature of equipment in normal service is greater than 122°F (50°C) in accordance with this Section.
- .2 Insulate Cold and Dual Temperature Ductwork where surface temperature in normal service is less than 60°F (14°C) in accordance with this Section complete with a vapour barrier jacket.
- .3 Insulation shall be provided to ensure maximum duct surface temperature does not exceed 110°F (44°C). Where ASTM C1055 "Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries" allows for surface temperatures to be exceeded, submit for Consultant review the Insulation Trades Value Engineering proposal to reduce the extent of insulation, including a corresponding savings to the Owner. Under no circumstances shall surface temperature on the outside of insulation exceed 150°F (66°C) when piping system is operating under design service conditions.
- .4 Insulation, self-adhesive tape, adhesives and any insulation finishes to be ULC labelled and listed for flame spread rating of less than 25 and smoke development classification of less than 50.

2.02 D1 - GLASS FIBRE BLANKET WITH VAPOUR BARRIER

- .1 Application:
 - .1 flexible blanket,

- .2 service temperature: up to **250°F (121°C)**
- .2 Material:
 - .1 to ASTM C1290 "Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts"
 - .2 FSK jacket of kraft bonded to aluminum foil reinforced with glass fibre yarn
 - .3 thermal performance: R = 4.2 sq.ft*°F*hr/BTU @ 75°F (0.74 sq.m*°C/W @ 24°C)
 - .4 density: 0.75 lb/cu.ft (12 kg/cu.m)
 - .5 Rated 25/50 per ASTM E84, UL 723 and NFPA 255
 - .6 vapor transmission : maximum 0.02 perms
- .3 Acceptable Manufacturers:
 - .1 John Manville Microlite XG Duct Wrap
 - .2 Owens Corning SOFTR Duct Wrap
 - .3 Knauf Fibreglass Friendly Feel Duct Wrap
- .4 Glass Fibre Blanket with Vapour Barrier Thickness Table:

D1 - Glass Fibre Blanket with Vapour Barrier Thickness Table				
Nominal Surface Temperature Range	Application	Insulation Type	Insulation Thickness	Description
40°F to 150°F (5°C to 65°C)	Rectangular supply – indoors - concealed	D1	1½" (38mm)	Do not insulate terminal supply air ductwork that is exposed in the room that it serves. Where supply air ducts continue to another space, maintain ductwork insulation This includes all supply air ductwork from outside air plenums to air handling units.
40°F to 150°F (5°C to 65°C)	Round and Oval supply – indoors - concealed	D1	1½" (38mm)	Do not insulate terminal supply air ductwork that is exposed in the room that it serves. Where supply air ducts continue to another space, maintain ductwork insulation This includes all supply air ductwork from outside air plenums to air handling units.
40°F to 150°F (5°C to 65°C)	Round and Rectangular return – indoors - concealed	D1	1½" (38mm)	Applies to return air ductwork located above the ceiling and below the building roof.
Notes: (1) Insulation thickness indicated is "out of box" prior to installation. (2) Where insulation is installed on ductwork having flanged connections, increase duct insulation as required to provide a 1/2" (12 mm) cover on flanges and duct angles. (3) For duct sizes 20" (500 mm) to 34" (850 mm) utilize either 1-1/2" (40 mm) flexible wrap or 1" (25 mm) rigid board insulation where 1" (25 mm) insulation is called for. For thicknesses greater than 1" utilize rigid board insulation. (4) For ductwork exposed to the outdoors the top section of the insulation shall be sloped to ensure positive drainage (5) Pre-insulated flexible ductwork need not have additional insulation provided.				

2.03 D2 – MINERAL FIBER RIGID BOARD WITH VAPOUR BARRIER

- .1 Application:

- .1 Insulation System D2 **for ducting temperature up to 450°F (232°C)** on exposed cold or dual temperature rectangular and curved surfaces 10" (250mm) dia and over;
- .2 Material(s):
 - .1 rigid board insulation shall comply with ASTM C 612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation", Type 1;
 - .2 thermal performance: 0.23 btu/hr/in/sq.ft/°F @ 75°F (0.033 W/m/°C @ 24°C)
 - .3 vapor transmission: maximum 0.02 perms
 - .4 density: 3.0 lb/cu.ft (48 kg/cu.m)
 - .5 service temperature: up to jacket surface temperature (air contact) up to 66°C (150°F) and un-jacketed surface temperature (equipment contact) up to **232°C (450°F)**.
 - .6 rated at 25/50 per ASTM E84, UL 723 and NFPA 255;
 - .7 product must comply with the requirements of ASTM C 795 when being used over stainless steel,
- .3 Vapour Retardant Jacketing:
 - .1 vapour retardant jacketing shall be bleached "KRAFT" paper reinforced with a glass fibre yarn and bonded to an aluminum foil or aluminum foil reinforced with a glass fibre yarn and laminated to fire resistant kraft, secured with ULC or cUL listed pressure sensitive tape and/or outward clinched expanded staples and vapour barrier mastic as required;
 - .2 Fibreglass Reinforced Foil and Fire Retardant "KRAFT" Facing.
- .4 Acceptable Manufacturers:
 - .1 Johns Manville - Manville 814 Spin-Glas
 - .2 Owens Corning - 703 Board
 - .3 Knauf Fiberglass - Insulating Board
 - .4 Manson
 - .5 Or equivalent
- .5 Mineral Fiber Rigid Board with Vapour Barrier Thickness Table:

D2 - Mineral Fiber Rigid Board with Vapour Barrier Thickness Table				
Nominal Surface Temperature Range	Application	Insulation Type	Insulation Thickness	Description
-40 to 150°F (-40 to 65 C)	Outside Air Intake:	D2	Two layers each 2" (50mm)	Outside air plenum and all ductwork up to mixing box or heating coil where air temperature will be heated above ambient air dew point. This includes all outside air ductwork from the point that it enters the building to the air handling unit or supply air fan.
-40 to 150°F (-40 to 65 C)	Exhaust Air Discharge	D2	2" (50 mm)	From wall/roof penetration to 20 feet (6m) from exterior. Terminate at fan if fan closer than 20 feet (6m). Include the exhaust air plenum.
-40 to 150°F (-40 to 65 C)	Smoke control pressurization ductwork	D2	1½" (38mm)	Entire length

D2 - Mineral Fiber Rigid Board with Vapour Barrier Thickness Table				
Nominal Surface Temperature Range	Application	Insulation Type	Insulation Thickness	Description
-40 to 150°F (-40 to 65 C)	Rectangular - Outdoor - Supply	D2	2" (50 mm)	Entire length
-40 to 150°F (-40 to 65 C)	Rectangular - Outdoor - Return	D2	1½" (38mm)	Required for return air ductwork exterior to the building. Insulate entire exposed length of ductwork including ductwork up and downstream of heat recovery devices (ERV, enthalpy wheel) and silencers.
-40 to 150°F (-40 to 65 C)	Rectangular - Outdoor - Exhaust	D2	1½" (38mm)	Insulate entire exposed length of ductwork exterior to the building up and downstream of heat recovery devices (ERV, enthalpy wheel) and silencers. All other exhaust air ductwork does not require insulation.
40°F to 150°F (5°C to 65°C)	Supply unit casings and plenums - indoors	D2	1" (25mm)	Entire length
40°F to 150°F (5°C to 65°C)	Rectangular supply – indoors - exposed	D2	1" (25mm)	Do not insulate terminal supply air ductwork that is exposed in the room that it serves. Where supply air ducts continue to another space, maintain ductwork insulation This includes all supply air ductwork from outside air plenums to air handling units.
40°F to 150°F (5°C to 65°C)	Rectangular supply – indoors - concealed	D2	1" (25mm)	Do not insulate terminal supply air ductwork that is exposed in the room that it serves. Where supply air ducts continue to another space, maintain ductwork insulation This includes all supply air ductwork from outside air plenums to air handling units.
65°F to 90°F (18°C to 32°C)	Return air – indoor - unheated spaces	D2	2" (50 mm)	Ductwork passing through unheated spaces where the temperature will be below 50°F (10°C). Insulate entire exposed length of ductwork including silencers.
70°F to 200°F (20°C to 93°C)	Exhaust Systems for Dishwasher Exhaust - indoors	D2	1" (25mm)	Entire length

D2 - Mineral Fiber Rigid Board with Vapour Barrier Thickness Table				
Nominal Surface Temperature Range	Application	Insulation Type	Insulation Thickness	Description
<p>Notes:</p> <p>(1) Insulation thickness indicated is "out of box" prior to installation.</p> <p>(2) Where insulation is installed on ductwork having flanged connections, increase duct insulation as required to provide a 1/2" (12 mm) cover on flanges and duct angles.</p> <p>(3) For duct sizes 20" (500 mm) to 34" (850 mm) utilize either 1-1/2" (40 mm) flexible wrap or 1" (25 mm) rigid board insulation where 1" (25 mm) insulation is called for. For thicknesses greater than 1" utilize rigid board insulation.</p> <p>(4) For ductwork exposed to the outdoors the top section of the insulation shall be sloped to ensure positive drainage</p> <p>(5) Pre-insulated flexible ductwork need not have additional insulation provided.</p>				

2.04 D3 - FLEXIBLE ELASTOMERIC CLOSED CELL FOAM

- .1 Application:
 - .1 service temperature: up to **180°F (82°C)**;
 - .2 sheet self-adhering, roll type;
- .2 Material(s):
 - .1 to ASTM C534,
 - .2 thermal performance: 0.28 btu/hr/in/sq.ft/°F @ 75°F (0.04 W/m/°C @ 24°C)
 - .3 manufacturer specific sealer/adhesive.
- .3 Acceptable manufacturers:
 - .1 Armstrong - AP Armaflex Self-Adhering Sheet Insulation
 - .2 Rubatex
- .4 Flexible Elastomeric Closed Cell Foam Insulation Thickness Table:

D3 - Flexible Elastomeric Closed Cell Foam Insulation Thickness Table				
Nominal Surface Temperature Range	Application	Insulation Type	Insulation Thickness	Description
-40 to 150°F (-40 to 65 C)	Round – Outdoor – Supply, Return, Exhaust	D3	Two layers each 1" (25mm)	Required for ductwork exterior to the building. Insulate entire exposed length of ductwork including ductwork up and downstream of heat recovery devices (ERV, enthalpy wheel) and silencers. All other exhaust air ductwork does not require insulation.
-40 to 150°F (-40 to 65 C)	Drain pans	D3	3/4" (20mm)	

D3 - Flexible Elastomeric Closed Cell Foam Insulation Thickness Table				
Nominal Surface Temperature Range	Application	Insulation Type	Insulation Thickness	Description
<p>Notes:</p> <p>(1) Insulation thickness indicated is "out of box" prior to installation.</p> <p>(2) Where insulation is installed on ductwork having flanged connections, increase duct insulation as required to provide a 1/2" (12 mm) cover on flanges and duct angles.</p> <p>(3) For duct sizes 20" (500 mm) to 34" (850 mm) utilize either 1-1/2" (40 mm) flexible wrap or 1" (25 mm) rigid board insulation where 1" (25 mm) insulation is called for. For thicknesses greater than 1" utilize rigid board insulation.</p> <p>(4) For ductwork exposed to the outdoors the top section of the insulation shall be sloped to ensure positive drainage</p> <p>(5) Pre-insulated flexible ductwork need not have additional insulation provided.</p>				

2.05 D4 - LOW TEMPERATURE PHENOLIC BOARD

- .1 Application:
 - .1 **High humidity environments**
 - .2 rigid for flat surfaces,
 - .3 service temperature: -100°F to 250°F (-73°C to +121°C)
- .2 Material(s):
 - .1 to ASTM C1126 (Gr.1),
 - .2 meeting 25/50 flame spread/smoke development when tested to ASTM E84,
 - .3 thermal performance: 0.145 btu/hr/in/sq ft/°F @ 50°F (0.021 W/m/°C @ 10°C)
 - .4 density: 2.3 lb/cu.ft (37 kg/cu.m)
- .3 Acceptable manufacturers:
 - .1 Kingspan - Koolphen K
 - .2 Or equivalent
- .4 Low Temperature Phenolic Board Insulation Thickness Table:

D4 - Low Temperature Phenolic Board Insulation Thickness Table				
Nominal Surface Temperature Range	Application	Insulation Type	Insulation Thickness	Description
-40 to 150°F (-40 to 65 C)	Outside Air Intake:	D4	3" (75mm)	Outside air plenum and all ductwork up to mixing box or heating coil where air temperature will be heated above ambient air dew point. This includes all outside air ductwork from the point that it enters the building to the air handling unit or supply air fan.
-40 to 150°F (-40 to 65 C)	Exhaust Air Discharge	D4	1½" (38mm)	From wall/roof penetration to 20 feet (6m) from exterior. Terminate at fan if fan closer than 20 feet (6m). Include the exhaust air plenum.
-40 to 150°F (-40 to 65 C)	Blanked Off Louvres	D4	3" (75mm)	

D4 - Low Temperature Phenolic Board Insulation Thickness Table				
Nominal Surface Temperature Range	Application	Insulation Type	Insulation Thickness	Description
<p>Notes:</p> <p>(1) Insulation thickness indicated is "out of box" prior to installation.</p> <p>(2) Where insulation is installed on ductwork having flanged connections, increase duct insulation as required to provide a 1/2" (12 mm) cover on flanges and duct angles.</p> <p>(3) For duct sizes 20" (500 mm) to 34" (850 mm) utilize either 1-1/2" (40 mm) flexible wrap or 1" (25 mm) rigid board insulation where 1" (25 mm) insulation is called for. For thicknesses greater than 1" utilize rigid board insulation.</p> <p>(4) For ductwork exposed to the outdoors the top section of the insulation shall be sloped to ensure positive drainage</p> <p>(5) Pre-insulated flexible ductwork need not have additional insulation provided.</p>				

2.06 FASTENINGS:

- .1 Contact bond cement:
 - .1 quick hydraulic-setting finishing type for metal surfaces.
 - .2 Volatile Organic Content: maximum 80 g/L.
 - .3 Acceptable manufacturers:
 - .1 Bakor - No. 220-05
 - .2 Foster – Drion 85-75
 - .3 Or equivalent
- .2 Adhesive for flexible closed cell foam insulation:
 - .1 Volatile Organic Content: maximum 80 g/L.
 - .2 Acceptable manufacturers:
 - .1 Armaflex 520BLV
 - .2 Armaflex Low VOC Spray Contact Adhesive
 - .3 Rubatex R-373
 - .4 Or equivalent
- .3 Vapour barrier tape:
 - .1 Self –adhesive;
 - .2 colour matched and foil faced;
 - .3 UL 181A listed;
 - .4 4" (100 mm) wide;
 - .5 under 25 Flame Spread and under 50 Smoke Developed rating.
 - .6 Acceptable manufacturers:
 - .1 Johns Manville - Zeston Z-Tape
 - .2 MacTac Canada Limited - Vinyl Scrim or Foil Scrim Kraft
 - .3 Compac Corp.
 - .4 Fattal Canvas Inc. – Insultape
 - .5 Or equivalent
- .4 Fibrous insulation adhesive:
 - .1 Volatile Organic Content: maximum 250 g/L.

- .2 15 Flame Spread and 0 Smoke Developed ratings.
- .3 Acceptable manufacturers:
 - .1 Childers CHIL-STIX FRN CP-82
 - .2 Foster No. 85-70
 - .3 Or equivalent
- .5 Lap Seal Adhesive:
 - .1 Quick-setting adhesive for joints and lap sealing of vapour barriers.
 - .2 10 Flame Spread and 0 Smoke Developed ratings.
 - .3 Volatile Organic Content: maximum 250 g/L.
 - .4 Acceptable manufacturers:
 - .1 Bakor 220-05
 - .2 Childers CHIL-STIX FRN CP-82
 - .3 Foster: 85-75, Asbestos Free, Drion.
 - .4 Or equivalent
- .6 Canvas adhesive:
 - .1 Washable adhesive for cementing canvas lagging cloth to duct insulation.
 - .2 Acceptable manufacturers:
 - .1 Foster: 30-36 Asbestos Free.
- .7 Weld Pins, Studs and Clips:
 - .1 Acceptable manufacturers:
 - .1 Midwest Fasteners
 - .2 Continental Studwelding
 - .3 Or equivalent
- .8 Staples:
 - .1 Monel, flare type, minimum size ½" (12mm)
- .9 Tie Wire:
 - .1 16 ga. (1.6mm) stainless steel with twisted ends.
- .10 Caulking for sheetmetal jackets (outdoor use only):
 - .1 flexible butyl elastomer based vapour barrier sealant;
 - .2 fast-drying, aluminum colour finish;
 - .3 Acceptable manufacturers:
 - .1 Foster 95-44
 - .2 Or equivalent

2.07 COATINGS AND MEMBRANES

- .1 Reinforcing Membrane:
 - .1 synthetic fibre:
 - .1 Leno weave,
 - .2 indoor and outdoor use.
 - .3 Acceptable manufacturers:
 - .1 Foster Mast-A-Fab

- .2 Or equivalent
 - .2 glass-fibre fabric:
 - .1 indoor use.
 - .2 Acceptable manufacturers:
 - .1 Childers Chil-Glas #5/#10
 - .2 Or equivalent
 - .3 glass-fibre fabric for use with elastomeric closed cell foam:
 - .1 indoor use.
 - .2 Acceptable manufacturers:
 - .1 Childers Chil-Glass #10
 - .2 Or equivalent
- .2 Breather Coating - Indoors:
 - .1 for breather coatings and lagging adhesive,
 - .2 Volatile Organic Content: maximum 50 g/L.
 - .3 white in colour,
 - .4 Acceptable manufacturers:
 - .1 Childers CP-50A HV2
 - .2 Foster 30-36
 - .3 Or equivalent
- .3 Breather Mastic - Outdoors:
 - .1 for breather coatings and lagging adhesive,
 - .2 abrasion resistive, flexible,
 - .3 UV stabile,
 - .4 grey in colour.
 - .5 Acceptable manufacturers:
 - .1 Childers Vi-Cryl CP-10/11
 - .2 Foster 35-00 / 45-00
 - .3 Bakor 120-10
 - .4 Or equivalent
- .4 Vapour Barrier Coatings - Indoors:
 - .1 Volatile Organic Content: maximum 50 g/L.
 - .2 for vapour barrier coatings and lagging adhesive except for elastomeric closed cell foam,
 - .3 permeance rating 0.02 perms maximum,
 - .4 white in colour
 - .5 Acceptable manufacturers:
 - .1 Childers Chil Perm CP-34/35
 - .2 Foster 30-80, 30-90
 - .3 Or equivalent
- .5 Vapour Barrier Coatings for use with elastomeric closed cell foam- Indoors
 - .1 Acceptable manufacturers:

- .1 Childers CHIL-SPRAY WB CP-56 Adhesive
- .2 Or equivalent
- .6 Vapour Barrier Mastic - Outdoors:
 - .1 Outdoor vapour barrier mastic complete with reinforcing glass fabric for vapor barrier coatings and lagging adhesive,
 - .2 asphalt cutback,
 - .3 permeance rating 0.02 perms maximum,
 - .4 grey in colour.
 - .5 for outdoor use only; not rated to meet fire/smoke rating of 25/50.
 - .6 Acceptable manufacturers:
 - .1 Childers Chil-Pruf CP-22
 - .2 Foster 60-25/60-26
 - .3 Or equivalent

2.08 FIELD APPLIED FINISHES

- .1 PVC (Polyvinyl Chloride) finish jacket:
 - .1 minimum 20 mil thickness with permeability not more than 0.09 perms,
 - .2 flexible flat-sheet;
 - .3 Acceptable manufacturers:
 - .1 Johns Manville - Manville Zeston 2000
 - .2 ACWIL Insulations
 - .3 Sure Fit Systems
 - .4 Proto PVC – LoSMOKE
 - .5 Or equivalent
 - .4 pressure sensitive, colour matching vinyl tape.
 - .5 3M Venture Clad model 1579CW-WME, or equivalent, is acceptable for use in lieu of PVC finish jacket.
- .2 Canvas finish jacket:
 - .1 Apply in exposed areas, compacted firm, ULC listed, heavy plain weave cotton fabric at 6 oz./sq. yd. (220 g/m2) treated with diluted fire retardant lagging adhesive; and two applications of white fire resistant coatings.
 - .2 re-wettable fiberglass lagging fabric with water activated self-adhesive.
 - .3 suitable for field painting.
 - .4 Acceptable manufacturers:
 - .1 Fattal's Thermocanvas
 - .2 Alpha-Maritex 3451-RW
 - .3 Clairmont Diplag 60
 - .4 Glass-Cell FR
 - .5 Newtex - Zetex Rewettable
 - .6 Johns Manville
 - .7 Or equivalent

- .5 3M Venture Clad model 1579CW-WME, or equivalent, is acceptable for use in lieu of canvas finish jacket.
- .3 Metal finish jacket:
 - .1 Recover insulation and insulation finishes outside building or exposed to the weather with metallic jacket with metallic fittings.
 - .2 Band all transverse seams with waterproof mastic tape and caulk all longitudinal seams with silicone caulking.
 - .3 Seal the entire covering to achieve a watertight assembly.
 - .4 Equipment:
 - .1 stucco embossed aluminum not less than 0.016" (0.45mm) thick sheet or,
 - .2 corrugated stainless steel not less than 0.010" (0.25mm) thick sheet.
 - .5 Fittings:
 - .1 Custom made swaged ring or lobster back covers on bends and die shaped fitting covers over fittings, flanges, and couplings.
 - .6 Bands:
 - .1 12 mm (½ in) wide stainless steel with mechanical fasteners.
 - .7 Acceptable manufacturers:
 - .1 Alcan Canada Products - Thermaclad Type 1
 - .2 Childers Products Inc. - Fab Straps
 - .3 Or equivalent
- .4 Self-adhesive weather barrier membrane (SAWB):
 - .1 self-adhering membrane of acrylic adhesive with siliconized release paper, not exceeding flame/smoke generation rating of 25/50, for indoor and outdoor use,
 - .2 self-adhering membrane of rubberized asphalt compound with siliconized release paper, for outdoor use only
 - .3 laminated to stucco-embossed aluminum foil,
 - .4 self-sealing with penetration of self-tapping screws.
 - .5 water vapour permeance 0.05 perms.
 - .6 Acceptable manufacturers:
 - .1 3M Venture Clad 1579CW - indoor and outdoor applications
 - .2 Bakor - Foilskin - outdoor applications
 - .3 Polyguard Products Alumaguard 60 - outdoor applications
 - .4 Or equivalent
- .5 Protective finish for elastomeric cellular foam insulation
 - .1 indoors and outdoors:
 - .1 Armaflex WB Finish
 - .2 Or equivalent

2.09 DUCT LINER

- .1 Due to the cleaning requirements for the ducting, no internal acoustical lining is allowed. Use appropriate noise silencers instead.
- .2 Internal acoustical insulation may be used for transfer ducting only.
- .3 Rigid Duct Liner (for transfer ducts only)

- .1 Yellow or naturally coloured internal rigid glass fibre acoustical insulation with black sealer coating on one face.
- .2 Minimum sound absorption (NRC) of 0.60 as tested per ASTM C423 using Type "A" mounting.
- .3 Thermal conductivity at 75°F - 0.020 BTU/hr/ft/°F (24°C - 0.035 W/m/°C).
- .4 Acceptable Manufacturers:
 - .1 Certaineed Toughgard 300#, Manson Akousti-Liner R, Knauf Rigid Plenum Liner with ECOSE technology, Johns-Manville Permacoat R300, Owens Corning Quiet-R Rigid Coated Duct Liner.
- .4 Flexible Duct Liner
 - .1 Yellow or naturally coloured internal flexible glass fibre acoustical insulation with one face faced with non-woven fibreglass mat.
 - .2 Minimum sound absorption (NRC) of 0.60 as tested per ASTM C423 using Type "A" mounting.
 - .3 Thermal conductivity at 75°F - 0.023 BTU/hr/ft/°F (24°C - 0.040 W/m/°C).
 - .4 Acceptable Manufacturers:
 - .1 Certaineed Toughgard Duct Liner 150# or Type 150,
 - .2 Manson Akousti-Liner,
 - .3 Knauf Duct Liner with ECOSE technology,
 - .4 Owens Corning Quiet-R Rotary Duct Liner,
 - .5 Or equivalent.

2.10 VINYL NOISE ATTENUATION WRAP

- .1 1.0 lb/sq.ft non-lead loaded non-reinforced vinyl barrier sheets faced with a fibrous glass "scrim" reinforced aluminium foil facing on one side.
- .2 Thickness: 0.09"
- .3 Flammability: Must pass UL94V and FMVSS 302. Meet Class A flammability rating per ASTM E-84.
- .4 All hangers, support rods, concrete anchors shall be in accordance with manufacturers' Instructions.
- .5 Sound transmission loss requirements based on ASTM E90-09 and ASTM E413-04:

Sound Transmission Loss (db per Centre Line Frequency)						
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	STC
15	16	21	26	33	38	26

- .6 Acceptable manufacturers:
 - .1 EAR Specialty Composites Tufcote Noise Barrier Lag-10;
 - .2 Audioseal Sound Barrier AB10-Lag;
 - .3 Or equivalent.

2.11 FIRE WRAP FOR DUTWORK

- .1 Where ductwork is indicated on the drawings to be wrapped in an equivalent fire rated enclosure, ductwork shall be provided with a fire rated wrap consisting of 40 mm (1-1/2") thick, non-combustible, flexible fireproof blanket, supplied in roll form. Provide sufficient number of layers to ensure the wrap provides the required fire separation.

- .2 Apply wrap directly onto the ductwork in strict accordance with the manufacturers' recommendation and ULC listing, Design No. FRD-4 Guide No. 40 U21 "FIRE RESISTANT DUCTS" as tested to ISO Standard 6944 and ULC Guide No. 440E9 per 0 mm clearance to combustibles.
- .3 Provide an aluminum foil face to exposed surface.
- .4 All hangers, support rods, concrete anchors and firestopping of duct penetrations through fire separations shall be in accordance with ULC listing and manufacturers' instructions.
- .5 Obtain approval from authorities having jurisdiction prior to ordering.
- .6 Fire wrap manufacturer shall review installation of the wrap prior to concealment and provide written confirmation that the installation is complete to the required listing. All items identified as deficient shall be rectified.
- .7 Refer to drawings for duct systems requiring fire wrap.
- .8 Acceptable Manufacturers:
 - .1 Thermal Ceramics;
 - .2 Unifrax FyreWrap;
 - .3 Or equivalent.

PART 3 - EXECUTION

3.01 GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

- .1 Performance Requirements:
 - .1 As a minimum, insulation application methods and standards shall be as per the NATIONAL INSULATION STANDARDS of the Thermal Insulation Association of Canada.
- .2 General Insulation Application Requirements:
 - .1 General requirements pertaining to the application of mechanical insulation are indicated in Table 1.
 - .2 Prior to finishing of insulation of hot and cold exposed rectangular ductwork, provide corner beads similar to Roll-on Type.
 - .3 Unless otherwise specified, do not insulate the following:
 - .1 factory insulated equipment /plenums/ panels and piping;
 - .2 heated liquid system pump casings, valves, strainers and similar accessories;
- .3 Quality Assurance:
 - .1 Mechanical insulation shall be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic, and the company with the sub-contract for mechanical insulation work shall be a member in good standing of the Thermal Insulation Association of Canada.
 - .2 Store and use adhesives, mastics, and insulation cements at ambient temperatures and conditions recommended by product manufacturers.
 - .3 Surfaces to be clean and dry before application of insulation. Apply insulation after pressure and leakage testing is completed and accepted.
 - .4 Place insulation with joints staggered and tightly butted, with no visible gaps.
 - .5 Neatly finish insulation at supports, protrusions, and interruptions.
 - .6 Seal exposed insulation with reinforced vapor barrier or breather coating/mastic as shown.
 - .7 Ductwork shall be field installed with finished jacket specified.
- .4 Flanges and Mechanical Couplings:
 - .1 Terminate sectional insulation approximately 50 mm from the flange or coupling on each side of the flange or coupling. Cover the flange or coupling with a minimum 50 mm

thickness of blanket mineral fibre insulation wide enough to butt tightly to the ends of the adjacent sectional insulation. Secure the blanket insulation in place and cover with a PVC cover.

- .5 For cold surfaces with the possibility of condensation, install insulation directly over ducts and not over hangers and supports.
- .6 For warm surfaces, line size hangers shall be permitted and insulation shall cover the hanger to maintain the specified thickness in accordance with ASHRAE 90.1.

3.02 INSULATION LIMITS

- .1 Externally insulate air distribution system components:
 - .1 Air conditioned with cooling or both heating and cooling: supply unit casings and plenums, free standing supply fans for both recirculating and non-recirculating type systems, and supply air ducts and plenums including the space served,
 - .2 Air conditioned only with heating: supply unit casing and plenums, free-standing supply fans, and supply air ducts and plenums up to the space served but not in the space itself,
 - .3 Conditioned air supply ducts including downstream of reheat coils,
 - .4 Un-conditioned supply air ducts and plenums that pass through unheated rooms or spaces,
 - .5 The first 12" (300mm) length of acoustically lined ductwork,
 - .6 Return air ducts and plenums in unheated spaces,
 - .7 Exhaust air ducts and plenums in unheated spaces,
 - .8 Exhaust air ducts between exhaust air damper and point of discharge to outside of building,
 - .9 Outside air intake ducts and plenums;
 - .1 for non-recirculating type ventilation systems without cooling coils, terminate plenum or casing insulation 12" (300mm) downstream of final heating coil,
 - .10 Mixed air plenums and ducts;
 - .1 for recirculating type ventilation systems without cooling coils, terminate outside air intake insulation 12" (300mm) downstream of mixing plenum,
 - .11 sheet metal blank-off plates behind unused sections of air intake louvers.
- .2 Externally insulate ductwork located outdoors:
 - .1 supply ducts;
 - .2 conditioned supply ducts;
 - .3 return ducts;
 - .4 exhaust ducts, excluding fan discharge duct;
 - .5 kitchen exhaust ducts with more than 3 m (10 ft) length of duct on roof, excluding fan discharge duct.
- .3 External insulation is not required on:
 - .1 casings, ducts or plenums which have been lined with acoustic insulation, except as described above,
 - .2 portions of intake ducts or plenums, unit casings and conditioned air plenums which are of double wall insulated construction,
 - .3 pre-insulated flexible ducts.
 - .4 factory insulated air handling units.

3.03 DUCTWORK INSULATION APPLICATION

- .1 Secure insulation on exposed rectangular ductwork with welded impaling pins and speed washer type fasteners at 12" (300 mm) on centre. Provide a minimum of two (2) rows of fasteners on each side of the duct.
- .2 In addition to the mechanical fasteners, adhere insulation to the duct with fire resistive adhesive applied to the duct in 6" (150 mm) wide strips at 18" (450 mm) centres. Tightly butt all joints and breaks in the insulation and seal with fire resistive mastic and 3" (75 mm) wide scrim foil pressure sensitive tape. Cut off protruding ends of welded pins and cover speed washers with same tape to ensure a smooth application of exterior jacket.
- .3 Fasten insulation to rectangular ductwork less than 31" (787 mm) wide and round ductwork with adhesive applied in 6" (150 mm) wide strips at 18" (450 mm) centres. Tightly butt all joints and breaks in the insulation. Seal with fire resistive mastic and 3" (75 mm) wide scrim foil pressure sensitive tape. Use tying cord only to temporarily secure insulation until adhesive has set. Remove prior to application of exterior jacket.
- .4 Insulate access doors or removable panels in ductwork as separate units to permit opening or removal without damage to the adjoining insulation.
- .5 Rigid insulation - fans, ducts, and casing:
 - .1 overlap horizontal boards over vertical boards, and butt edges tightly together.
 - .2 impale insulation on weld pins, studs, and clips at 12" (300mm) centres in all directions, with not less than 2 rows per side and bottom.
 - .3 secure insulation laps with mechanical fasteners (staples).
- .6 Rigid insulation - outside air duct and plenums - glass fibre:
 - .1 as above for fans, ducts, and casings, and;
 - .1 apply first layer of insulation without integral vapour barrier,
 - .2 apply second layer of insulation with integral vapour barrier with staggered joints.
- .7 Rigid insulation - outside air duct and plenum - phenolic board:
 - .1 as above for fans, ducts, and casings, but with only one layer of insulation board.
- .8 Rigid insulation - exhaust air plenums:
 - .1 as above for fans, ducts, and casings.
- .9 Flexible insulation:
 - .1 overlap insulation 2" (50mm) on each lap joint, and butt end edges tightly together,
 - .2 on rectangular ducts 24" (600mm) and wider, and round ducts 18" (450mm) diameter and larger;
 - .1 secure insulation to the underside of duct with weld pins, studs, and clips at 12" (300mm) centres in all directions, with not less than 2 rows per side and bottom,
 - .2 secure insulation laps with mechanical fasteners (staples),
 - .3 for round ductwork, the underside of duct is measured as being half the circumference of the duct.
- .10 Flexible elastomeric:
 - .1 wrap tightly onto ductwork and drain pans, and secure with 100% adhesive coverage.
 - .2 on round ducts, overlap insulation 2" (50mm) on each lap joint, and butt end edges tightly together,
- .11 Cover angles or standing seams on the outside of plenums, casings and ducts which extend beyond face of applied rigid insulation;
 - .1 with same material and thickness as adjacent ductwork,

- .2 extend this insulation 3" (75mm) on each side of the angle and place tight around the projecting leg of the angle.
- .3 apply rigid insulation overlapping edge of flexible insulation on angle so that outstanding part of insulated angle projects through work.
- .12 Cut and mitre rigid insulation at elbows and fittings and attach to ductwork with 50% coverage of adhesive, and mechanical fasteners with weld pins, speed clips and washers.
- .13 Attach speed washers when insulation has been placed on metal pins and cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape.
- .14 At junctions between external insulation and acoustic insulation, overlap external insulation 12" (300mm) over acoustic lining.

3.04 EXTERIOR DUCTWORK INSULATION APPLICATION

- .1 In addition to requirements above, the following shall apply to all duct insulation exposed to the outdoors.
 - .1 All joints and penetrations shall be covered with two 3mm wet coats of vapour mastic reinforced with glass fabric.
 - .2 When dry, cover entire surface with 3mm coat of vapour mastic and while this coat is still wet, embed a layer of glass fabric, with all joints overlapped a minimum of 3" (75mm) and cover entire surface with another coat of mastic.
 - .3 All penetrations of angle iron supports shall be completely sealed to weather.
 - .4 Built up centre to slope top surface of insulation to prevent ponding.
 - .5 Paint mastic assembly with white coloured weather resistant paint when it is dry.
 - .6 Recover insulation and insulation finishes outside building or exposed to the weather with aluminum jacket with aluminum fittings. Band all transverse seams with waterproof mastic tape and caulk all longitudinal seams with silicone caulking. Seal the entire covering to achieve a watertight assembly. Aluminum jacket shall be reinforced to prevent buckling on horizontal surfaces.
 - .7 For rectangular and flat-oval ductwork:
 - .1 build-up and slope insulation on top of ductwork to provide a 1:100 drainage slope,
 - .2 where width of ductwork exceeds 24" (600mm), slope insulation in both directions.

3.05 SEALING INSULATION

- .1 Hot ducts, casings, and plenums - Indoors:
 - .1 service temperature: 70°F to 150°F (20°C to 65°C)
 - .2 apply vapour barrier tape to butt joints, overlapping my minimum 50 mm (2 in) each side,
 - .3 do not tape lap joints.
- .2 Cold or dual temperature ducts, casings, and plenums - Indoors:
 - .1 service temperature: Ambient to 70°F (20°C)
 - .2 apply reinforced vapor barrier coating to all corners, lap edges and butt edges, overlapping joint by minimum 2" (50mm) each side,
 - .3 cover mechanical fastener (staple) penetrations with reinforced vapour barrier coating and/or vapor barrier tape,
 - .4 insulate flanges and standing seams with overlapping strips of flexible insulation, and cover with reinforced vapour barrier coating.
- .3 Ducts - Hot Temperature - Outdoors:
 - .1 service temperature: 70°F to 150°F (20°C to 65°C)

- .2 apply reinforced breather mastic to all corners, lap edges and butt edges, overlapping joint by minimum 2" (50mm) each side.
- .3 cover mechanical fastener (staple) penetrations with reinforced breather mastic,
- .4 insulate flanges and standing seams with overlapping strips of flexible insulation, and cover with reinforced breather mastic.
- .5 for greater clarity, do not use vapor barrier tape on outdoor applications.
- .4 Ducts - Cold or Dual Temperature - Outdoors:
 - .1 service temperature: Ambient to 70°F (20°C)
 - .2 apply reinforced vapor barrier mastic to all corners, lap edges and butt edges, overlapping joint by minimum 2" (50mm) each side,
 - .3 cover mechanical fastener (staple) penetrations with reinforced vapour barrier mastic,
 - .4 insulate flanges and standing seams with overlapping strips of flexible insulation, and cover with reinforced vapour barrier mastic,
 - .5 for greater clarity, do not use vapor barrier tape on outdoor applications.
- .5 Apply mastics and coatings when ambient temperature is above 40°F (4°C), unless manufacturer's instructions permit colder ambient installation conditions.

3.06 INSULATION FINISH

- .1 Install protective finish on insulation in accordance with Table 2, after breather and vapour barrier sealing is completed.
- .2 Install finish jacket materials used for covering to allow 2" to 4" (50mm to 100mm) overlap on longitudinal and circumferential edges.
- .3 Fabric:
 - .1 Cotton lagging:
 - .1 apply cotton lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the duct system, and finish to provide a smooth surface free of wrinkles and sags.
 - .2 where cotton lagging with appropriate coating is used this satisfies the requirements of a sealer coating for Hot or Cold/Dual temperature ducting systems.
 - .2 Fibreglass lagging:
 - .1 apply re-wettable fibreglass lagging in accordance with manufacturer instructions. Finish to provide a smooth surface free of wrinkles and sags.
 - .2 where re-wettable fiberglass lagging is used this satisfies the requirements of a breather sealer coating for Hot piping systems.
- .4 Metal:
 - .1 use lock-on systems or secure sheeting with bands 18" (450mm) apart.
 - .2 joint sealing, indoor:
 - .1 Hot ducts and plenums: do not seal joints.
 - .2 Cold or Dual Temperature ducts and plenums: seal joints with caulking.
 - .3 curved surfaces: custom made swaged ring or lobster back covers,
 - .4 on outdoor hot and cold/dual temperature ductwork, caulk overlapping metal joints to permit expansion of metal jacket.
- .5 Self-Adhesive Weather Barrier (SAWB):
 - .1 Apply SAWB in accordance with manufacturer's instructions.
- .6 Flexible elastomeric closed cell foam insulation:

- .1 Apply thin coat of lagging adhesive, and apply glass mesh,
- .2 When dry apply indoor or outdoor finish at 400 square feet per gallon,
- .3 Apply second coat of same material, at same rate of application, after four hours.

Ductwork Insulation Finishes				
Location	Weather Exposure	System/Space	Finish	Insulation Type
Concealed	Indoors	All	Fabric	D1, D2, D4
Exposed	Indoors	Service Rooms	Fabric or PVC	D1, D2, D4
	Indoors	Public Spaces	PVC	D1, D2, D4
	Outdoors	All	Metal	D1, D2, D4
	Outdoors	All	SAWB	D1, D2, D4

3.07 VINYL DUCT WRAP INSTALLATION

- .1 Vinyl wrap manufacturer shall review installation of the wrap prior to concealment. All items identified as deficient shall be rectified.
- .2 Install in accordance with manufacturers' recommendations.

3.08 PAINTED DUCTWORK

- .1 Not applicable.

3.09 INSULATION PROTECTION

- .1 For indoor installation, protect exposed insulated ductwork from floor level up to 1200 mm (4 ft) above floor with 1.2 mm (18 ga) stainless steel jacket, secured to floor slab.
- .2 Provide access opening in protective sheeting for access to fire separation closures (fire dampers, smoke dampers and combination fire smoke dampers). Do not overlap closure slip joint with protective sheeting.

3.10 FIRE WRAP FOR DUCTWORK INSTALLATION

- .1 Fire wrap ductwork in accordance with manufacturer's installation ULC or cUL listing requirements, and any additional requirements of the Authorities Having Jurisdiction ("AHJs")
- .2 Fire wrap ductwork to maintain the continuity of the fire rating of the fire compartment of the source and/ or destination of the ductwork passing through other fire compartments. Maintain the requisite fire rating of the complete assembly.
- .3 Fire wrap manufacturer shall review installation of the wrap prior to concealment and provide written confirmation that the installation is complete to the required listing. All items identified as deficient shall be rectified.

3.11 FIELD INSPECTION QUALITY CONTROL

- .1 The Consultant reserves the right to have protective finish coverings removed on up to 5% of all fittings and flanges and duct mounted accessories to review the sealing of the insulation.
- .2 Upon inspection, if insulation sealing is found to be incorrect at any one, the Consultant, in their sole discretion, may call for the removal of the protective finish on fittings and flanges and duct mounted accessories for further review.
- .3 Repair defective sealing and replace protective coverings at no additional cost to the Owner.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with the requirements of Section 20 05 05 Mechanical Demolition

1.02 REFERENCES

- .1 Material and method of application to comply with or be tested in accordance with following Standards;
 - .1 Thermal Insulation Association of Canada (TIAC) National Insulation Standard, excluding section 12
 - .2 NFPA 90-A Installation of Air-Conditioning and Ventilating Systems
 - .3 ASHRAE/IES 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
 - .4 NFPA 255 Test of Surface Burning Characteristics of Building Materials
 - .5 CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering, and Miscellaneous Materials and Assemblies
 - .6 ASTM C411 Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation
 - .7 ASTM C518 Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flo Meter Apparatus
 - .8 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
 - .9 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - .10 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation
 - .11 ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 - .12 ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
 - .13 ASTM C1055 Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries
 - .14 ASTM C1126 (Gr.1) Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation
 - .15 CGSB 51-GP-52MA Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.
 - .16 CGSB 51.53-95 Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts.

1.03 DEFINITIONS

- .1 In this Section;
 - .1 "Ambient": as applied to temperatures means outdoor design temperature.
 - .2 "Concealed": as applied to mechanical services and equipment located in space above opaque suspended ceilings, and within trenches not in boiler rooms, pipe and/or duct shafts, and non-accessible chases and furred spaces.
 - .3 "Exposed": as applied to remainder of mechanical services and equipment which are not "concealed" as defined above. For greater certainty, the following locations are Exposed:

- .4 Services in tunnels,
- .5 Services in space beneath raised floors.
- .6 Trenches located in boiler rooms.
- .7 "Conditioned air": air supplied from air handling units which heats, cools, dehumidifies, or humidifies the air.
- .8 "Unconditioned space": rooms or spaces that are not supplied with conditioned air, including ceiling spaces which are not part of a ceiling return plenum system
- .9 "Outdoor": mechanical services and equipment located outside of the building envelope including services located beneath overhangs and soffits, and exposed to any outdoor condition including temperature, sun exposure, or precipitation.
- .10 "Mastic": heavy-consistency waterproof compound for outdoor applications used in conjunction with reinforcing fabric, that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish to insulation.
- .11 "Coating": light-consistency compound for indoor applications used in conjunction with reinforcing fabric, to provide either a breathable or vapour barrier finish to insulation.
- .12 "Finish Jacket": final finish protective layer for insulation, including lagging fabric, PVC, metal, and adhesive films; that provides weather-protective finish depending on application.
- .13 "Service temperature": for purpose of equipment temperature, is equal to the maximum heating or maximum cooling gas or vapour design operating temperature or the liquid supply operating temperature associated with the equipment.

1.04 SCOPE OF WORK

- .1 Demolition and removal of existing equipment insulation.
- .2 Generally equipment to be insulated shall include, but shall not limited to, the following:
 - .1 chilled water and/or potable cold water pump casings;
 - .2 roof drain sumps where inside the building;
 - .3 water meter(s);
 - .4 heat exchangers;
 - .5 expansion tank(s);
 - .6 Refer to Equipment Insulation Tables herein and Part 3 of these Specifications for additional requirements.
- .3 Finishes for Insulation shall include, but not limited to, the following:
 - .1 Canvas: Unless otherwise specified or required, jacket all exposed calcium silicate insulation, exposed mineral fibre duct, plenum and casing insulation, and mineral fibre equipment insulation with canvas;
 - .2 PVC: Unless otherwise specified or required, jacket all exposed pipe insulation other than calcium silicate and flexible elastomeric where inside the building with white sheet PVC and PVC fitting covers;
 - .3 Aluminium: Unless otherwise specified or required, jacket all pipe insulation outside the building with aluminium;
 - .4 Protective Coatings: Unless otherwise specified or required, apply a protective coating to all flexible elastomeric insulation. Apply one (1) coat where inside the building and two (2) coats where outside the building.
 - .5 Refer to Equipment Insulation Protective Finishes Tables herein for additional requirements.

1.05 QUALITY ASSURANCE

- .1 Qualifications: Execute work of this Section only by skilled tradesmen knowledgeable in the application of insulation to piping, ductwork, and equipment for building fire protection, plumbing and drainage, heating, cooling, and ventilating systems.
- .2 Quality Assurance: Execute work of this Section by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic. The company performing the mechanical insulation work shall be a member in good standing of the Thermal Insulation Association of Canada.

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

1.07 VOC REQUIREMENTS

- .1 All adhesives, sealants, paints and coatings used on or inside of building weatherproofing layer shall have a VOC content that is less than the content limits defined in LEED Product Requirements.

PART 2 - PRODUCTS

2.01 EQUIPMENT INSULATION SELECTION

- .1 Insulate Hot Equipment where surface temperature of equipment in normal service is greater than 122°F (50°C) in accordance with this Section.
- .2 Insulate Cold and Dual Temperature Equipment where surface temperature of equipment in normal service is less than 60°F (14°C) in accordance with this Section complete with a vapour barrier jacket.
- .3 Insulation shall be provided to ensure maximum equipment surface temperature does not exceed 110°F (44°C). Where ASTM C1055 "Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries" allows for surface temperatures to be exceeded, submit for Consultant review the Insulation Trades Value Engineering proposal to reduce the extent of insulation, including a corresponding savings to the Owner. Under no circumstances shall surface temperature on the outside of insulation exceed 140°F (60°C) when equipment is operating under design service conditions.
- .4 Insulation, self-adhesive tape, adhesives and any insulation finishes to be ULC labelled and listed for flame spread rating of less than 25 and smoke development classification of less than 50.

2.02 E1 – BLANKET MINERAL FIBERBOARD

- .1 Application:
 - .1 service temperature: up to jacket surface temperature (air contact) up to 150°F (66°C) and un-jacketed surface temperature (equipment contact) up to 450°F (232°C).
 - .2 rigid for flat surfaces or,
 - .3 scored board for curved surfaces 10 " (250mm) dia and over,
- .2 Materials(s):
 - .1 Rigid, non-combustible fibreglass board insulation complying with the requirements of ASTM C 612, Type II;
 - .2 jacket of kraft bonded to aluminum foil reinforced with glass fibre yarn;
 - .3 thermal performance: 0.23 btu/hr/in/sq ft/°F @ 75°F (0.033 W/m/°C @ 24°C)
 - .4 rated 25/50 per ASTM E 84, UL 723 and NFPA 255.
 - .5 vapor transmission: maximum 0.02 perms

- .6 density: 3.0 lb/cu.ft (48 kg/cu.m)
- .7 product must comply with the requirements of ASTM C 795 when being used over stainless steel,
- .3 Acceptable Manufacturers:
 - .1 Fiberglass,
 - .2 Knauf Fiberglass - Insulating Board
 - .3 Manson,
 - .4 Johns Manville - Manville 814 Spin-Glas
 - .5 Owens Corning - 703 Board
 - .6 Or equivalent.

- .4 Table E1: Blanket Mineral Fibreboard Thicknesses as follows:

TABLE E1: Blanket Mineral Fibreboard Thicknesses		
Service	Operating Temperature Range	Thickness
Hot Water Storage Tanks and Hydro-pneumatic Tanks	up to 200°F (80°C)	2" (50mm)
Hot Equipment plate-and-frame heat exchangers	60°F to 300°F (14°C to 150°C)	2" (50mm)
Cold and Dual Temperature plate-and-frame heat exchangers	Below 60°F (14°C)	2" (50mm)
Air Separators	up to 250°F (107°C)	2" (50mm)
Expansion Tanks	up to 250°F (107°C)	2" (50mm)
Pot feeders and filters.	up to 250°F (107°C)	2" (50mm)
Water softener	Below 60°F (14°C)	1" (25mm)
Any other Cold and Dual Temperature equipment	Below 60°F (14°C)	1" (25mm)

2.03 E2 – MINERAL GLASS SEMI-RIGID BOARD

- .1 Application:
 - .1 service temperature: up to jacket surface temperature (air contact) of 150°F (66°C) and un-jacketed surface temperature (equipment contact) up to 450°F (232°C)
- .2 Materials:
 - .1 to ASTM C795,
 - .2 semi-rigid or scored and folded board,
 - .3 FSK jacket of kraft bonded to aluminum foil reinforced with glass fibre yarn, maximum 0.02 perms to ASTM E96 Procedure A.
 - .4 noncombustible,
 - .5 thermal performance: 0.35 btu/hr/in/sq ft/°F @ 200°F (0.050 W/m/°C @ 93°C)
 - .6 vapor transmission : maximum 0.02 perms
 - .7 product must comply with the requirements of ASTM C 795 when being used over stainless steel,

- .3 Acceptable Manufacturers:
 - .1 John Manville Spin-Glas 813
 - .2 Owens Corning Pipe and Tank
 - .3 Knauf Fibreglass Pipe and Tank
 - .4 Or equivalent
- .4 Table E2: Mineral Glass Semi-rigid Board

TABLE E2: Mineral Glass Semi-rigid Board		
Service	Operating Temperature Range	Thickness
Hot Equipment shell-and-tube heat exchangers	up to 300°F (150°C)	2" (50mm)
Expansion tanks	up to 300°F (150°C)	2" (50mm)
Domestic hot water tank & heaters	up to 200°F (95°C)	1½" (40mm)
Radiant ceiling panels	up to 300°F (150°C)	2" (50mm)
Any other Hot Equipment	up to 300°F (150°C)	2" (50mm)
Cold or Dual Temperature shell-and-tube heat exchangers	Below 60°F (14°C)	2" (50mm)
Water dealkalizer	Below 60°F (14°C)	1" (25mm)
Any other Cold or Dual Temperature equipment	Below 60°F (14°C)	1" (25mm)

2.04 E3 – FLEXIBLE ELASTOMERIC SHEET

- .1 Application:
 - .1 Cold Curved Surfaces -40°F to 200°F (-40 to 95°C)
 - .2 service temperature: up to 82°C (180°F).
- .2 Materials:
 - .1 Flexible fire retardant elastomeric unicellular sheet covering to ASTM C534,
 - .2 sheet self-adhering, roll type,
 - .3 thermal performance: 0.28 btu/hr/in/sq ft/°F @ 75°F (0.04 W/m/°C @ 24°C)
 - .4 manufacturer specific sealer/adhesive.
- .3 Acceptable Manufacturers:
 - .1 Armstrong - AP Armaflex Self-Adhering Sheet Insulation
 - .2 Johns Manville;
 - .3 Nomaco;
 - .4 Therma-Cel
 - .5 Rubatex
 - .6 Or equivalent
- .4 Table E3: Flexible Elastomeric Sheet Thickness

TABLE E3: Flexible Elastomeric Sheet Thickness		
Service	Operating Temperature Range	Thickness
Water meters;	Below 60°F (14°C)	1" (25mm)
Chilled water and glycol cooling system expansion tanks;	Below 60°F (14°C)	1" (25mm)
Chilled water and glycol cooling system storage tanks	Below 60°F (14°C)	1½" (40mm) applied in two (2) staggered ¾" (20mm) layers
Chilled water and glycol cooling system air separators;	Below 60°F (14°C)	1" (25mm)
Chiller evaporator shells;	Below 60°F (14°C)	2" (50mm) applied in two (2) staggered 1" (25mm) layers
Chiller evaporator heads;	Below 60°F (14°C)	1½" (40mm) applied in two (2) ¾" (20mm) layers with removable box
Chiller components as follows: <ul style="list-style-type: none"> • evaporator unit including nozzles; • intercooler including drop leg and heads; • suction connection between compressor and evaporator; • inter-stage gas connection; • liquid connection between intercooler drop leg and evaporator unit; 	Below 60°F (14°C)	1½" (40mm) applied in two (2) staggered ¾" (20mm) layers
Chilled water and glycol cooling system pot feeders and filters;	Below 60°F (14°C)	¾" (20mm) applied in two (2) 3/8" (10mm) layers
Chilled water and glycol cooling system pumps;	Below 60°F (14°C)	1" (25mm) with removable box
Chilled water and glycol cooling pump suction and discharge guides;	Below 60°F (14°C)	1" (25mm) with removable box
Condenser water pump suction and discharge guides used in free cooling applications;		1" (25mm) with removable box
Cold water booster pumps		1" (25mm) with removable box
Cold water booster pumps suction and discharge guides;		1" (25mm) with removable box
Softener tanks;		¾" (20mm)
Pot feeders and filters;		¾" (20mm)

TABLE E3: Flexible Elastomeric Sheet Thickness		
Service	Operating Temperature Range	Thickness
Cold or Dual Temperature heat exchangers.	Below 60°F (14°C)	1½" (40mm) applied in two (2) staggered ¾" (20mm) layers

2.05 E5 – LOW TEMPERATURE PHENOLIC BOARD

- .1 Application:
 - .1 Cold and Dual Temperature Equipment with service temperatures in the range of -100°F to 250°F (-73°C to 121°C)
- .2 Materials:
 - .1 to ASTM C1126 (Gr.1),
 - .2 rigid for flat surfaces,
 - .3 meeting 25/50 flame spread/smoke development when tested to ASTM E84,
 - .4 thermal performance: 0.145 btu/hr/in/sq ft/°F @ 50°F (0.021 W/m/°C@ 10°C)
 - .5 density: 2.3 lb/cu.ft (37 kg/cu.m)
- .3 Acceptable Manufacturers:
 - .1 Kingspan - Koolphen K
 - .2 Or equivalent
- .4 Table E5: Low Temperature Phenolic Board

TABLE E5: Low Temperature Phenolic Board		
Service	Operating Temperature Range	Thickness
Chilled water and glycol cooling system pumps	Below 60°F (14°C)	1" (25mm) with removable box
Cold water booster pumps	Below 60°F (14°C)	1" (25mm) with removable box
Chiller evaporator shell heads;	Below 60°F (14°C)	1" (25mm) with removable box
Chilled water and glycol cooling system storage tank	Below 60°F (14°C)	1" (25mm)
Cold or Dual Temperature heat exchangers.	Below 60°F (14°C)	1" (25mm)
Exterior louver blank-off panels	Below 60°F (14°C)	Two staggered layers of 2" (50mm) sandwiched between two sheets of 20 ga. Galvanized sheet metal

2.06 E6 – MINERAL WOOL FIBRE ROLL:

- .1 Application:
 - .1 Hot Equipment with service temperatures up to 1200°F (650°C)
- .2 Materials:
 - .1 to ASTM C553
 - .2 flexible faced industrial blanket,
 - .3 FRK and black scrim facing,
 - .4 thermal performance: 0.25 btu/hr/in/sq ft/°F @ 100°F (0.04 W/m/°C @ 50°C)
 - .5 density: 8.0 lb/cu.ft (128 kg/cu.m)
- .3 Acceptable Manufacturers:
 - .1 Roxul Enerwrap 80
 - .2 IIG MinWool-1200 Pipe and Tank
 - .3 Or equivalent
- .4 Table E6: Mineral Wool Fibre Roll

TABLE E6: Mineral Wool Fibre Roll		
Service	Operating Temperature Range	Thickness
Shell-and-Tube Heat exchangers	Up to 300°F (150°C)	1" (25mm)
Expansion tanks	Up to 300°F (150°C)	1" (25mm)
Domestic hot water tank & heaters	Up to 300°F (150°C)	1" (25mm)
Any other Hot Equipment	Up to 300°F (150°C)	1½ " (40mm)
Any other Hot Equipment	Between 300°F to 750°F (150°C to 400 °C)	2" (50mm)

2.07 E7 – MINERAL WOOL FIBRE BOARD

- .1 Application:
 - .1 Hot Equipment with service temperatures up to 1200°F (650°C)
- .2 Materials:
 - .1 to ASTM C612
 - .2 rigid board
 - .3 thermal performance: 0.25 btu/hr/in/sq ft/°F @ 100°F (0.04 W/m/°C @ 50°C)
 - .4 density: 4.4 lb/cu.ft (70 kg/cu.m)
 - .5 Roxul RHT 60
 - .6 IIG MinWool-1200 Industrial Board
 - .7 Or equivalent
- .3 Table E7: Mineral Wool Fibre Board:

TABLE E7: Mineral Wool Fibre Board		
Service	Operating Temperature Range	Thickness
Plate-and-frame heat exchangers	Up to 300°F (150°C)	1" (25mm)
Boilers	Up to 300°F (150°C)	2" (50mm)
Any other Hot Equipment	Up to 300°F (150°C)	1½ " (40mm)
Any other Hot Equipment	Between 300°F to 750°F (150°C to 400 °C)	2" (50mm)

2.08 ADHESIVES, FASTENERS, AND TAPE

- .1 Contact bond cement:
 - .1 for quick setting for metal surfaces.
 - .2 85-20 asbestos free, 5sq.2/L
 - .3 Volatile Organic Content: maximum 80 g/L
 - .4 Acceptable Manufacturers:
 - .1 Bakor - No. 220-05
 - .2 Foster – Drion 85-75
 - .3 Armstrong: 520.
 - .4 Or equivalent
- .2 Lap seal adhesive:
 - .1 Quick-setting for joints and lap sealing of vapour barriers;
 - .2 asbestos free, 6 sq.m/L;
 - .3 Volatile Organic Content: maximum 250 g/L
 - .1 Bakor 220-05
 - .2 Childers CHIL-STIX FRN CP-82
 - .3 Foster 85-70
 - .4 Or equivalent
- .3 Fibrous insulation adhesive:
 - .1 Volatile Organic Content: maximum 250 g/L
 - .2 Acceptable Manufacturers:
 - .1 Childers CHIL-STIX FRN CP-82
 - .2 Foster No. 85-70
 - .3 Or equivalent
- .4 Vapour barrier tape:
 - .1 Self Adhesive: 4" (100mm) wide.
 - .2 colour matched and foil faced
 - .3 UL 181A listed.
 - .4 Acceptable Manufacturers:
 - .1 Johns Manville - Zeston Z-Tape
 - .2 MacTac Canada Limited - Vinyl Scrim or Foil Scrim Kraft

- .3 Compac Corp.
 - .4 Fattal Canvas Inc. – Insultape
 - .5 Or equivalent
- .5 Weld Pins, Studs and Clips:
 - .1 Acceptable Manufacturers:
 - .1 Midwest Fasteners
 - .2 Continental Studwelding
 - .3 Or equivalent
- .6 Staples:
 - .1 Monel, flare type, minimum size ½" (12mm)
- .7 Tie Wire
 - .1 16 ga (1.6mm) stainless steel with twisted ends.
- .8 Caulking for equipment jackets (outdoor use only):
 - .1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.
 - .2 Acceptable Manufacturers:
 - .1 Foster 95-44
 - .2 Or equivalent

2.09 COATINGS AND MEMBRANES

- .1 Reinforcing Membrane:
 - .1 synthetic fibre:
 - .1 Leno weave,
 - .2 indoor and outdoor use.
 - .3 Acceptable Manufacturers
 - .1 Foster Mast-A-Fab
 - .2 Or equivalent
 - .2 glass-fibre fabric:
 - .1 indoor use.
 - .2 Acceptable Manufacturers
 - .1 Childers Chil-Glas #5/#10
 - .2 Or equivalent
 - .3 glass-fibre fabric for use with elastomeric closed cell foam:
 - .1 indoor use.
 - .2 Acceptable Manufacturers
 - .1 Childers Chil-Glass #10
 - .2 Or equivalent
- .2 Breather Coating - Indoors:
 - .1 for breather coatings and lagging adhesive,
 - .2 Volatile Organic Content: maximum 50 g/L
 - .3 white in colour,
 - .4 for insulation except elastomeric closed cell foam.

- .5 Acceptable Manufacturers
 - .1 Childers CP-50A HV2
 - .2 Foster 30-36
 - .3 Or equivalent
- .3 Breather Mastic - Outdoors:
 - .1 for breather coatings and lagging adhesive,
 - .2 abrasion resistive, flexible,
 - .3 UV stabile,
 - .4 grey in colour.
 - .5 Acceptable Manufacturers:
 - .1 Childers Vi-Cryl CP-10/11
 - .2 Foster 35-00 / 45-00
 - .3 Bakor 120-10
 - .4 Or equivalent
- .4 Vapor Barrier Coatings - Indoors:
 - .1 Volatile Organic Content: maximum 50 g/L.
 - .2 for vapor barrier coatings and lagging adhesive except for elastomeric closed cell foam,
 - .1 permeance rating 0.02 perms maximum,
 - .2 white in colour
 - .3 Acceptable Manufacturers:
 - .1 Childers Chil Perm CP-34/35
 - .2 Foster 30-80, 30-90
 - .3 Or equivalent
 - .4 for use with elastomeric closed cell foam.
 - .1 Acceptable Manufacturers:
 - .1 Childers CHIL-SPRAY WB CP-56 Adhesive
 - .2 Or equivalent
- .5 Vapor Barrier Mastic - Outdoors:
 - .1 for vapor barrier coatings and lagging adhesive,
 - .2 asphalt cutback,
 - .3 permeance rating 0.02 perms maximum,
 - .4 grey in colour.
 - .5 for outdoor use only; not rated to meet fire/smoke rating of 25/50.
 - .6 Acceptable Manufacturers:
 - .1 Childers Chil-Pruf CP-22
 - .2 Foster 60-25/60-26
 - .3 Or equivalent
- .6 Insulation Cement
 - .1 Hydraulic-setting finishing type.

2.10 FIELD APPLIED FINISHES

- .1 Fabric finish jacket:
 - .1 ULC listed plain weave cotton fabric at 6 oz/sq.yd (220 g/sq.m) treated with fire retardant lagging adhesive, or
 - .2 re-wettable fiberglass lagging fabric with water activated self-adhesive.
 - .3 suitable for field painting.
 - .4 Acceptable Manufacturers:
 - .1 Fattal's Thermocanvas
 - .2 Alpha-Maritex 3451-RW
 - .3 Clairmont Diplag 60
 - .4 Glass-Cell FR
 - .5 Newtex - Zetex Rewettable
 - .6 Or equivalent
- .2 PVC (Polyvinyl Chloride) finish jacket:
 - .1 minimum 20 mil thickness with permeability not more than 0.09 perms,
 - .2 flexible flat-sheet,
 - .3 Acceptable Manufacturers:
 - .1 Johns Manville - Manville Zeston 2000
 - .2 ACWIL Insulations
 - .3 Sure Fit Systems
 - .4 Proto PVC – LoSMOKE
 - .5 Or equivalent
 - .4 pressure sensitive, colour matching vinyl tape.
- .3 Metal finish jacket:
 - .1 Equipment:
 - .1 stucco embossed aluminum not less than 0.45 mm (0.016 in) thick sheet or,
 - .2 corrugated stainless steel not less than 0.25 mm (0.010 in) thick sheet.
 - .2 Fittings:
 - .1 Custom made swaged ring or lobster back covers on bends and die shaped fitting covers over fitting, valves, strainers, flanges, and grooved couplings.
 - .3 Bands:
 - .1 ½" (12mm) wide stainless steel with mechanical fasteners.
 - .4 Acceptable Manufacturers:
 - .1 Alcan Canada Products - Thermaclad Type 1
 - .2 Childers Products Inc. - Fab Straps
 - .3 Or equivalent
- .4 Self-adhesive weather barrier membrane (SAWB):
 - .1 self-adhering membrane of acrylic adhesive with siliconized release paper, not exceeding flame/smoke generation rating of 25/50, for indoor and outdoor use,
 - .2 self-adhering membrane of rubberized asphalt compound with siliconized release paper, for outdoor use only
 - .3 laminated to stucco-embossed aluminum foil,

- .4 self-sealing with penetration of self-tapping screws.
- .5 water vapour permeance 0.05 perms.
- .6 Acceptable Manufacturers:
 - .1 VentureClad 1579CW - indoor and outdoor applications
 - .2 Bakor - Foilskin - outdoor applications
 - .3 Polyguard Products Alumaguard 60 - outdoor applications
 - .4 Or equivalent
- .5 Protective finish for elastomeric cellular foam insulation
 - .1 indoors and outdoors:
 - .2 Acceptable Manufacturers:
 - .1 Armaflex WB Finish
 - .2 Or equivalent

2.11 REMOVABLE/REUSABLE HIGH TEMPERATURE INSULATION BLANKETS

- .1 custom fabricated single piece construction, removable insulation covers for hot surfaces,
- .2 suitable for outdoor use,
- .3 maximum touch-safe temperature protection: 203°F (95°C) (to UL2200.
- .4 insulation: high density, fire resistant mineral or fibreglass insulation suitable for system operating temperature.
- .5 cover: silicone impregnated fibreglass cover, for temperatures up to 500°F (260°C)
- .6 internal liner: silicone impregnated fibreglass fabric, or stainless steel knitted wire mesh.
- .7 metal identification tag, referenced equipment served.
- .8 tie-straps with D-rings, or Velcro™ closures.
- .9 Acceptable Manufacturers:
 - .1 Firwin Corporation
 - .2 Thermohelp Canada Inc.
 - .3 Or equivalent

2.12 RADIANT CEILING PANEL INSULATION:

- .1 Provision of insulation over radiant ceiling panels shall be by the Insulation Trades.
- .2 Insulation shall be foil faced back, mineral 2" (50mm).
- .3 Fibre blanket shall be in accordance with CGSB51-GP-1M and Amdt Apr.78 and GCSB51-GP-52M.

2.13 VINYL NOISE ATTENUATION WRAP:

- .1 1.0 lb/sq.ft non-lead loaded non-reinforced vinyl barrier sheets faced with a fibrous glass "scrim" reinforced aluminium foil facing on one side.
- .2 Thickness: 0.09"
- .3 Flammability: Must pass UL94V and FMVSS 302. Meet Class A flammability rating per ASTM E-84.
- .4 All hangers, support rods, concrete anchors shall be in accordance with manufacturers' Instructions.
- .5 Sound transmission loss requirements based on ASTM E90-09 and ASTM E413-04

TABLE 7 – Sound Transmission Loss (db per Centre Line Frequency)						
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	STC
15	16	21	26	33	38	26

- .6 Acceptable Manufacturer (as listed or equal): EAR Specialty Composites Tufcote Noise Barrier Lag-10, Audioseal Sound Barrier AB10-Lag.

PART 3 - EXECUTION

3.01 GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

- .1 Insulation Thickness: All plumbing piping to be insulated, including insulation for condensate drain piping from equipment drain pans, and refrigerant piping, shall be minimum 25 mm thick unless noted otherwise.
- .2 Performance Requirements: As a minimum, insulation application methods and standards shall be as per the NATIONAL INSULATION STANDARDS of the Thermal Insulation Association of Canada.
- .3 General Insulation Application Requirements: General requirements pertaining to the application of mechanical insulation are specified below. Unless otherwise specified, do not insulate the following:
 - .1 factory insulated equipment /plenums/ panels and piping;
 - .2 heated liquid system pump casings, valves, strainers and similar accessories;
- .4 Place insulation with joints staggered and tightly butted,
- .5 Secure insulation with:
 - .1 stainless steel bands 300 mm (12 in) on centre, or
 - .2 attach to equipment surfaces with adhesive, applied in strips 150 mm (6 in) wide at 300 mm (12 in) on centre.
 - .3 do not use weld pins on plate-and-frame heat exchangers.
- .6 Curved surfaces with radius less than 250 mm (10 in):
 - .1 insulate with type E-1, E-3, or E-6 insulation as shown.
- .7 Flat surfaces, and curved surfaces with radius 250 mm (10 in) and greater:
 - .1 insulate with type E-2, E-4, E-5, E-7 as shown.
 - .2 provide metal corner beads to reinforce corners and edges.
- .8 Irregular shaped surfaces (cold and dual temperature only):
 - .1 insulate with type E-1 or E-3 as shown,
 - .2 use preformed insulation fittings, mitred segments of board insulation, or flexible blanket insulation with portions built-up to specified thickness.
- .9 Nozzles, manholes, and access doors:
 - .1 terminate insulation with straight cut with space of 25 mm (1 in) at connection,
 - .2 seal cut with insulation coatings/mastic beveled away from flanged or union connections; and
 - .3 cover flanged joint, union, manhole and access doors with removable and replaceable aluminum insulated box overlapping adjacent insulation by 50 mm (2 in) and secured with bands.
- .10 Instruments and instrument sensor risers:
 - .1 tightly fit equipment insulation to instrument riser/piping,

- .2 in addition for cold and dual temperature equipment, insulate the instrument sensor riser for a length equal to four (4) times the diameter of the riser pipe.
- .11 Flanges and Mechanical Couplings: Terminate sectional insulation approximately 50 mm from the flange or coupling on each side of the flange or coupling. Cover the flange or coupling with a minimum 50 mm thickness of blanket mineral fibre insulation wide enough to butt tightly to the ends of the adjacent sectional insulation. Secure the blanket insulation in place and cover with a PVC cover.
- .12 For cold surfaces with the possibility of condensation, install insulation directly over pipes and ducts and not over hangers and supports.
- .13 For warm surfaces, line size hangers shall be permitted and insulation shall cover the hanger to maintain the specified thickness in accordance with ASHRAE 90.1.
- .14 On equipment insulation with vapour barriers, maintain integrity of vapour barrier without penetration.
- .15 Do not cover equipment nameplates with insulation. Do not allow insulation to interfere with the operation of mechanical equipment or the equipment of other Divisions.

3.02 SEALING INSULATION - HOT EQUIPMENT

- .1 Indoor installation:
 - .1 no sealing of insulation is required prior to application of finish protection.
- .2 Outdoor installation:
 - .1 apply breather mastic with reinforcing membrane over equipment insulation, regardless of final finish application.
 - .2 apply mastics when ambient temperature is above 40°F (4°C), unless manufacturer's instructions permit colder ambient installation conditions.

3.03 SEALING INSULATION - COLD AND DUAL TEMPERATURE EQUIPMENT

- .1 Type E1, E2, and E5 insulation - indoor and outdoor installation:
 - .1 apply vapor barrier coating/mastic with reinforcing membrane over equipment insulation, regardless of final finish application.
 - .2 only use mastics on outdoor installations.
 - .3 apply mastics and coatings when ambient temperature is above 4°C (40°F), unless manufacturer's instructions permit colder ambient installation conditions.
 - .4 at pipe connections, cut-back insulation and seal with coating/mastic; insulate pipe flanges in accordance with requirements for piping insulation.
 - .5 at instruments and instrumentation sensor riser, cut-back and seal insulation with coating/mastic at riser, and seal sensor riser insulation.
- .2 Type E3 (flexible elastomeric closed cell foam) insulation - indoor installation:
 - .1 seal transverse and butt joints with sealer/adhesive.

3.04 INSULATION FINISH

- .1 Install protective finish on insulation in accordance with Equipment Insulation Protective Finishes Table herein, after breather and vapour barrier sealing is completed.
- .2 Install finish jacket materials used for covering to allow 50 mm to 100 mm (2 in to 4 in) overlap on longitudinal and circumferential edges.
- .3 On vertical tanks, vessels, and similar equipment. arrange circumferential overlap on adjacent sheets outside of sheet below and under sheet above.
- .4 PVC sheeting :
 - .1 Hot Equipment:

- .1 overlap longitudinal edges and adjacent sheets by minimum of 2" (50mm) and staple fasten the sheets.
 - .2 secure sheeting with colour matched tape around circumference, at least two places per section of sheet, and by stapling longitudinal and circumferential edges.
 - .3 do not seal edges with vapour barrier tape.
- .2 Cold and Dual Temperature Equipment:
 - .1 overlap longitudinal edges and adjacent sheets by minimum of 50 mm (2 in) and seal longitudinal edges with vapor barrier coating adhesive for full depth and 100% coverage of overlap,
 - .2 seal circumferential edges of PVC fitting covers with reinforced vapour barrier coating adhesive extending over adjacent pipe insulation section with an overlap of at least 50 mm (2 in).
 - .3 seal PVC fitting covers at throat and heel seams by solvent bonding and secured over insulation with reinforced vapor barrier coating/mastic overlapping adjacent pipe insulation a minimum of 2" (50mm).
- .5 Metal:
 - .1 Use lock-on systems or secure sheeting with bands 18" (450mm) apart.
 - .2 Joint sealing:
 - .3 Hot equipment: do not seal joints.
 - .4 Cold and Dual Temperature equipment: seal joints with caulking.
 - .5 Curved surfaces: custom made swaged ring or lobster back covers.
 - .6 On outdoor hot and cold/dual temperature equipment, caulk overlapping metal joints to permit expansion of metal jacket.
- .6 Fabric:
 - .1 Cotton lagging:
 - .1 apply cotton lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the piping system, and finish to provide a smooth surface free of wrinkles and sags.
 - .2 where cotton lagging with appropriate coating is used this satisfies the requirements of a sealer coating for Hot or Cold/Dual temperature piping systems.
 - .2 Fibreglass lagging:
 - .1 apply re-wettable fiberglass lagging in accordance with manufacturer instructions. Finish to provide a smooth surface free of wrinkles and sags.
 - .2 where re-wettable fiberglass lagging is used this satisfies the requirements of a sealer coating for Hot piping systems.
 - .3 Type E3 (flexible elastomeric closed cell foam) insulation:
 - .1 apply thin coat of lagging adhesive, and apply glass mesh,
 - .2 when dry apply indoor or outdoor finish at 400 square feet per gallon,
 - .3 apply second coat of same material, at same rate of application, after four hours.
- .7 Equipment Insulation Protective Finishes Table

Equipment Insulation Protective Finishes Table				
Location	Weather Exposure	System/Space	Finish	Insulation Type
Concealed	Indoors	All	Fabric	E1, E2, E4, E5, E6, E7, E8, E9
Exposed	Indoors	Service Rooms	Fabric or PVC	E1, E2, E4, E5, E6, E7, E8, E9
	Indoors	Public Spaces	PVC	E1, E2, E4, E5, E6, E7, E8, E9
	Outdoors	All	Metal	E1, E2, E4, E5, E6, E7, E8, E9
	Outdoors	All	SAWB	E1, E2, E4, E5, E6, E7, E8, E9

3.05 CENTRIFUGAL REFRIGERATION MACHINES

- .1 insulate evaporator shell with two staggered layers of $\frac{3}{4}$ " (20mm) type E-3 insulation adhered to clean oil-free metal surfaces by compression fit method with full coverage of adhesive.
- .2 Insulate refrigeration machine evaporator heads and water boxes with removable, replaceable insulated boxes consisting of:
 - .1 16 ga. (1.6mm) aluminum or stainless steel sheeting, with edges and corners caulked and sealed;
 - .2 lined with $1\frac{1}{2}$ " (40mm) of two layers $\frac{3}{4}$ " (20mm) thick type E-3, or one layer 1" (25mm) thick E-4 insulation;
 - .3 vapour seal joints between adjacent casing sections after box is in place, and;
 - .4 attach boxes so that they may be removed without disturbing casing insulation.

3.06 FIELD APPLIED FINISHES

- .1 Fabric finish jacket application: All exposed insulated equipment (except chiller) including:
 - .1 heat exchangers;
 - .2 storage tanks;
 - .3 air separators;
 - .4 deaerator tanks;
 - .5 blowdown tanks;
 - .6 condensate receivers;
 - .7 flash tanks.

3.07 MECHANICAL DAMAGE PROTECTION - INDOORS

- .1 Protect exposed insulated equipment floor supports with 18 ga. (1.2 mm) stainless steel jacket approximately 4" (100mm) high, secured to floor slab. Conceal fastenings by floor plate.

3.08 FIELD INSPECTION QUALITY CONTROL

- .1 The Consultant reserves the right to have protective finish coverings removed on up to 5% of all fittings, flanges, couplings, and accessories to review the sealing of the insulation, at no change in cost.
- .2 Upon inspection, if insulation sealing is found to be incorrect at any one, the Consultant, in their sole discretion, may call for the removal of the protective finish on all fittings, flanges, couplings, and accessories for further review.
- .3 Repair defective sealing and replace protective coverings at no additional cost to the Owner.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with the requirements of Section 20 05 05 Mechanical Demolition

1.02 SCOPE OF WORK

- .1 Demolition and removal of existing pipe insulation.
- .2 Generally piping to be insulated shall include, but not limited to, the following:
 - .1 potable and non-potable cold water piping;
 - .2 potable and non-potable hot water piping, supply and recirculation;
 - .3 tempered potable and non-potable water piping, supply and return;
 - .4 storm drainage piping from roof drains to the point where main vertical risers extend straight down, without offsets, and connect to horizontal mains;
 - .5 condensate drainage piping from air conditioning equipment drain pans;
 - .6 chilled water piping, supply and return;
 - .7 hot water heating piping, supply and return;
 - .8 glycol solution heating or heat reclaim piping, supply and return;
 - .9 chilled glycol solution piping, supply and return
 - .10 steam piping;
 - .11 condensate piping;
 - .12 all piping located outside building or inside building in unheated areas and indicated to be traced with electric heating cable;
 - .13 air compressor set fresh air intake piping;
 - .14 refrigerant piping;
 - .15 Refer to Insulation Thickness Tables herein and Part 3 of these Specifications for additional requirements.
- .3 Finishes for Insulation shall include, but not limited to, the following:
 - .1 Canvas: Unless otherwise specified or required, jacket all exposed calcium silicate insulation, exposed mineral fibre duct, plenum and casing insulation, and mineral fibre equipment insulation with canvas;
 - .2 PVC: Unless otherwise specified or required, jacket all exposed pipe insulation other than calcium silicate and flexible elastomeric where inside the building with white sheet PVC and PVC fitting covers;
 - .3 Aluminum: Unless otherwise specified or required, jacket all pipe insulation outside the building with aluminum;
 - .4 Protective Coatings: Unless otherwise specified or required, apply a protective coating to all flexible elastomeric insulation. Apply one (1) coat where inside the building and two (2) coats where outside the building.

1.03 REFERENCES

- .1 Thermal Insulation Association of Canada (TIAC) National Insulation Standard, excluding section 12
- .2 NFPA 90-A Installation of Air-Conditioning and Ventilating Systems

- .3 ASHRAE/IES 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
- .4 NFPA 255 Test of Surface Burning Characteristics of Building Materials
- .5 CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering, and Miscellaneous Materials and Assemblies
- .6 ASTM C411 Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation
- .7 ASTM C518 Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flo Meter Apparatus
- .8 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
- .9 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- .10 ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation
- .11 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation
- .12 ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
- .13 ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
- .14 ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
- .15 ASTM C1055 Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries
- .16 ASTM C1126 (Gr.1) Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation
- .17 CGSB 51-GP-52MA Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.
- .18 CGSB 51.53-95 Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts.

1.04 DEFINITIONS

- .1 "Ambient": as applied to temperatures means outdoor design temperature.
- .2 "Concealed": as applied to mechanical services and equipment located in space above opaque suspended ceilings, and within trenches not in boiler rooms, pipe and/or duct shafts, and non-accessible chases and furred spaces.
- .3 "Exposed": as applied to remainder of mechanical services and equipment which are not "concealed" as defined above. For greater certainty, the following locations are Exposed:
 - .4 Services in tunnels,
 - .5 Services in space beneath raised floors.
 - .6 Trenches located in boiler rooms.
- .7 "Conditioned air": air supplied from air handling units which heats, cools, dehumidifies, or humidifies the air.
- .8 "Unconditioned space": rooms or spaces that are not supplied with conditioned air, including ceiling spaces which are not part of a ceiling return plenum system
- .9 "Outdoor": mechanical services and equipment located outside of the building envelope including services located beneath overhangs and soffits, and exposed to any outdoor condition including temperature, sun exposure, or precipitation.
- .10 "Mastic": heavy-consistency waterproof compound for outdoor applications used in conjunction with reinforcing fabric that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish to insulation.

- .11 "Coating": light-consistency compound for indoor applications used in conjunction with reinforcing fabric, to provide either a breathable or vapour barrier finish to insulation.
- .12 "Finish Jacket": final finish protective layer for insulation, including lagging fabric, PVC, metal, and adhesive films; that provides weather-protective finish depending on application.
- .13 "Service temperature": for purpose of piping temperature, is equal to the gas or vapour design operating temperature, or the liquid supply operating temperature.
- .14 "Pure water": water which has been treated with filtration equipment, including but not limited to reverse osmosis, deionization, ultra-filtration, ultra-violet, distillation or any combination of such or similar equipment, to achieve water quality significantly free of impurities.

1.05 QUALITY ASSURANCE

- .1 Qualifications: Execute work of this section only by skilled tradesmen regularly employed in the application of insulation to piping, ductwork, and equipment for building fire protection, plumbing and drainage, heating, cooling, and ventilating systems.
- .2 Insulation, self-adhesive tape, adhesives and any insulation finishes to be ULC labelled and listed for flame spread rating of less than 25 and smoke development classification of less than 50.
- .3 Insulating Trades performing the work shall be a member in good standing of the Thermal Insulation Association of Canada.
- .4 Acceptable Manufacturers:
 - .1 Insulation: Fiberglas Canada Inc., Knauf Fiber Glass, Manson, Roxul, or equivalent.
 - .2 Tape: Avery Dennison, Mactac, Tuck, Compac, or equivalent.
 - .3 Canvas: Fattal hermocanvas, Alpa-Maritex 3451-RW, Clairmont Diplag 60, or equivalent.
 - .4 Lagging adhesive: Childers CP.50A-HV2, Fosters 30-36 asbestos free, or equivalent.

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

1.07 VOC REQUIREMENTS

- .1 All adhesives, sealants, paints and coatings used on or inside of building weatherproofing layer shall have a VOC content that is less than the content limits defined in LEED Product Requirements.

PART 2 - PRODUCTS

2.01 PIPING INSULATION SELECTION

- .1 Insulate Hot Piping where surface temperature of equipment in normal service is greater than 122°F (50°C) in accordance with this Section.
- .2 Insulate Cold and Dual Temperature Piping where surface temperature of equipment in normal service is less than 60°F (14°C) in accordance with this Section complete with a vapour barrier jacket.
- .3 Insulation shall be provided to ensure maximum piping surface temperature does not exceed 110°F (44°C). Where ASTM C1055 "Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries" allows for surface temperatures to be exceeded, submit for Consultant review the Insulation Trades Value Engineering proposal to reduce the extent of insulation, including a corresponding savings to the Owner. Under no circumstances shall surface temperature on the outside of insulation exceed 150°F (66°C) when piping system is operating under design service conditions.

- .4 Insulation, self-adhesive tape, adhesives and any insulation finishes to be ULC labelled and listed for flame spread rating of less than 25 and smoke development classification of less than 50.

2.02 P1 – FORMED FIBROUS GLASS:

- .1 Application:
 - .1 Pipe size application: up to and including **NPS 24"**
 - .2 Factory molded rigid pipe insulation system P1 **for hot system piping, valves, and fittings.**
- .2 Material(s):
 - .1 Insulate all piping with a preformed fiberglass pipe insulation, complying with **ASTM C 547**, Class 3 to 850°F. (454°C.), rigid, moulded pipe insulation, non-combustible and conforming with the following:
 - .1 reduced environmental impact feature of either: bio-based binders, 25% minimum recycled glass content, and/or paper-free ASJ jacket material.
 - .2 thermal performance: 0.23 btu/hr/in/sq ft/°F @ 75°F (0.033 W/m/°C @ 24°C)
 - .3 service temperature: -18°C (0°F) to jacket surface temperature (air contact) of 66°C (150°F) and un-jacketed surface temperature (equipment contact) up to 232°C (450°F).
 - .4 noncombustible meeting 25/50 flame spread/smoke developed when tested to ASTM E84, UL 723 and NFPA 255;
 - .5 when used over stainless steel, product must comply with ASTM C795 "Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel".
- .3 Vapour Retardant Jacketing:
 - .1 ASJ white jacket of "KRAFT" paper-free bonded to aluminum foil reinforced with glass fibre yarn and self-sealing longitudinal laps and butt strips, maximum 0.02 perms to ASTM E96 Procedure A.
- .4 Acceptable Manufacturers:
 - .1 Fiberglass Canada: 850 with ASJ-SSL Jacket,
 - .2 Manson: Alley K with all-purpose APT Jacket,
 - .3 Knauf Fiberglass Redi-Klad 1000 Ecosse (bio-based binders)
 - .4 John Manville Micro-Lok HP (25% recycled content)
 - .5 Owens Corning Fiberglas Evolution (paper-free ASJ)
 - .6 Or Equivalent
- .5 Table P1 – Formed Fibrous Glass Insulation Thicknesses:

TABLE P1- Formed Fibrous Glass Insulation Thicknesses							
Service	Fluid Design Operating Temperature Range	Insulation Thickness Based On Nominal Pipe Size (in.)					
		Runouts Up to 2"	1" & less	1-1/4" to 2"	2-1/2" to 4"	6"	8" & larger
Dom. Hot Water & Recirc Piping & Tempered Water	Up to 180°F Up to 82°C	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.5" 40mm	1.5" 40mm	1.5" 40mm
Hot water Heating, Glycol and Reheat, Snow Melting, Heat Recovery	Up to 200°F. Up to 93°C.	1.0" 25mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm
Humidification	Up to 250°F. Up to 121°C.	1.0" 25mm	1.5" 40mm	1.5" 40mm	2.0" 50mm	2.0" 50mm	3.5" 90mm
Condensate Lines (Low Pressure)	Up to 200°F. Up to 93°C.	0.5" 12mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm
Equipment Drain Lines, Safety Valve Vents, etc.	Up to 200°F. Up to 93°C.	0.5" 12mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm
Drains Under Counter	Up to 180°F. Up to 82°C	n/a	1.0" 25mm	1.0" 25mm	1.0" 25mm	n/a	n/a
Notes: (1) Insulation exposed to exterior shall be double the stipulated thickness in two staggered layers. (2) Steam Lines: For steam pressures not listed above, use insulation thickness as specified for the next higher pressure listed.							

2.03 P2 – FORMED FIBROUS GLASS WITH VAPOUR BARRIER:

- .1 Application:
 - .1 Pipe size application: up to and including **NPS 24"**
 - .2 Insulation System P2 for cold and dual temperature (hot and cold) system piping, valves and fittings.
- .2 Material(s):
 - .1 Insulate all piping with a preformed fiberglass pipe insulation, complying with **ASTM C 547**, Class 3 to 850°F. (454°C.), rigid, moulded pipe insulation, non-combustible and conforming with the following:
 - .1 reduced environmental impact feature of either: bio-based binders, 25% minimum recycled glass content, and/or paper-free ASJ jacket material.
 - .2 thermal performance: 0.23 btu/hr/in/sq ft/°F @ 75°F (0.033 W/m/°C @ 24°C)
 - .3 service temperature: -18°C (0°F) to jacket surface temperature (air contact) of 66°C (150°F) and un-jacketed surface temperature (equipment contact) up to 232°C (450°F).
 - .4 noncombustible meeting 25/50 flame spread/smoke developed when tested to ASTM E84, UL 723 and NFPA 255;

- .5 when used over stainless steel, product must comply with ASTM C795 "Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel".
- .3 Vapour Retardant Jacketing:
 - .1 ASJ white jacket of "KRAFT" paper-free bonded to aluminum foil reinforced with glass fibre yarn and self-sealing longitudinal laps and butt strips, maximum 0.02 perms to ASTM E96 Procedure A.
- .4 Acceptable Manufacturers:
 - .1 Fiberglass Canada: 850 with ASJ-SSL Jacket,
 - .2 Manson: Alley K with all-purpose APT Jacket,
 - .3 Knauf Fiberglass Redi-Klad 1000 Ecosse (bio-based binders)
 - .4 John Manville Micro-Lok HP (25% recycled content)
 - .5 Owens Corning Fiberglas Evolution (paper-free ASJ)
 - .6 Or Equivalent
- .5 Table P2 – Formed Fibrous Glass with Vapour Barrier Insulation Thicknesses:

TABLE P2- Formed Fibrous Glass with Vapour Barrier Insulation Thicknesses							
Service	Fluid Design Operating Temperature Range	Insulation Thickness Based On Nominal Pipe Size (in.)					
		Runouts Up to 2"	1" & less	1-1/4" to 2"	2-1/2" to 4"	6"	8" & larger
Domestic Cold Water, RO Water, DI Water, Softened Water, Dialysis Water	40 to 50°F (4 to 10°C)	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.5" 40mm	1.5" 40mm
Storm Water	n/a	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm
Chilled Water Piping, Condensate Drain Piping/ Drain Pans	40 to 65°F (4 to 18°C)	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.5" 40mm	1.5" 40mm
Refrigeration machine oil cooler and purge	n/a	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm
Drain from Sinks and Lavatories	n/a	n/a	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.5" 40mm	1.5" 40mm
Heat Traced Piping Systems	n/a	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	2.0" 50mm	2.0" 50mm
Sanitary Piping	n/a	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm

2.04 P3 - GLASS FIBRE SEMI-RIGID BOARD

- .1 Application for hot system piping, valves, and fittings as follows:

- .1 pipe size application: **NPS 16" and larger:**
- .2 service temperature: up to 454°C (850°F)
- .2 Material:
 - .1 to ASTM C795,
 - .2 scored and folded board,
 - .3 ASJ jacket of kraft bonded to aluminum foil reinforced with glass fibre yarn, maximum 0.02 perms to ASTM E96 Procedure A.
 - .4 noncombustible meeting 25/50 flame spread/smoke developed when tested to ASTM E84,
 - .5 thermal performance: 0.35 btu/hr/in/sq ft/°F @ 200°F (0.050 W/m/°C @ 93°C)
 - .6 vapor transmission : maximum 0.02 perms
- .3 Acceptable manufacturers:
 - .1 John Manville Spin-Glas 813
 - .2 Owens Corning Pipe and Tank
 - .3 Knauf Fibreglass Pipe and Tank
 - .4 Or equivalent
- .4 Vapour Retardant Jacketing:
 - .1 White "KRAFT" paper-free reinforced with a glass fibre yarn and bonded to an aluminium foil, with self-sealing longitudinal laps and butt strips.
- .5 Table P3 –Glass Fiber Semi-Rigid Board Insulation Thicknesses:

TABLE P3- Glass Fiber Semi-Rigid Board Insulation Thicknesses							
Service	Fluid Design Operating Temperature Range	Insulation Thickness Based On Nominal Pipe Size (in.)					
		Runouts Up to 2"	1" & less	1-1/4" to 2"	2-1/2" to 4"	6" to 14"	16" & larger
Steam and Condensate ≤ 15 psi (100 kPa)	201 to 250°F (94 to 121°C)	---	n/a	n/a	n/a	n/a	3.5" 90mm
Safety relief piping	251 to 350°F (122 to 176°C)	---	n/a	n/a	n/a	n/a	3.5" 90mm

2.05 P4 – FLEXIBLE FIBROUS GLASS BLANKET WITH VAPOUR BARRIER:

- .1 Application:
 - .1 Blanket type roll insulation for **cold and dual temperature (hot and cold) system piping, valves and fittings.**
- .2 Material(s):
 - .1 CGSB 51-GP-11M+Amdt-Apr-78, mineral fibre blanket for piping and CGSB 51-GP-52M vapour barrier jacket and facing material.
 - .2 24 kg/cu.m density;

- .3 installed "RSI" value of 0.83 sq.m°C/W;
- .4 factory applied vapour barrier facing;
- .5 noncombustible meeting 25/50 flame spread/smoke developed when tested to ASTM E84.
- .3 Acceptable Manufacturers:
 - .1 Fiberglass Canada;
 - .2 Manson;
 - .3 Knauf;
 - .4 Or equivalent.
- .4 Thickness:
 - .1 Table 3 – Flexible Fibrous Glass With Vapour Barrier-Insulation follows:

TABLE P4 – Flexible Fibrous Glass with Vapour Barrier		
Service	Line Size Nominal	Thickness
Underside of roof drain body	All Sizes	1" (25mm)

2.06 P5 – FLEXIBLE FOAM ELASTOMERIC CLOSED CELL

- .1 Application:
 - .1 Preformed flexible elastomeric closed cell insulation for installation on **cold and dual temperature (hot and cold) system piping, valves and fittings.**
- .2 Material(s):
 - .1 to ASTM C534 "Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form"
 - .2 thermal performance: 0.04 W/m°C @ 24°C (0.28 btu/hr/in/sq ft°F @ 75°F) established in accordance with ASTM C 177 "Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus" or ASTM C 518 "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus";
 - .3 CAN2-51.40-M80+Amendment-Aug-83 "Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering", flexible fire retardant elastomeric unicellular sheet and pipe covering;
 - .4 pipe size application: up to and including **NPS 6"**
 - .5 service temperature: -40°F to 203°F (-40°C to 95°C)
 - .6 tubular with self-sealing seams
 - .7 noncombustible meeting 25/50 flame spread/smoke developed when tested to ASTM E84,
 - .8 a water vapour transmission rating of 0.08 in accordance with ASTM E96-90, Procedure A;
 - .9 manufacturer specific sealer/adhesive.
- .3 Acceptable manufacturers:
 - .1 ARMACELL - AP Armaflex SS Pipe Insulation
 - .2 Johns Manville.
 - .3 Rubatex
 - .4 Or equivalent
- .4 Table P5 – Flexible Elastomeric Insulation Thickness:

TABLE P5- Flexible Elastomeric Insulation Thickness							
Service	Fluid Design Operating Temperature Range	Insulation Thickness Based On Nominal Pipe Size (in.)					
		Runouts Up to 2"	1" & less	1-1/4" to 2"	2-1/2" to 4"	6"	8" and larger
Refrigeration suction and hot gas lines (also see architectural drawings for walk-in freezers/coolers location);	-40°F to 203°F (-40°C to 95°C)	---	1.5" 40mm	1.75" 45mm	2.0" 50mm	2.0" 50mm	---
chilled water piping connections to chiller;	40°F to 65°F (4°C to 18°C)	---	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	---
chilled water pot feeder and filter.	40°F to 65°F (4°C to 18°C)	---	1.0" 25mm	1.0" 25mm	1.0" 25mm	1.0" 25mm	---
Equipment Drains	40 to 65°F (4 to 18°C)	---	0.75" 20mm	0.75" 20mm	0.75" 20mm	0.75" 20mm	---

2.07 P6 - MOLDED PHENOLIC RIGID

- .1 Application:
 - .1 For use in high humidity environments.
 - .2 factory made insulation pieces, each consisting of longitudinally split phenolic foam insulation molded pipe, fitting, and hanger support inserts on hot, cold and dual temperature piping to thickness noted in Table P6, or to match the adjacent insulation at hangers and supports, whichever is greater.
 - .3 pipe size application: up to and including **NPS 24"**.
 - .4 service temperature: -100°F to 250°F (-73°C to +121°C)
 - .5 a vapour barrier jacket with overlap flap, and an integral steel shield at hangers and supports
- .2 Material:
 - .1 to ASTM C1126 (Gr.1),
 - .2 noncombustible meeting 25/50 flame spread/smoke developed when tested to ASTM E84,
 - .3 thermal performance: 0.13 btu/hr/in/sq ft/F° @ 75°F (0.019 W/m/C° @ 24°C),
 - .4 density: 120 kg/cu.m (7.5 lb/cu.ft)
- .3 Acceptable manufacturers:
 - .1 Kingspan - Kooltherm K/Kooltherm High Density
 - .2 Or equivalent
- .4 Table P6 - Molded Phenolic Insulation Thickness:

TABLE P6 – Molded Phenolic Rigid Insulation Thickness							
Service	Fluid Design Operating Temperature Range	Insulation Thickness Based On Nominal Pipe Size (in.)					
		Runouts Up to 2"	1" & less	1" to 1¼ "	1½ " to 3"	4" to 6"	8" & larger
Safety relief piping	251 to 350°F 122 to 176°C	---	2.0" 50mm	2.5" 65mm	3.0" 75mm	3.5" 90mm	3.5" 90mm
Hot Water Heating	141 to 200°F (61 to 93°C)	---	0.75" (20mm)	1" (25mm)	1" (25mm)	1" (25mm)	1" (25mm)
Glycol Heating	141 to 200°F (61 to 93°C)	---	0.75" (20mm)	1" (25mm)	1" (25mm)	1" (25mm)	1" (25mm)
Low Temperature Hot Water Heating	105 to 140°F (40 to 60°C)	---	0.75" (20mm)	0.75" (20mm)	0.75" (20mm)	1" (25mm)	1" (25mm)
Low Temperature Glycol Heating	105 to 140°F (40 to 60°C)	---	0.75" (20mm)	0.75" (20mm)	0.75" (20mm)	1" (25mm)	1" (25mm)
Domestic Cold Water	40 to 65°F (4 to 18°C)	---	---	---	1" (25mm)	1" (25mm)	1" (25mm)
Non-potable cold water	40 to 65°F (4 to 18°C)	---	---	---	1" (25mm)	1" (25mm)	1" (25mm)
Drainage	40 to 65°F (4 to 18°C)	---	---	---	1" (25mm)	1" (25mm)	1" (25mm)
Chilled Water	40 to 65°F (4 to 18°C)	---	1" (25mm)	1" (25mm)	1" (25mm)	1" (25mm)	1" (25mm)

TABLE P6 – Molded Phenolic Rigid Insulation Thickness							
Service	Fluid Design Operating Temperature Range	Insulation Thickness Based On Nominal Pipe Size (in.)					
		Runouts Up to 2"	1" & less	1" to 1¼ "	1½ " to 3"	4" to 6"	8" & larger
Dual Temperature Heating/Cooling	40 to 65°F (4 to 18°C)	---	1" (25mm)	1" (25mm)	1" (25mm)	1" (25mm)	1" (25mm)
Refrigerant Suction	-40°F to 203°F (-40°C to 95°C)	---	1" (25mm)	1" (25mm)	1" (25mm)	1" (25mm)	1" (25mm)

2.08 P7 – CALCIUM SILICATE

- .1 Application:
 - .1 Boiler beaching and generator exhaust piping and muffler where no prefabricated double wall system has been specified in the documents.
- .2 Material(s):
 - .1 preformed, rigid, hydrous calcium silicate pipe and block, asbestos free, complying with:
 - .1 ASTM C533 "Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation", Type 1, to 1200°F. (640°C.);
 - .2 CAN/CGSB 51.2 "Calcium Silicate Thermal Insulation for Piping, Machinery and Boilers"
 - .2 pipe size application: up to and including **NPS 24"**;
 - .3 service temperature: to 649°C (1200°F);
 - .4 thermal performance: 0.058 W/m°C @ 149°C (0.40 btu/hr/in/sq ft/°F @ 300°F);
 - .5 density 232 kg/cu.m (14.5 lb/cu ft);
 - .6 compressive strength of 160 psi at 5% compression;
 - .7 molded or block type;
 - .8 asbestos-free;
 - .9 when used over stainless steel, product must comply with the requirements of ASTM C795, MIL-I-24244 or NRC 1.36;
 - .10 product shall carry a 0/0 Flame Spread/Smoke Developed rating as tested in accordance with ASTM E84/NFPA 255/UL 723;
 - .11 product shall be rated as non-combustible as tested per ASTM E136.
 - .12 Acceptable manufacturers:
 - .1 Industrial Insulation Group - Thermo-12/Blue
 - .2 Kaylo-10;
 - .3 Manson;
 - .4 Knauf;
 - .5 Johns Manville;

.6 Or equivalent

.3 Table P7 – Calcium Silicate Insulation thickness as follows:

TABLE P7 - Calcium Silicate Insulation Thickness							
Service	Fluid Design Operating Temperature Range	Insulation Thickness Based On Nominal Pipe Size (in.)					
		Runouts Up to 2"	1" & less	1" to 1¼ "	1½ " to 3"	4" to 6"	8" & larger
Safety relief piping	251 to 350°F (122 to 176°C)	--	2" (50mm)	2.5" (65mm)	3" (75mm)	3.5" (90mm)	3.5" (90mm)

2.09 P8 - MOLDED MINERAL WOOL FIBRE:

.1 Application:

- .1 pre-moulded mineral fibre: rigid, sectional glass fibre or mineral wool sleeve type insulation pipe size application: up to and including **NPS 30"**,
- .2 service temperature: up to **650°C (1200°F)**,

.2 Material:

- .1 to ASTM C547,
- .2 thermal performance: 0.25 btu/hr/in/sq ft/F @ 100°F (0.042 W/m/C @ 50°C),
- .3 a factory applied vapour barrier jacket;

.3 Acceptable manufacturers:

- .1 Roxul Techton 1200
- .2 Fibrex Coreplus 1200 Pipe Insulation
- .3 Or equivalent

.4 Table P8 – Molded Mineral Wool Fiber Insulation Thickness:

TABLE P8- Molded Mineral Wool Fiber Insulation Thickness							
Service	Fluid Design Operating Temperature Range	Insulation Thickness Based On Nominal Pipe Size (in.)					
		Runouts Up to 2"	1" & less	1-1/4" to 2"	2-1/2" to 4"	6"	8" & larger
Safety relief piping	251 to 350°F 122 to 176°C	---	2.0" 50mm	2.5" 65mm	3.0" 75mm	3.5" 90mm	3.5" 90mm
Hot Water Heating	141 to 200°F (61 to 93°C)	---	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm
Glycol Heating	141 to 200°F (61 to 93°C)	---	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm	1.5" 40mm

2.10 BARRIER FREE LAVATORY INSULATION KITS

- .1 Removable, flexible, reusable, white molded plastic insulation kits for a handicapped lavatory drain piping and potable water supplies exposed under the lavatory.

2.11 ADHESIVES, FASTENERS, AND TAPE

- .1 Contact bond cement:

- .1 10 Flame Spread and 0 Smoke Developed ratings.
- .2 for quick setting for metal surfaces.
- .3 Volatile Organic Content: maximum 80 g/L.
- .4 Acceptable manufacturers:
 - .1 Bakor - No. 220-05
 - .2 Foster – Drion 85-75
 - .3 Or equivalent
- .2 Fibrous insulation adhesive:
 - .1 10 Flame Spread and 0 Smoke Developed ratings.
 - .2 Volatile Organic Content: maximum 250 g/L
 - .3 Acceptable manufacturers:
 - .1 Childers CHIL-STIX FRN CP-82
 - .2 Foster No. 85-70
 - .3 Or equivalent
- .3 Adhesive for flexible closed cell foam insulation:
 - .1 Quick-setting adhesive for seams and joints of flexible unicellular insulation.
 - .2 5 Flame Spread and 0 Smoke Developed rating
 - .3 Volatile Organic Content: maximum 80 g/L.
 - .4 Acceptable manufacturers:
 - .1 Armaflex 520 BLV
 - .2 Armaflex Low VOC Spray Contact Adhesive
 - .3 Or equivalent
- .4 Calcium Silicate fasteners:
 - .1 cut and mitred to fit, secured in place with 16 gauge stainless steel with twisted ends on maximum 12" (300mm) centres;
 - .2 all joints shall be painted with high temperature insulating cement.
- .5 Lap seal adhesive:
 - .1 Quick-setting adhesive for joints and lap sealing of vapour barriers.
 - .2 10 Flame Spread and 0 Smoke Developed ratings.
 - .3 Volatile Organic Content: maximum 250 g/L.
 - .4 Acceptable manufacturers:
 - .1 Bakor 220-05
 - .2 Childers CHIL-STIX FRN CP-82
 - .3 Or equivalent
- .6 Vapour barrier tape:
 - .1 Tape: Colour matching, pressure sensitive, self-adhesive vinyl tape.
 - .2 Under 25 for Flame Spread and under 50 for Smoke Developed ratings.
 - .3 UL 181A listed.
 - .4 Acceptable manufacturers:
 - .1 Johns Manville - Zeston Z-Tape

- .2 MacTac Canada Limited - Vinyl Scrim or Foil Scrim Kraft
 - .3 Compac Corp.
 - .4 Fattal Canvas Inc. – Insultape
 - .5 Or equivalent
- .7 Weld Pins, Studs and Clips:
 - .1 Acceptable manufacturers:
 - .1 Midwest Fasteners
 - .2 Continental Studwelding
 - .3 Or equivalent
- .8 Staples:
 - .1 Monel, flare type, minimum size ½" (12mm).
- .9 Tie Wire:
 - .1 16 ga (1.6mm) stainless steel with twisted ends.
- .10 Caulking for metal finish jacketing (outdoor use only)
 - .1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.
 - .2 Acceptable manufacturers:
 - .1 Foster 95-44
 - .2 Or equivalent

2.12 COATINGS AND MEMBRANES

- .1 Reinforcing Membrane:
 - .1 synthetic fibre:
 - .1 Leno weave,
 - .2 indoor and outdoor use.
 - .3 Acceptable manufacturers:
 - .1 Foster Mast-A-Fab
 - .2 Or equivalent
 - .2 glass-fibre fabric:
 - .1 indoor use.
 - .2 Acceptable manufacturers:
 - .1 Childers Chil-Glas #5/#10
 - .2 Or equivalent
 - .3 glass-fibre fabric for use with elastomeric closed cell foam insulation:
 - .1 indoor use.
 - .2 Acceptable manufacturers:
 - .1 Childers Chil-Glass #10
 - .2 Or equivalent
- .2 Breather Coating - Indoors:
 - .1 Non-combustible, less than 25/50 fire/smoke rating.
 - .2 for breather coatings and lagging adhesive,
 - .3 Volatile Organic Content: maximum 50 g/L

- .4 white in colour,
- .5 Acceptable manufacturers:
 - .1 Childers CP-50A HV2
 - .2 Foster 30-36
 - .3 Or equivalent
- .3 Breather Mastic - Outdoors:
 - .1 for breather coatings and lagging adhesive,
 - .2 abrasion resistive, flexible,
 - .3 UV stabile,
 - .4 grey in colour.
 - .5 Acceptable manufacturers:
 - .1 Childers Vi-Cryl CP-10/11
 - .2 Foster 35-00 / 45-00
 - .3 Bakor 120-10
 - .4 Or equivalent
- .4 Vapor Barrier Coatings - Indoors:
 - .1 Non-combustible, less than 25/50 fire/smoke rating.
 - .2 Volatile Organic Content: maximum 50 g/L.
 - .3 for vapor barrier coatings and lagging adhesive except for elastomeric closed cell foam,
 - .1 permeance rating 0.02 perms maximum,
 - .2 white in colour
 - .3 Acceptable manufacturers:
 - .1 Childers Chil Perm CP-34/35
 - .2 Foster 30-80, 30-90
 - .3 Or equivalent
 - .4 for use with elastomeric closed cell foam.
 - .1 Acceptable manufacturers:
 - .1 Childers CHIL-SPRAY WB CP-56 Adhesive
 - .2 Or equivalent
- .5 Vapor Barrier Mastic - Outdoors:
 - .1 for vapor barrier coatings and lagging adhesive,
 - .2 asphalt cutback,
 - .3 permeance rating 0.02 perms maximum,
 - .4 Grey in colour.
 - .5 For outdoor use only; not rated to meet fire/smoke rating of 25/50.
 - .6 Acceptable manufacturers:
 - .1 Childers Chil-Pruf CP-22
 - .2 Foster 60-25/60-26
 - .3 Or equivalent

2.13 INSULATION CEMENT

- .1 Hydraulic-setting finishing type.

2.14 FIELD APPLIED FINISHES AND JACKETING

- .1 PVC (Polyvinyl Chloride) finish jacket:
 - .1 Apply in exposed areas on piping with operating temperatures less than 180°F. (80°C.).
 - .2 Ultraviolet resistant.
 - .3 Piping: ULC listed PVC moulded type jacketing material, gloss white complying with 25 Flame Spread and 50 Smoke Developed ratings.
 - .4 minimum 20 mil thickness with permeability not more than 0.09 perms,
 - .5 Fittings: ULC listed PVC, gloss white, 1-piece, pre-molded fittings complying with 25 Flame Spread and 50 Smoke Developed ratings.
 - .6 Glass-fibre insulation inserts for elbows, tees, valves, end-caps, mechanical pipe couplings,
 - .7 Fastenings: self-sealing longitudinal joints in accordance with manufacturer's standard(s).
 - .8 Pressure sensitive, colour matching vinyl tape.
 - .9 Acceptable manufacturers:
 - .1 Johns Manville - Manville Zeston 2000
 - .2 ACWIL Insulations
 - .3 Sure Fit Systems
 - .4 Proto PVC – LoSMOKE
 - .5 Or equivalent
 - .10 3M Venture Clad model 1579CW-WME, or equivalent, is acceptable for use in lieu of PVC finish jacket.
- .2 Fabric Finish Jacket:
 - .1 Apply in exposed areas: compacted firm, ULC listed, heavy plain weave, cotton fabric at 6 oz. per sq. yd (220g/sq.m) treated with diluted fire retardant lagging adhesive, or;
 - .2 Re-wetable fiberglass lagging fabric with water activated self-adhesive.
 - .3 On concealed valves and fittings, use ULC listed plain weave cotton fabric at 3 oz. per sq. yd (120 g/sq.m).
 - .4 Suitable for field painting.
 - .5 Acceptable manufacturers:
 - .1 Fattal's Thermocanvas
 - .2 Johns Manville
 - .3 Alpha-Maritex 3451-RW
 - .4 Clairmont Diplag 60
 - .5 Glass-Cell FR
 - .6 Newtex - Zetex Rewettable
 - .7 Or equivalent
 - .6 3M Venture Clad model 1579CW-WME, or equivalent, is acceptable for use in lieu of fabric finish jacket.
- .3 Metal Finish Jacket:
 - .1 Apply in areas exposed to the outdoors to CSA HA Series-M1980:
 - .2 straight pipe:

- .1 Crimped or embossed alloy jacketing 0.016" (0.045 mm) 26 gauge thick with longitudinal slip joints and 2" (50mm) end laps with factory attached protective liner on interior surface or,
- .2 Corrugated stainless steel not less than 0.25 mm (0.010 in) thick sheet.
- .3 fittings:
 - .1 Minimum 0.016" (0.045mm) thick, custom made swaged ring or lobster back covers on bends and die shaped fitting covers over fitting, valves, strainers, flanges, and grooved couplings with factory attached protective liner on interior surface.
- .4 bands:
 - .1 12 mm (½ in) wide stainless steel with mechanical fasteners.
 - .2 Acceptable manufacturers:
 - .1 Alcan Canada Products - Thermo-clad Type 1
 - .2 Childers Products Inc. - Fab Straps
 - .3 Or equivalent
- .5 Band all transverse seams with waterproof mastic tape and caulk all longitudinal seams with silicone caulking. Seal the entire covering to achieve a watertight assembly.
- .4 Self-adhesive Weather Barrier Membrane (SAWB):
 - .1 self-adhering membrane of acrylic adhesive with siliconized release paper, not exceeding flame/smoke generation rating of 25/50, for indoor and outdoor use,
 - .2 self-adhering membrane of rubberized asphalt compound with siliconized release paper, for outdoor use only
 - .3 laminated to stucco-embossed aluminum foil,
 - .4 Self-sealing with penetration of self-tapping screws.
 - .5 Water vapour permeance 0.05 perms.
 - .6 Acceptable manufacturers:
 - .1 3M Venture Clad 1579CW - indoor and outdoor applications
 - .2 Bakor - Foilskin - outdoor applications
 - .3 Polyguard Products Alumaguard 60 - outdoor applications
 - .4 Or equivalent
- .5 Protective finish for elastomeric cellular foam insulation
 - .1 indoors and outdoors:
 - .2 Acceptable manufacturers:
 - .1 Armaflex WB Finish
 - .2 Or equivalent

PART 3 - EXECUTION

3.01 GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

- .1 Insulation Thickness: All plumbing piping to be insulated, including insulation for condensate drain piping from equipment drain pans, and refrigerant piping, shall be minimum 25 mm thick unless noted otherwise.
- .2 Performance Requirements: As a minimum, insulation application methods and standards shall be as per the NATIONAL INSULATION STANDARDS of the Thermal Insulation Association of Canada.

- .3 General Insulation Application Requirements: General requirements pertaining to the application of mechanical insulation are specified herein. Unless otherwise specified, do not insulate the following:
 - .1 factory insulated equipment /plenums/ panels and piping;
 - .2 heated liquid system pump casings, valves, strainers and similar accessories;
- .4 Flanges and Mechanical Couplings: Terminate sectional insulation approximately 2" (50mm) from the flange or coupling on each side of the flange or coupling. Cover the flange or coupling with a minimum 2" (50mm) thickness of blanket mineral fibre insulation wide enough to butt tightly to the ends of the adjacent sectional insulation. Secure the blanket insulation in place and cover with a PVC cover.
- .5 For cold and dual temperature surfaces with the possibility of condensation, install insulation directly over pipes and not over hangers and supports.
- .6 For warm surfaces, line size hangers shall be permitted and insulation shall cover the hanger to maintain the specified thickness in accordance with ASHRAE 90.1.
- .7 Pipe Insulation Sizing:
 - .1 Provide minimum insulation thickness for services in accordance with Insulation Thickness Tables specified.

3.02 PIPING INSULATION APPLICATION

- .1 Apply insulation materials, accessories and finishes in accordance with manufacturer's recommendations.
- .2 Apply insulation once required tests are complete and approved by the Consultant and heat tracing is installed.
- .3 Surfaces shall be clean and dry when insulation is applied and during application of any finish.
- .4 Store and use adhesives, mastics, and insulation cements at ambient temperatures and conditions recommended by product manufacturers.
- .5 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.
- .6 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted or engaged together. Lap canvas or other specified wrapping over all joints and thoroughly cement down with adhesive. Vapour barriers and insulation shall be complete over the full length of pipe or surface, without penetration for hangers, and without interruption at sleeves, pipe and fittings.
- .7 Do not apply insulation on chrome-plated surfaces of piping, valves, fittings, and equipment.
- .8 Cut and bevel insulation around nameplates and pressure vessel stamps.
- .9 Neatly finish insulation at supports, protrusions, and interruptions.
- .10 Extend insulation through sleeves in walls (except firewalls) or other openings in the building for a continual insulation and vapour barrier of uniform diameter.
- .11 Terminate insulation at each side of the firewalls and pack the space between the wall sleeve and pipe.
- .12 Replace removed insulation from existing piping to make tie-in connections with new insulation. Cut back existing insulation a sufficient distance to make/form a neat and firm butt joint between old and new insulation.
- .13 Protect insulation on cold and dual temperature services with insulation shields consisting of high-density insulation and sheet steel support.
- .14 Apply specified adhesives, mastics and coatings to manufacturer's recommended minimum coverage per gallon.
- .15 Install insulation with smooth and even surfaces.

- .16 Where piping is indicated to be heat traced, provide oversized insulation to accommodate heat-tracing cable.
- .17 Seal exposed insulation with reinforced vapor barrier or breather coating or mastic.
- .18 Finish piping with field installed finish jackets as specified herein.
- .19 Pipe Insulation:
 - .1 Preformed Insulation: Sectional insulation up to NPS 12" (300mm), sectional or curved segmented above NPS 12" (300mm).
 - .2 Multi-Layered Insulation: Use staggered butt joint construction.
 - .3 Vertical Pipe over NPS 3" (75mm): Use insulation supports welded or bolted to pipe directly above lowest pipe fitting. Thereafter, locate on 15' (4.5 m) centres and at each valve and flange.
 - .4 At expansion joints in piping, apply insulation over a 16 gauge sleeve fabricated to fit around expansion joint without restricting its movement. Fabricate sleeve(s) so it may be removed to allow for the repacking and lubrication of the expansion joint without damaging adjoining insulation. Extend sleeves a minimum of 3" (75mm) longer than the expansion joint, fit with insulation retaining flanges and with a means of maintaining the position of the sleeve over the expansion joint.
 - .5 Terminate insulation at each end of unions and flanges on hot lines, and at other points where indicated, with insulation cement, to CGSB 51-GP-6M, trowelled on bevel.
 - .6 Gouge out insulation for a proper fit where there is interference between the weld bead and the insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles, supports, hangers, and clamp guides and seal with insulating cement.
 - .7 Insulate flanges, valves and fittings with segments of insulation of the same type and thickness as the insulation on the pipe, secured in place with soft annealed galvanized wire. Finish with cement and canvas while the cement is still wet.
 - .8 Provide fire retardant coating on all field applied finishes and jacketing.
 - .9 Priming:
 - .1 Coat canvas covering exposed insulation in finished spaces with diluted coat of lagging adhesive, as recommended by the insulation manufacturer.

3.03 HOT PIPING SYSTEMS INSULATION

- .1 Insulate hot piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Insulation Thickness Tables.
- .2 Insulate Condensate piping to the same criteria as its associated steam system.
- .3 Insulate Safety Relief valve piping located between floor or elevated work surface, up to 8 ft. (2.4m) above same, that passes within 4 ft. (1.2m) of a floor or elevated work surface.

3.04 COLD AND DUAL TEMPERATURE PIPING SYSTEMS INSULATION

- .1 Insulate cold and dual temperature piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Insulation Thickness Tables.
- .2 For drainage systems insulate:
 - .1 storm water roof drain body,
 - .2 storm water piping from roof drain body to the floor level of the story below the drain body,
 - .3 sanitary piping in the following locations,
 - .1 horizontal sanitary drainage piping NPS 3" (75mm) and larger in ceiling spaces,
 - .2 exposed sanitary drainage piping in wet areas including sterile processing, dishwashing, cart-washing

- .3 exposed sanitary drainage piping in IT/Data rooms,
- .4 exposed sanitary drainage piping in service tunnels
- .5 exposed sanitary drainage piping serving spaces located above a parking garage open to the outdoors.
- .3 For greater clarity, domestic hot water, domestic hot water recirculation, non-potable hot water, and non-potable hot water recirculation piping systems are treated as “cold and dual temperature” for the purpose of application of vapour barriers to both hot and cold domestic and non-potable water piping.

3.05 PIPING

- .1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn each butt joint.
- .2 Secure insulation at centre of each section, at each end, and at not more than 24” (600mm) intervals with:
 - .1 vapor barrier tape in addition to jackets with self-adhering lap joints for type P1 (molded glass fibre, hot temperature), P2 (molded glass fibre, cold and dual temperature) and P3 (glass fibre semi-rigid board) insulation on **Cold and Dual Temperature piping**,
 - .2 mechanical fastened (stapled) or jackets with self adhering lap joints on type P1 (molded glass fibre, hot temperature), P2 (molded glass fibre, cold and dual temperature) and P3 (glass fibre semi-rigid board) insulation on **Hot piping**,
 - .3 bands or wire for type P6 (molded phenolic), P7 (calcium silicate), P8 (molded mineral wool fibre), P9 (molded mineral wool fibre high temperature) and P11 (cellular glass) insulation,
 - .4 self-adhered or provide 100% coverage of contact adhesive for type P5 (flexible elastomeric closed cell) insulation,
 - .5 in accordance with listing requirements for type P10 (fire rated) insulation.

3.06 FITTINGS, FLANGES, COUPLINGS, AND STRAINERS

- .1 Insulate fittings including elbows and tees:
 - .1 NPS 1½” (40mm) and smaller:
 - .1 mitre cut insulation to create tight fit,
 - .2 for PVC cover, trim backside of insulation on elbows to suit cover but do not reduce total thickness less than that of adjacent pipe insulation.
 - .2 NPS 2” (50mm) and larger:
 - .1 use matching preformed insulation inserts, or fabricate mitred insulation segments made from same material as pipe insulation,
 - .2 number of mitred segments to be sufficient to maintain thickness of insulation around throat of elbow,
 - .3 secure inserts and fabricated segments with wire prior to application of coatings or finishes.
- .2 Insulate flanges and grooved joint couplings:
 - .1 Insulate with preformed inserts or build-up insulation with same material as on adjacent pipe:
 - .1 butt pipe insulation to each side of flange, coupling, valve, or strainer,
 - .2 build up rigid insulation blocking on each side of fitting, coupling, valve or strainer, with a width dimension same as pipe insulation thickness, and
 - .3 apply insulation layer over outside of flange, coupling, valve or strainer to a thickness equal to pipe insulation thickness.
 - .4 provide removable insulation section on strainer head.

- .2 Where phenolic insulation is used;
 - .1 same as above except use factory made insulation inserts, or fabricate inserts to suit fixture.
- .3 Where elastomeric insulation is used;
 - .1 same as above except adhere insulation to flange, coupling, or strainer with full coverage of adhesive,
 - .2 do not adhere insulation across bolted connections - insulate on each side of connection and add additional insulation layer across connection and fix in place with bands.

3.07 PIPELINE ACCESSORIES

- .1 Insulate pipeline accessories:
 - .1 valves
 - .2 strainers
 - .3 pressure reducing valves
 - .4 safety valves
 - .5 meters
 - .6 steam separators
- .2 Insulate accessories for Hot Temperature piping systems with design temperatures greater than 200°F (93°C):
 - .1 where located within 7 ft. (2.1m) above a floor or work surface
 - .2 with type P12 removable/ reuseable high temperature insulated fitted jackets,
 - .3 allow free movement of valve actuator.
- .3 No insulation is required on pipeline accessories for Hot Temperature piping systems with design temperatures of 200°F (93°C) or less.
- .4 Insulate accessories for Cold and Dual Temperature piping systems for chilled water and liquid refrigerant piping:
 - .1 detachable insulated box type with embossed aluminum or stainless steel jacket, with vapour barrier tape applied to seams when installed,
 - .1 lined with two layers of 25 mm (1 in) P5 (flexible elastomeric closed cell) blanket or one layer of 25 mm (1 in) thick P6 (molded phenolic) insulation, with no voids at corners or joints,
 - .2 at locations requiring access, extend insulation to create collar around bolted connection, and install a compression fit piece of insulation to cover equipment.
- .5 Insulate accessories for all other Cold and Dual Temperature piping systems:
 - .1 insulate with flexible blanket of same material and thickness of adjacent piping and seal with reinforced vapour barrier sealer.
 - .2 at locations requiring access including valve handles, valve actuators, drain valves, and other similar serviceable equipment, cut-back insulation and seal exposed edges.

3.08 DRAINAGE SYSTEMS - ADDITIONAL REQUIREMENTS

- .1 Insulate underside of roof drain hoppers with flexible blanket insulation of same type as pipe insulation.

3.09 HANGERS AND SUPPORTS

- .1 Provide insulation protection in accordance with Insulation Hanger Protection Table of this Section, based on pipe size and service process temperature.

- .2 Pipe saddle insulation protection:
 - .1 insulate the interior void spaces of pipe saddles, of same material as adjacent pipe insulation,
 - .2 butt insulation up to sides and end of pipe saddle, and leave bottom surface of saddle exposed for direct contact with pipe support.
- .3 Pipe shield insulation protection:
 - .1 install insulation shield between outside of insulation and pipe support; pipe support is sized for outside dimension of insulation.
 - .2 in accordance with pipe size, provide high density insulation insert of same thickness as adjacent pipeline material, fabricated from:
 - .1 cold and dual temperature piping: type P6 (molded phenolic),
 - .2 hot temperature piping: type P6 (molded phenolic),
 - .3 10" (250mm) long for pipe size up to NPS 1-1/2" to 2-1/2" (40mm to 65mm);
 - .4 12" (300mm) long for pipe size up to NPS 3" to 6" (75mm to 150mm);
 - .5 16" (400mm) long for pipe size up to NPS 8" to 10" (200mm to 250mm);
 - .6 22" (550mm) long for pipe sizes NPS 12" (300mm) and larger.

Insulation Hanger Protection Table				
Process Temperature	Pipe Size NPS	Pipe Saddle	Insulation Shield	High-Density Insert
> 200°F (> 93°C)	≤ 1 ¼"	---	•	---
	≥ 1 ½"	•	---	---
141°F to 200°F (61°C to 93°C)	≤ 1 ¼"	---	•	---
	≥ 1 ½" & ≤ 6"	---	•	•
	> 6"	•	---	---
80°F to 140°F (26°C to 60°C)	≤ 1 ¼"	---	•	---
	≥ 1 ½"	---	•	•
Cold & Dual Temp	≤ 1 ¼"	---	•	---
	≥ 1 ½"	---	•	•

3.10 INSULATION AT PIPE ANCHORS

- .1 Insulate pipe anchor plates and frames with flexible elastomeric closed cell foam blanket of type P5 (flexible elastomeric closed cell) insulation and seal with vapour barrier coating.
- .2 Extend insulation along anchor steel a minimum distance of 6" (150mm) outside the piping insulation thickness.

3.11 FLOOR AND WALL SLEEVES

- .1 Extend pipe insulation including coatings and finishes through floor and wall sleeves.
- .2 For penetrations through fire rated separations, provide finishes in accordance with fire stopping manufacturer's listing requirements.
- .3 For outdoor piping passing through exterior walls or roof, terminate mastic lagging at outside face of sleeve and protected by storm flashing, caulked to lagging and to building structure.

3.12 SEALING INSULATION

- .1 Apply coatings and mastic in accordance with manufacturer requirements.
 - .1 Hot Temperature piping: breather coating/mastic
 - .2 Cold and Dual Temperature piping: vapor barrier coating/mastic
- .2 Only use mastics on outdoor installations.
- .3 Apply mastics and coatings when ambient temperature is above 40°F (4°C) unless manufacturer's instructions permit colder ambient installation conditions.
- .4 Hot Temperature piping;
 - .1 seal lap joints with self-adhesive lap joint, reinforced breather coat, or vapour barrier tape,
 - .2 seal butt joints with matching vapour barrier tape.
- .5 Cold and Dual Temperature Piping;
 - .1 tightly seal insulation with factory applied all-purpose jacket using self-adhering or field applied adhesive on longitudinal laps and butt joint.
 - .2 where sealing strips are damaged, apply secondary layer of colour matched vapor barrier tape.
 - .3 seal insulation without factory applied jackets with 100% coverage of vapor barrier coating/mastic as applicable complete with reinforcing membrane.
 - .4 seal insulation butt ends with vapor barrier coating every four (4) lengths of insulation but not to exceed 8ft. (2.4m) of pipe length.
- .6 Hanger high-density insulation inserts:
 - .1 seal inserts with reinforced breather or vapour barrier coating as applicable, overlapping adjacent insulation a minimum of 2" (50mm).
- .7 Elbows, tees, flanges, and fittings;
 - .1 Apply applicable breather or vapor barrier coating/mastic with reinforcing membrane over fitting insulation and overlap 2" (50mm) onto adjacent pipe insulation.
 - .2 For greater clarity, use of vapor barrier tape to seal insulation is not permitted.
- .8 Apply coating/mastic and reinforcing membrane regardless of final finish application.
- .9 Maintain integrity of vapor barrier through sleeves, around fittings and at hangers and supports.

3.13 INSULATION FINISH COVERINGS

- .1 Install protective finish coverings on insulation in accordance with Piping Insulation Protective Finishes Table of this Section, after breather and vapor barrier sealing is completed.
- .2 Cut finish jacket materials used for covering to allow 2" to 4" (50mm to 100mm) longitudinal overlap and similar circumferential overlap onto adjacent sheets.
- .3 On vertical pipes arrange circumferential overlap on adjacent sheets outside of sheet below and under sheet above.
- .4 PVC sheeting:
 - .1 Hot Temperature piping:
 - .1 overlap longitudinal edges and adjacent sheets by minimum of 2" (50mm) and staple fasten the sheets.
 - .2 secure sheeting with colour matched tape around circumference, at least two places per section of sheet, and by stapling longitudinal and circumferential edges.
 - .3 do not seal edges with vapour barrier tape.

- .4 seal PVC fitting covers at throat and heel seams by stapling and secure over insulation by banding or taping ends to adjacent pipe finish covering with colour matched tape.
- .2 Cold and Dual Temperature piping:
 - .1 overlap longitudinal edges and adjacent sheets by minimum of 2" (50mm) and seal longitudinal edges with vapor barrier coating adhesive for full depth and 100% coverage of overlap,
 - .2 seal circumferential edges of PVC fitting covers with reinforced vapour barrier coating adhesive extending over adjacent pipe insulation section with an overlap of at least 2" (50mm).
 - .3 seal PVC fitting covers at throat and heel seams by solvent bonding and secured over insulation with reinforced vapor barrier coating/mastic overlapping adjacent pipe insulation a minimum of 2" (50 mm).
- .5 Metal:
 - .1 Use lock-on systems or secure sheeting with bands 18" (450mm) apart.
 - .2 Joint sealing:
 - .1 Hot pipe: do not seal joints.
 - .2 Cold and dual temperature pipe: seal joints with caulking.
 - .3 Curved surfaces: custom made swaged ring or lobster back covers.
 - .4 On outdoor hot and cold/dual temperature piping, caulk overlapping metal joints to permit expansion of metal jacket.
- .6 Canvas Fabric:
 - .1 Canvas lagging:
 - .1 apply canvas lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the piping system, and finish to provide a smooth surface free of wrinkles and sags.
 - .2 where cotton lagging with appropriate coating is used this satisfies the requirements of a sealer coating for Hot or Cold/Dual temperature piping systems.
 - .2 Fiberglass lagging:
 - .1 apply re-wettable fiberglass lagging in accordance with manufacturer instructions. Finish to provide a smooth surface free of wrinkles and sags.
 - .2 where re-wettable fiberglass lagging is used this satisfies the requirements of a sealer coating for Hot piping systems.

Piping Insulation Protective Finishes				
Location	Weather Exposure	System/Space	Finish	Insulation Type
Concealed	Indoors	All	Fabric	P1, P2, P3, P4, P6, P7, P8, P9, P11
Exposed	Indoors	Service Rooms	Fabric or PVC	P1, P2, P3, P4, P6, P7, P8, P9, P11
	Indoors	Public Spaces	PVC	P1, P2, P3, P4, P6, P7, P8, P9, P11
	Outdoors	All	Metal	P1, P2, P3, P4, P6, P7, P8, P9, P11
	Outdoors	All	SAWB	P1, P2, P3, P4, P6, P7, P8, P9, P11

3.14 PAINTED PIPING

- .1 Not applicable.

3.15 MECHANICAL DAMAGE PROTECTION

- .1 For indoor installations, protect exposed pipe insulation extending up through a floor sleeve at floor line with 18 ga. (1.2mm) stainless steel jacket approximately 4" (100mm) high, secured to floor slab. Conceal fastenings by floor plate.
- .2 For piping systems using metal finishes, this protection cover replaces a portion of the specified pipe cover.
- .3 For piping systems using other finishes, this protection cover is in addition to the specified pipe cover.

3.16 FIELD INSPECTION QUALITY CONTROL

- .1 The Consultant reserves the right to have protective finish coverings removed on up to 5% of all fittings, flanges, couplings, valves, and pipeline accessories to review the sealing of the insulation.
- .2 Upon inspection, if insulation sealing is found to be incorrect at any one, the Consultant, in their sole discretion, may call for the removal of the protective finish on all fittings, flanges, couplings, valves, and pipeline accessories for further review.
- .3 Repair defective sealing and replace protective coverings at no additional cost.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Division 01 General Requirements and all documents referred to therein.

1.02 SCOPE OF WORK

- .1 The Contractor shall provide all services, materials and labour required to fully Commission the Mechanical Systems as specified herein.
- .2 The Contractor shall provide all services, materials and labour required to successfully complete Functional Performance Testing of the Mechanical Systems as part of Commissioning the overall building systems as a holistic operation.
- .3 Integrated Systems Testing of Fire Protection and Life Safety Systems shall be completed in accordance with CAN/ULC-S1001-11.
- .4 Equipment Suppliers, Vendors and other Sub-Trades are expected to support the Contractor complete Mechanical Commissioning Specified in this Section. Support may come in the form of attendance on site to verify correct installation, performance, trouble shooting, training and final documentation at turn-over. The Contractor shall ensure Equipment Suppliers and Vendors provide the support necessary for successful Mechanical Commissioning.
- .5 ***Perform IAQ Testing or Flush Out as described in this Section of the Specifications.***

1.03 COORDINATION

- .1 Appoint a single person as Commissioning Coordinator who shall be responsible for advancing the commissioning activities of the Mechanical Division.

1.04 QUALITY ASSURANCE

- .1 The following Standards shall be used to guide the commissioning process:
 - .1 ASHRAE Guideline 0 (2019) "The Commissioning Process"
 - .2 ASHRAE Standard 1-1996 Guideline for Commissioning of HVAC Systems.
 - .3 CAN/ULC-S1001 (2011) "Integrated Systems Testing of Fire Protection and Life Safety Systems"
 - .4 NFPA 4 (2021) "Standard for Integrated Fire Protection and Life Safety System Testing"
- .2 Hold and attend regular meetings during the commissioning process. Prepare detailed progress reports to coincide with regular commissioning meetings.
- .3 In addition to all tests listed under this section, the Mechanical Division shall complete its own tests and any additional tests required by the Owner's Commissioning Authority to ensure that all facility, in its entirety, operates as intended.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

- .1 All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by Division contractor for equipment being tested. For example, Mechanical Trades shall ultimately be responsible for all standard testing equipment for HVAC system and controls system provided as part of the Mechanical Work, except for equipment specific to and used by TAB Trades in their Commissioning responsibilities.
- .2 Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in base bid price to Contractor and left on site, except for stand-alone data-logging equipment that may be used by Commissioning Authority.
- .3 All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with tolerances specified in Specifications. If not otherwise noted, following minimum requirements apply:

- .1 Temperature sensors and digital thermometers shall have a certified calibration within past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F.
- .2 Pressure sensors shall have an accuracy of + or - 2.0% of value range being measured (not full range of meter) and have been calibrated within twelve (12) months of scheduled commissioning testing.
- .3 All equipment shall be calibrated according to manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.01 DESIGN AND PERFORMANCE REQUIREMENTS

- .1 Provide a schedule with regular updates for the completion of Mechanical Division equipment and systems.
- .2 Six (6) weeks prior to the target Substantial Performance date, submit a detailed and comprehensive installation completion/ start-up/ testing schedule. Update the schedule and resubmit for review, on a bi-weekly basis, during the course of Commissioning. Provide regular revisions and updates to the schedule to suit the updated construction schedule. This schedule shall include, but is not limited to, the following items:
 - .1 Installation and testing of piping systems
 - .2 Chemical clean out and treatment of pipe systems, including disinfection of domestic water piping;
 - .3 Duct cleaning;
 - .4 Control system wiring;
 - .5 Air and hydronic system balancing;
 - .6 Electrical service connections;
 - .7 Equipment suppliers prestart inspection, testing and results of the mechanical equipment installations, including controls;
 - .8 Start-up of various pieces of mechanical equipment and systems;
 - .9 Operational testing and results of mechanical system components;
 - .10 Performance testing and results of mechanical equipment and systems;
 - .11 Acceptance testing of mechanical equipment installations and systems including fire and sprinkler systems, by Authorities Having Jurisdiction ("AHJs") and the Owner's insurance company;
 - .12 Troubleshooting: determination and reiteration of performance issues documenting cause, effect, revisions, and re-test results.
 - .13 Calibration of controls and point-to-point testing results;
 - .14 Control software setup inspection, testing and results including seasonal and response of operating sequences, including Proportional Integral Derivative ("PID") loop optimization
 - .15 Emergency system inspection, testing and results;
 - .16 Fire alarm and control system interfacing results;
 - .17 Submittal of completed mechanical equipment and systems test record sheets;
 - .18 Demonstration of mechanical systems and equipment;
 - .19 Operating and Maintenance ("O&M") manual preparation and submittal;
 - .20 Operator training program
 - .21 Record documentation submittal

3.02 RECORD DOCUMENTATION

- .1 Prepare record documentation for each equipment installation covering:
 - .1 Equipment identification and supplier
 - .2 Shop Drawing submittal, review, production release, and delivery dates
 - .3 Dates for completion of all work required to prepare for equipment installation
 - .4 Dates for equipment installation, supplier prestart checkout and system availability for start-up
 - .5 Dates for equipment start-up, performance testing, proposal for temporary use, acceptance testing, demonstration, turnover and warranty start/finish
 - .6 List all specialist personnel and equipment required for the test and ensure that these are available by the test date.
 - .7 Provide documentation of the commissioning process for inclusion into the maintenance manuals. These are to include checkout sheets, equipment data sheets, start-up certificates from suppliers involved in start-up, documentation concerning demonstration to the Owner. Include all records and result sheets from commissioning tests.
 - .8 Maintain a log of key operating parameters, problems encountered, solutions employed and verification of effectiveness of solutions. Include log in maintenance manuals.

3.03 START-UP

- .1 Coordinate and supervise the start-up of the various pieces of equipment and systems. Utilize the start-up services of the manufacturer's representative. Ensure that the equipment is operating in a satisfactory manner. Check the following items:
 - .1 Direction of rotation
 - .2 Grease and lubricants
 - .3 Noise, if deemed to be a problem
 - .4 Seals
 - .5 Alignment of base mounted pumps, fan drives and turbine drives by a Millwright
 - .6 Piping connections and safeties
 - .7 Electrical amp draw, starting inrush current and trip/heater settings
- .2 Prior to the equipment start-up, arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations.
- .3 Functional testing is intended to begin upon successful completion of start-up. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the Owner and the Owner's Commissioning Consultant. Beginning system functional testing prior to full completion does not relieve the Mechanical Division from fully completing the system, including all start-up checklists.

3.04 TROUBLESHOOTING

- .1 Resolve inter-Division coordination problems.
- .2 Where problems become apparent during the commissioning process, identify and resolve these problems. The basic functions of troubleshooting include:
 - .1 Identify and define the problems
 - .2 Determine and evaluate the causes
 - .3 Determine the time available to resolve the problem
 - .4 Involve the designing authority in the review of the problem and proposed resolution
 - .5 Coordinate remedial action with the appropriate parties
 - .6 Evaluate the effectiveness of the remedial action

- .7 Record the problem, cause, remedial action and result

3.05 OPERATIONAL TESTING

- .1 Test the operation of the individual components and systems. Go through each step of the sequence of operation and verify that each component operates correctly. Direct and ensure that all trades involved make the required changes and adjustments to effect the proper operation of all components and systems. Meet commissioning test requirements.
- .2 Document the operation and testing.
- .3 Ensure operational tests are completed for heating, cooling and intermediate seasons.
- .4 For any systems and assemblies where some testing has been deferred, coordinate seasonal commissioning for those systems that have been functionally tested and handed over in seasons where retesting and commissioning will be required during the opposite season.

3.06 DEMONSTRATION AND TRAINING

- .1 Demonstrate to the operating staff the proper operation of all mechanical equipment and systems. Demonstrations shall occur only after the operation and testing has been successfully completed. Ensure that all affected Mechanical Division Trade Contractor(s) and equipment suppliers participate in the demonstrations as required.
- .2 Thoroughly instruct the operating staff in the safe and efficient operation and maintenance of all systems and equipment.
- .3 Provide designated operating personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of mechanical equipment including, but not limited to, pumps, boilers, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, fuel systems and other mechanical systems.
- .4 Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including start-up, shutdown, fire/smoke alarm, power failure, and other similar modes of operation.
- .5 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- .6 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative.
- .7 Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
- .8 The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
- .9 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
- .10 Training shall include:
 - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - .2 A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
 - .3 Discussion of relevant health and safety issues and concerns.
 - .4 Discussion of warranties and guarantees.

- .5 Common troubleshooting problems and solutions.
- .6 Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
- .7 Discussion of any peculiarities of equipment installation or operation.
- .8 Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
- .9 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
- .10 The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- .11 During any demonstration or hands-on training, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- .12 There shall be three controls training sessions:
 - .1 Training I. Control System. This training will be held on-site. Upon completion, each trainee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
 - .2 Training II. Building Systems. The second session shall be held on-site and shall include hands-on training after the completion of system commissioning. The session shall include instruction on:
 - .1 Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems and any interface with other communication systems.
 - .2 Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
 - .3 All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends.
 - .4 Trainees will actually set-up trends in the presence of the trainer.
 - .5 Every screen shall be completely discussed, allowing time for questions.
 - .6 Use of keypad or plug-in laptop computer at the zone level.
 - .7 Use of remote access to the system via phone lines or networks.
 - .8 Setting up and changing an air terminal unit controller.
 - .9 Graphics generation.
 - .10 Point database entry and modifications.
 - .11 Understanding DDC field panel operating programming (when applicable).
 - .12 Trend log set-up and exporting.
 - .3 Training III. The third training shall be conducted on-site six months after occupancy. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

3.07 IAQ TESTING OR FLUSH-OUT

- .1 ***Prior to occupancy perform an IAQ testing or flush-out in accordance with the following procedural requirements.***
- .2 ***IAQ testing is the preferred method, however, a flush-out of the construction area may be performed in lieu of IAQ Testing at the discretion of the Owner's Project Manager.***
- .3 ***Any costs associated with IAQ Testing and/or flush-out shall be carried by the Contractor in their bid price.***
- .4 ***IAQ Testing Procedure:***
 - .1 ***IAQ testing protocols shall be consistent with the United States Environmental Protection Agency Compendium of Methods for Determination of Air Pollutants in Indoor Air.***
 - .2 ***Testing shall be completed over the course of one (1) normal operating day (additional days are acceptable if required due to sampling equipment limitations). Testing shall be performed by parties experienced in IAQ testing.***
 - .3 ***All HVAC systems shall be fully operational in their normal operating mode during all testing periods.***
 - .4 ***The number of sampling locations shall be not less than six (6), five (5) indoors and one (1) outdoors, and there shall be a minimum of one sample per 1000 square meters of floor space, and one sample per floor.***
 - .5 ***Sample locations shall be evenly distributed throughout the floor space.***
 - .6 ***A minimum of one outdoor sample is required for each day of indoor testing, preferably from near the building's outdoor air intake if possible.***
 - .7 ***Indoor testing is to be completed between 4 ft. (1200mm) and 7ft. (2100mm) from the floor in an effort to represent the breathing zone of occupants.***
 - .8 ***The following table indicates contaminants to be measured as well as maximum allowable concentrations:***

Contaminant	Maximum Concentration
Formaldehyde	27 parts per billion
Respirable particulate matter (PM10)	50 micrograms per cubic metre
Total volatile organic compounds (VOC's)	500 micrograms per cubic metre
4-Phenycyclohexane (4-PC) [only required if carpets with styrene butadiene backing are installed)	6.5 micrograms per cubic metre
Carbon monoxide	9 parts per million and no greater than 2 parts per million above outdoor levels
Carbon dioxide	N/A - Measure only
Air temperature and relative humidity	N/A - Measure only

- .9 ***For each building area where the maximum concentration limits are exceeded, identify and mitigate pollutant sources and conduct a partial building flushout for a maximum of two (2) weeks. Retest for any contaminant concentrations that were***

exceeded. Repeat process until all contaminant concentrations are within the maximum limits.

.5 Flush Out Procedure:

- .1 Perform a flush-out procedure of the HVAC system to evacuate airborne contaminants after all construction work is completed, including any punch-list items.**
- .2 Prior to flush-out, complete the following:**
 - .1 Remove any temporary filters and duct coverings installed during the construction process.**
 - .2 Complete all cleaning activities.**
 - .3 Complete testing and balancing and HVAC controls**
- .3 The quantity of outside air that must be introduced to the project space for the flush-out is 4,300 cubic metres per square metre of floor area (14,000 cubic feet per square foot).**
- .4 Occupants may move in once 1,100 cubic meters per square meter has been replaced. A total of 4,300 cubic metres of outside air must be supplied per square metre of floor area before the HVAC system is switched to its normal operational mode.**
- .5 During the flush-out, the rate of outside air shall not cause the interior space temperature do drop below 16°C (60°F) and the relative humidity shall not exceed 60 per cent.**
- .6 During an occupied flush-out phase, a minimum ventilation rate of 1.5 L/s/m² or the design minimum outside air rate, whichever is greater shall be maintained. Ventilation shall be started a minimum of three (3) hours prior to daily occupancy and shall continue while the space is occupied.**
- .6 Upon successful completion of building IAQ testing and/or flush-out, return HVAC and lighting systems to their designed and/or modified operation.**

3.08 OPERATING AND MAINTENANCE MANUALS

- .1 Ensure that O&M Manuals are complete in accordance with the requirements of Section 20 01 10.**

3.09 "AS-CONSTRUCTED" DRAWINGS

- .1 Ensure that Mechanical Division Trade(s) "As-constructed" drawings have been produced and that they accurately reflect the completed mechanical systems.**

3.10 COMPLETION

- .1 Confirm completion of all Mechanical Work, including, but not limited to:**
 - .1 Removal of all debris from inside mechanical systems and equipment.**
 - .2 Compliance with manufacturer's written instructions regarding bearing lubrication**
 - .3 Alignment of all drives to manufacturer's acceptable tolerances.**
 - .4 Adjustment of belts for proper tension.**
 - .5 Alignment of all pumps to manufacturer's acceptable tolerances.**
 - .6 Removal of all temporary protection and covers.**
 - .7 Removal of oil and grease from equipment and bases.**
 - .8 Cleaning of all fixtures and equipment. Polishing of all plated surfaces.**
 - .9 Replacement of all air and water filters.**
 - .10 Removal, cleaning and reinstallation of pipeline strainer screens.**
 - .11 IAQ Testing or Flush-out Procedure complete.**

3.11 COMMISSIONING TESTS

- .1 Verify readings, calibration and set-up of sensors and equipment, including:
 - .1 Vibration analysis on fan and pump motors;
 - .2 Temperature sensors
 - .3 Humidity sensors
 - .4 Pressure sensors
 - .5 Flow sensors
 - .6 Freeze protection devices
 - .7 Pressure switches
 - .8 Flow switches
 - .9 Status switches
 - .10 Temperature and pressure gauges and gauge connection utilization
 - .11 Control damper positioning, including tightness when closed and full open/balance position
 - .12 Alarm contacts
- .2 Verify correct sensors are reporting accurately to the distributed field panels and operator workstation.
- .3 Verify operation of building storm and sanitary drainage and vent systems, including ancillary support systems:
 - .1 Drainage and vent piping test results;
 - .1 Pressure testing results;
 - .2 Ball test results;
 - .2 Backwater valve operation;
 - .3 Trap seal primer operation;
 - .4 Sump pump system performance
- .4 Verify operation of plumbing pumping, heating and distribution piping systems, including ancillary support systems:
 - .1 Piping system test results;
 - .1 Pressure testing results;
 - .2 Flushing and cleaning test results
 - .2 Domestic water backflow preventers;
 - .3 Service water heating systems;
 - .4 Pressure boost and recirculation systems;
 - .5 Water supply pressure maintenance and stability;
 - .6 Water supply temperature including time taken for domestic hot water supply at fixture outlet from opening;
- .5 Verify operation of hydronic heating and cooling systems and distribution piping systems, including ancillary support systems:
 - .1 Chillers, heat pumps, chilled water and heating water pumping systems
 - .2 Heat exchangers, dampers, heat pump control valves, and makeup water
 - .3 Full checkout by manufacturer's startup representative
 - .4 Heat exchanger operation

- .5 System pressure and temperature control maintenance and stability
- .6 Strainer performance
- .7 Pumping system performance
- .8 Piping system pressure test results;
- .6 Verify operation of air distribution and fan systems, including ancillary support systems:
 - .1 Supply, return, exhaust fan performance;
 - .2 Heating and cooling coil temperature control performance;
 - .3 Humidifier performance;
 - .4 Control damper performance;
 - .5 Full checkout by manufacturer's startup representative;
 - .6 System pressure and temperature control maintenance and stability;
 - .7 Filter performance;
 - .8 Duct pressure test results.
- .7 Verify systems pipe cleaning and chemical treatment condition for all systems.
- .8 Verify that all cooling coil drain pans and condensate piping operate.
- .9 Verify backflow preventer operation.
- .10 Participate in Integrated Systems Testing of Fire Protection and Life Safety Systems in accordance with CAN/ULC-S1001 with all affected Trades. Provide documentation in a form satisfactory to the Authority Having Jurisdiction (AHJ) that testing has been successfully completed.
- .11 Demonstrate access to all valves, equipment and components for servicing.
- .12 Verify the response and operation of all Variable Frequency Drives ("VFD's") and Electronically Commutated Motors ("ECM's") to inputs provided;
- .13 Access to Building Automation System ("BAS") from remote workstations;
- .14 BAS system set-up, operation and alarm sequencing;
- .15 BAS Preventative Maintenance (PM) program access and read/ write revision procedures.
- .16 Verify the operation of all other mechanical equipment in accordance with its intended function;
- .17 Demonstrate equipment access for servicing and replacement at end of useful-life-expectancy.
- .18 Verify that interfacing to the work of other Divisions results in complete and operational systems.

3.12 POST OCCUPANCY EVALUATION

- .1 The post-occupancy evaluation period shall run for one full year following Substantial Performance of the facility. The Commissioning Coordinator shall meet regularly with the operating staff throughout this period to review the operation of all mechanical systems and equipment. The Commissioning Coordinator shall provide written advice regarding questions and concerns raised by the operating staff.
- .2 Resolutions of operational problems shall, where appropriate, be used to modify the Operation and Maintenance Instructions for the equipment and systems involved.
- .3 Identify areas that may come under warranty and conduct a review of condition and operation. Seek remedy under warranty for any outstanding issues and problems before end of warranty period.

END OF SECTION

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- 3.01 INSTALLATION OF FIRE EXTINGUISHERS**
- 3.02 INSTALLATION OF FIRE EXTINGUISHER CABINETS**

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 DESCRIPTION

- .1 Provide fire extinguishers where indicated in the Documents, and in accordance with the requirements of the Authorities Having Jurisdiction (AHJs).

1.03 CODES AND STANDARDS

- .1 Fire extinguishers are to be in accordance with the following Codes and Standards:
 - .1 Ontario Fire Code (OFC);
 - .2 NFPA 10, Standard for Portable Fire Extinguishers;
 - .3 CAN/ULC-S508-02 (including Amendments 1 and 2), Standard for the Rating and Fire Testing of Fire Extinguishers.

PART 2 - PRODUCTS

2.01 GENERAL

- .1 All fire extinguishers are to be pressurized (stored pressure) rechargeable type, in accordance with NFPA 10, and UL and/or ULC listed and labelled for the class of fires and hazard locations for which they are specified.
- .2 Each extinguisher is to be complete with:
 - .1 a manufacturer's identification label indicating the extinguisher model number, rating, and operating instructions;
 - .2 an anodized aluminum or chrome plated forged brass valve with positive squeeze grip on-off operation and a pull-pin safety lock;
 - .3 discharge hose with nozzle or horn and hose securing clip;
 - .4 for wall mounted extinguishers, a wall mounting bracket.

2.02 MULTI-PURPOSE FIRE EXTINGUISHERS

- .1 Multi-purpose 4A 60B:C dry chemical extinguishers are to be 125 mm (5") dia., 4.54 kg (10 lb), each complete with a steel cylinder with a safety red baked enamel finish and a waterproof stainless steel pressure gauge.
- .2 Provide mounting bracket with each ABC-rated dry chemical fire extinguisher.

2.03 FIRE EXTINGUISHER CABINETS

- .1 Surface Mounted: Rectangular break-glass type enclosures sized to suit the extinguishers to be housed, constructed of #18-gauge corrosion resistant steel with a baked white enamel finish, front glass panel, break-glass mechanism, and keyed alike cylinder lock. Finish to be confirmed by architect.
- .2 Recessed: Rectangular cabinets sized to suit the extinguishers to be housed, with a #18 gauge corrosion resistant white enameled steel tub, #14 gauge cleaned and prime coat painted steel door and adjustable trim assembly with rounded corners, semi-concealed piano hinge, safety glass panel, and flush stainless steel door latch. Finish to be confirmed by architect.

PART 3 - EXECUTION

3.01 INSTALLATION OF FIRE EXTINGUISHERS

- .1 Provide fire extinguishers of the type(s) as per requirements of Ontario Fire Code and NFPA 10.

- .2 Install multi-purpose ABC-rated dry chemical fire extinguishers in each fire hose cabinet.
- .3 Unless otherwise shown or specified, wall mount extinguishers using wall brackets supplied with the extinguishers.
- .4 Do not install extinguishers until after wall finishing work is complete.
- .5 You will be responsible for all fire extinguishers until after Substantial Completion of the Work has been certified.
- .6 If extinguishers are indicated adjacent to a door, locate the extinguishers at the strike side of the door.

3.02 INSTALLATION OF FIRE EXTINGUISHER CABINETS

- .1 Provide wall cabinets for fire extinguishers where required.
- .2 Unless otherwise shown or specified, locate cabinets so that the centerline is approximately 1.2 m (4') above the finished floor.
- .3 Confirm exact locations prior to installation.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with the requirements of Section 25 10 10 BAS Control Network
 - .1 Comply with all requirements including those referenced in Article "BAS Integration with Third Party Devices"

1.02 SCOPE OF WORK

- .1 Provision of domestic water piping, valves, circulation pumps, and flushing and disinfection of piping.
- .2 Provision of water service piping for Owner's Fixture, Furniture and Equipment (FF&E) connection requirements;

1.03 QUALITY ASSURANCE

- .1 Execute work of this Section only by skilled tradesmen regularly employed in the installation of plumbing and drainage piping systems, and related equipment.

1.04 SUBMITTALS

- .1 Submit the following Shop Drawings:
 - .1 Stainless steel piping;
 - .2 Stainless steel piping system fittings;
 - .3 Stainless steel piping system joints;
 - .4 Formal cleaning and disinfecting procedure for stainless steel piping systems;
 - .5 Valves;
 - .6 Domestic water pressure booster pumps sets.

1.05 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Proponent is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the successful Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the Bid Price.

PART 2 - PRODUCTS

2.01 POTABLE WATER PIPE, FITTINGS AND JOINTS

- .1 Above Ground Piping: Copper Tubing, Type "L", Hard Drawn, ASTM B88. Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18.
- .2 Below Grade Piping: Type "K" soft copper to ASTM B88, supplied in continuous coil with no joints as possible, and with, when joints are required, complete with soldered fittings to the requirements specified elsewhere in this Article.
- .3 Copper Piping Soldered and Brazed Joints:
 - .1 Soldered Fittings in Potable Water Systems up to 200 psi: Solder filler material to ASTM B 32, Alloy Sn95 (or equal) with Tin (Sn) approximately 95%, and Silver (Ag) approximately 5%;

- .2 Brazed Fittings in Potable Water Systems 200 psi to 300 psi: Brazing filler material to ANSI/AWS A5.8, BAg Series Silver alloys.
- .3 Maximum Lead (Pb) content of solder and brazed joint filler materials shall not exceed 0.2%.
- .4 Copper Piping Grooved End Joints and Fittings:
 - .1 Domestic water piping in accessible spaces with working pressures up to 300 psig (2100 kPa), provide Victaulic QuickVic Style 607 grooved copper piping systems utilizing rigid couplings consisting of ductile iron cast housings, with Grade EPDM gaskets, or equal, meeting NSF/ANSI Standard 61 for cold water (+73°F/+23°C) and hot water (+180°F/+82°C), with plated nuts and bolts to secure assembly together.
 - .1 Wrought copper fittings per ASTM B75 C12200, or ASTM B152 C110001 and ANSI B16.22;
 - .2 Bronze sand cast fittings conforming to UNS C89836.
- .5 Stainless Steel Piping, Fittings and Joints:
 - .1 At the option of the Contractor, and where allowed by the Authorities Having Jurisdiction ("AHJs"), domestic water piping size 2" (50 mm) in diameter or larger may be Schedule 10 type 304 stainless steel pipe conforming to ASTM A-312 with stainless steel fittings per ASTM A-403.
 - .2 Stainless steel pipe joints shall be roll grooved Victaulic Style 807N rigid type couplings and Grade EPDM coupling gaskets, or approved equal, meeting NSF/ANSI Standard 61, with plated nuts and bolts to secure assembly together; welded joints in stainless steel piping systems are not allowed unless an acceptable quality control program can be demonstrated to the Consultant.

2.02 SHUT-OFF VALVES

- .1 Ball Valves: Class 600, 4140 kPa (600 psi) WOG rated full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, and blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle. Valves in insulated piping are to be complete with stem extensions.
- .2 Butterfly Valves - Flanged Ends: Non-corrosive, minimum 1200 kPa (175 psi) cold water pressure rated, resilient seated butterfly valves, each complete with a coated cast ductile iron lug type body, stainless steel shaft, bronze disc, and EPDM seat, and each suitable for domestic water bubble-tight dead end service with the valve in position and either side of the connecting piping removed. Butterfly valves to and including 100 mm (4") dia. are to be equipped with lever handles; valves larger than 100 mm (4") dia. are to be equipped with worm gear operators.

2.03 STRAINERS – Y (WYE) PATTERN

- .1 Size ½" (12mm) to 2" (50mm), **Class 125** cast copper silicon alloy body, Y (wye) pattern strainer, equal to Watts Series LF777 (threaded ends), or LFS777 (soldered ends), as follows:
 - .1 Standards:
 - .1 NSF 372 for potable water applications
 - .2 Pressure and Temperature:
 - .1 ¼" (6mm) to 3" (75mm):
 - .1 **400 psi WOG** at 210°F
 - .2 125 psi WSP to 353°F
 - .2 4" (100mm):
 - .1 **300 psi WOG** at 210°F
 - .2 125 psi WSP to 353°F
 - .3 Materials:

- .1 Body: cast copper silicon alloy
- .2 Solid retainer cap: cast copper silicon alloy
- .3 Cap seal: EPDM O-ring for sizes ¼" (6mm) to 3" (75mm); Garlock gasket for size 4" (100mm)
- .4 Gasket: EPDM
- .5 Screen: #20 stainless steel mesh for sizes ½" (12mm) to 2 ½" (65mm); 3/64" (1.2mm) 304 stainless steel perforated screen for size 3" (75mm); 1/8" (3mm) 304 stainless steel perforated screen for size 4" (100mm)
- .2 Size 2 ½" (65mm) to 12" (300mm), cast iron body, Y (wye) pattern strainer, equal to Watts Series 77F-DI-FDA-125 flanged ends, as follows:
 - .1 Standards:
 - .1 NSF 372 for potable water applications
 - .2 Pressure and Temperature:
 - .1 **200 psi WOG** at 210°F
 - .2 125 psi WSP to 353°F
 - .3 Maximum 140°F operating temperature with epoxy coating
 - .3 Materials:
 - .1 Body: ASTM A-126 Class B cast iron complete with FDA approved epoxy coating on the interior and exterior surfaces
 - .2 Cover: ASTM A-126 Class B cast iron with drain/ blowoff connection and ASTM A6 closure plug; assembly complete with FDA approved epoxy coating on the interior and exterior surfaces
 - .3 Cover bolt: ASTM A6
 - .4 Cover bolt nut: ASTM A6
 - .5 Set screw: ASTM B16
 - .6 Plate: ASTM A6 complete with FDA approved epoxy coating on the interior and exterior surfaces
 - .7 Cotter pin: ASTM A112
 - .8 Washer: ASTM A6
 - .9 Cover gasket: Graphite
 - .10 Screen: 304 stainless steel with 1/16" perforations for sizes 2" (50mm) to 5" (125mm); 304 stainless steel with 1/8" perforations for sizes 6" (150mm) to 8" (200mm); 304 stainless steel with 3/16" perforations for sizes 10" (250mm) to 12" (300mm)

2.04 CHECK VALVES

- .1 Horizontal: Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
- .2 Vertical: Bronze, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

2.05 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm (¾") dia., straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (¾") dia. garden hose, and a cap and chain.

2.06 DOMESTIC HOT WATER PIPING FLOW BALANCING VALVES

- .1 Solder or flanged end type as required, globe style, non-ferrous flow balancing valves suitable for potable water applications and designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off, complete with capped and valved drain connection, and valved ports for connection to a differential pressure meter.

2.07 DOMESTIC WATER PRESSURE BOOSTER PUMP PACKAGE

- .1 Skid-mounted pumping package Acceptable Manufacturers: Taco, Wilo, ITT Bell & Gossett, SA Armstrong, or approved equal.
- .2 The pumps shall be vertical inline, multi-stage design.
- .3 The capacities and characteristics shall be as called for in the Documents.
- .4 Pump outer casing shall be constructed as follows:
 - .1 For working pressure to 232 psig (16bar) at 248°F (120°F): 304 Stainless Steel with ANSI 150 Flanges;
 - .2 For working pressure to 370 psig (25bar) at 248°F (120°F): 304 Stainless Steel with ANSI 250 Flanges;
 - .3 For working pressure to 440 psig (30bar) at 248°F (120°F): 304 Stainless Steel with ANSI 300 Flanges.
- .5 Pump shall have type 304 Stainless Steel wetted parts, NSF 61 certified, suitable for use in potable water applications.
- .6 Each impeller shall be fitted with a Teflon seal ring; the 316L stainless steel shaft shall be fitted with Tungsten Carbide bearings.
- .7 The mechanical seal shall be suitable for the full pressure and temperature range of the pump and shall be fitted with carbon rotating face and silicon carbide stationary face.
- .8 The thrust bearing must be connected to the adaptor and shaft coupling in such manner as to eliminate pump axial loads from the motor, allowing NEMA design motors to be used.
- .9 Totally enclosed fan cooled ("TEFC") motors with thermal overload protection in accordance with Section 20 05 70 "Motors, Motor Starters, Motor Control Centres, and Wiring".
- .10 The base mounted pump shall be assembled in a vertical shaft configuration with the suction and discharge connections being in-line at the bottom.
- .11 The suction and discharge headers shall be made of Type L copper.
- .12 The system shall include mainly the pump & motor assemblies on a common structural steel base, the Integrated Drive Controller (IDC), suction and discharge piping & headers.
- .13 The system shall include stainless steel suction & discharge ball valves, bronze non-slam check valve on the discharge.
- .14 One single point pressure sensor to be wired by Mechanical Trades to the discharge pressure setpoint in accordance with the sequence of operation.
- .15 The system shall require only suction and discharge connections and a single point power connection.
- .16 Field connection of remote sensor/transmitters and connection to Building Automatic System (BAS) shall installed by Controls Trades.
- .17 All components shall be mounted on a structural steel base suitable for grouting.
- .18 The discharge of each pump shall be fitted with a check valve. Each pump and discharge valve assembly shall also be equipped with isolation valves so that the pump can be serviced without disruption to other pump operation.
- .19 Pressure gauges shall be installed on the suction and discharge headers.
- .20 Integrated Drive Controller:

- .1 The pump system controller shall be integrated with the variable frequency drive (IDC) as one unit.
- .2 The controller shall be microprocessor based capable of having software changes and updates via personal computer.
- .3 The controller shall have a fully graphic, multilingual display with a large, bright, backlit graphic display to provide complete drive information.
- .4 The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.
- .5 The controller shall display the following as status readings from a single display on the controller:
 - .1 Current value of the control parameter.
 - .2 Most recent existing alarm (if any).
 - .3 System status with current operating mode.
 - .4 Status of each pump with current operating mode and rotational speed as a percentage.
- .6 The controller shall have as a minimum the following hardware inputs and outputs:
 - .1 2 Analog Inputs (4-20mA or 0-5Vdc or 0-10Vdc).
 - .2 6 Digital Inputs (Programmable and 2 can be used as outputs).
 - .3 1 Analog Output (Programmable).
 - .4 2 Standard Form C 240V Relay.
 - .5 Ethernet connection.
 - .6 Field Service connection to PC.
- .7 All analog inputs shall be provided with current limit circuitry to provide short circuit protection and safeguard against incorrect wiring of sensors.
- .8 Pump system programming shall include the following protections:
 - .1 Ground Fault
 - .2 Motor stall
 - .3 Motor over temperature
 - .4 Motor compensation & overload
 - .5 Pump no-flow
 - .6 Dry Pump
 - .7 Fault Tolerant Control
 - .8 Pump end of curve
 - .9 Short-cycle
- .9 The controller shall be capable of receiving a remote analog set point (0-5V, and 0-10V).
- .10 No flow shutdown shall not require any external flow meters or flow switches or pressure switches to determine when a NO FLOW condition exists.
- .11 The controller shall be compatible with the following communication protocols via the RS-485 port :
 - .1 Johnson Controls Metasys (N2)
 - .2 Siemens Building technologies system 600 (FLN)
 - .3 BACnet, FC Protocol
 - .4 Modbus RTU systems

- .21 Variable Frequency Drive ("VFD"):
- .1 The VFD shall convert incoming fixed frequency single phase (1Ø) or three phase (3Ø) AC power into a variable frequency and voltage for controlling the speed of the three phases AC induction motors.
 - .2 The VFD shall be a six pulse input design, and the input voltage rectifier shall employ a full wave diode bridge; VFD's utilizing controlled SCR rectifiers shall not be acceptable. The output waveform shall closely approximate a sine wave. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.
 - .3 The VFD shall be in a NEMA 12 enclosure; VFD with plastic enclosure shall not be acceptable.
 - .4 The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor.
 - .5 The VFD shall be able to provide its full rated output current continuously at 110% of rated current for 60 seconds.
 - .6 Automatic motor adaptation (AMA) algorithm shall be utilized. This feature shall allow for automatically optimized drive performance and efficiency leading to additional energy savings.
 - .7 The VFD shall provide full torque to the motor given input voltage fluctuations of up to +10% to 15% of the rated input voltage.
 - .8 The VFD shall be suitable for elevations to 3300 feet above sea level without derating. Maximum operating ambient temperature shall not be less than 104 degrees 'F VFD shall be suitable for operation in environments up to 95% non-condensing humidity.
 - .9 The VFD shall be capable of displaying the following information in plain English via a 40-Character alphanumeric display:
 - .1 Frequency
 - .2 Voltage
 - .3 Current
 - .4 Actual System Set point
 - .5 Actual System Demand
 - .6 Kilowatts per hour
 - .7 Fault identification
 - .8 Percent torque
 - .9 Percent power
 - .10 RPM
- .22 Sensor/Transmitters:
- .1 Provide field mounted single point pressure sensor transmitter(s). Unit shall transmit an isolated 0-5V or 0-10V DC signal indicative of process variable to the integrated drive controller via standard two wire 24VDC system.
 - .2 Unit shall have stainless steel wetted parts and a ceramic diaphragm with one ¼" male NPT process connection.
 - .3 A pressure snubber shall be required to protect against any water hammering. Accuracy shall be within 0.25% of full span.
 - .4 A certification of final calibration shall be required for each sensor/transmitter.
- .23 Sequence of Operation:

- .1 The IDC shall compare each sensor signal to the independent DCC representative determined set points
- .2 When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.
- .3 The IDC shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.
- .4 If the set point cannot be satisfied by the designated lead pump, the IDC shall initiate a timed sequence of operation to stage a lag pump.
- .5 The lag pump shall accelerate resulting in the lead pump decelerating until they equalize in speed.
- .6 Further change in process variable shall cause the pumps to change speed together.
- .7 No-Flow Detection:
 - .1 In addition to staging a pump off when it is running at minimum frequency, the VFD can also monitor the power provided to the motor by the drive. If this power is low for the operating speed, a no-flow condition is indicated.
 - .2 The no-flow power level for each drive/pump combination can be easily determined by using an automated macro during system start-up. If a drive's output power for its operating speed indicates a no-flow condition and the No- Flow Delay timer expires, the drive will enter a sleep condition and turn off.
- .8 End-Of-Curve Detection:
 - .1 End-of-curve detection is intended to detect a situation where a broken pipe causes one or more pumps to run at full speed and create excessive flow without reaching the set point pressure, the LEAD drive will issue a warning to indicate this.
- .9 Dry Pump Protection:
 - .1 This feature is used to detect if a pump has run dry, such as improper system fill at start up or when a pump has been out of service and restarted without water. This condition can cause pump damage if not detected and corrected promptly.
- .10 IDC Duplex Pump Set Operation:
 - .1 Both VFD's will be configured to be the LEAD and LAG Pump.
 - .2 The first VFD will act as the LEAD drive, using its PID controller to control the pressure based on sensor readings. The word LEAD PUMP will be displayed on the screen.
 - .3 The second VFD will act as the LAG drive, it will be instructed when to run by the LEAD drive. The word LAG PUMP will be displayed on the screen.
 - .4 The role of LEAD and LAG drive will be alternated between the 2 VFDs based on a predetermined time schedule. The system can also be manually altered by simultaneously pressing the [OK] and [RIGHT] keys on drive 1's keypad.
 - .5 In the event that the LEAD pump cannot maintain the load it will bring on the LAG pump and both will run in unison to maintain pressure. Once the VFDs reach a predetermined low speed together the LAG VFD will turn off and the LEAD VFD will maintain the load.
 - .6 In the event that either drive should fail the other will automatically take over regardless of the timer.
 - .7 The feedback signal will be piggybacked to both VFDs.
 - .8 Stall protection will be provided in the event that either of the pumps should experience a stall or locked rotor.
 - .9 A personal menu in the drive will be set to allow the operator to easily access the pressure set point, the LEAD-LAG timer settings, and to access the sensor range.

- .10 In the event that the pressure sensor should fail the VFD will go to a predetermined speed and remain there until the sensor is repaired. The LAG VFD will display the "Live Zero" alarm while the LEAD VFD will continue to run with a warning "Live zero".
- .11 IDC Triplex Pump Set Operation:
 - .1 A pressure feedback signal is compared to a pressure set point. The LEAD drive uses IDC's PID to analyze the error between the pressure feedback and set point and to adjust the speed of the system to correct for any error. An auto-tuning algorithm is provided in the drive to simplify adjustment of the system. The drives my Personal Menu allows for easy access to the pressure set point.
 - .2 The three VFD's will work in unison to control the flow required to maintain building domestic water pressure. The VFDs are set up such that all three can act as the LEAD, LAG1 or LAG2 VFD. The lead drive will be cycled on a rotation that will allow for similar run time for all of the pumps.
 - .3 When VFD #1 is the LEAD it will operate standalone until such time that it can no longer maintain pressure. If VFD #1 can no longer maintain pressure it will bring on VFD #2 (First lag pump), and these pumps will operate in unison to control the flow required to maintain building pressure. If VFD #1 and VFD #2 cannot maintain flow then VFD#3 (Second lag pump) will be started and all three VFD's will operate in unison to control the flow to maintain building pressure. Once the pressure begins to rise above set point with all three VFDs running at minimum speed then the two lag pumps will sequentially be dropped off and the lead pump will control the flow to maintain building pressure.
 - .4 On a regular schedule the VFD's will share the time as the LEAD pump, LAG pump #1 and LAG pump #2. The control of the alternation schedule will be maintained within VFD #1, and in the event of a failure of this pump the VFD#2 will become the lead pump and remain this way until the schedule in pump #1 is re-engaged.
 - .5 In the event that any of the VFDs should go into a failure or alarm mode then the VFD next in line will pick up the control.
- .12 The sensor that is being used to control the building pressure will be daisy- chained to all Pump Set VFDs to give the active lead drive access to the sensor reading. The daisy-chaining shall be wired in the factory; the installing contractor shall be responsible to wire the sensor into the control relay box (CRB).
- .24 Factory Prefabrication:
 - .1 The system shall be factory prefabricated, including isolation ball valves on the suction and discharge of each pump as well as headers sized for the flow rate indicated in the schedule.
 - .2 Type L copper construction with flanged connections; the only field connections required shall be piping to the system headers, over temperature drain tube and one incoming power connection at the control panel.
- .25 Factory Test and Certification:
 - .1 The booster system and its component parts shall undergo a complete operational flow test from zero to 100% design flow rate under the specified suction pressure conditions at factory prior to shipment, or be tested on site.
 - .2 The system certification shall include copies of the test data as certified by a factory engineer. Performance test certifications to be placed inside the control panel and extra copies with installation manual.
 - .3 The entire system shall be third party certified by Underwriters Laboratories Inc. In accordance with OSHA 29 CFR with references to nationally recognized testing laboratories.

2.08 DOMESTIC HOT WATER RECIRCULATING PUMPS

- .1 Capacity: As shown on the Equipment Schedules.
- .2 All wetted surfaces shall be suitable for use in potable water applications, the entire assembly shall be NSF 61 certified.
- .3 Construction: Closed-coupled, in-line centrifugal, all bronze construction, stainless steel or alloy steel shaft, stainless steel or bronze shaft sleeve, two oil lubricated bronze sleeves or ball bearing. Design for 125 psi at 230°F (860 kPa at 105°C) continuous service.
- .4 Motor: Totally Enclosed Fan Cooled ("TEFC") in accordance with 20 05 70 "Motors, Motor Starters, Motor Control Centres, and Wiring" with thermal overload protection.
- .5 Where noted on the Equipment Schedules pump(s) shall be complete with Variable Frequency Drive ("VFD") in accordance with Section 20 05 75 "Variable Frequency Drives" for variable flow control.
- .6 Acceptable Manufacturers: Taco, Wilo, S.A. Armstrong, ITT Bell & Gossett, or approved equal.

PART 3 - EXECUTION

3.01 DOMESTIC WATER PIPING INSTALLATION REQUIREMENTS

- .1 Install plumbing and pumping systems in accordance with Manufacturer's requirements and the requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required domestic water piping. Type M copper piping shall not be allowed.
- .3 Lay pipes true to line and grade with bells up grade. Fit sections together so that, when complete, the pipe has a smooth and uniform invert. Keep pipe thoroughly clean so that jointed compound will adhere. Inspect the pipe for defects before being lowered into the trench.
- .4 Slope all piping so that it can be completely drained.
- .5 Provide proper dielectric unions in all connections between copper pipe and ferrous pipe or equipment. Dielectric unions are to conform to ASTM F1545-97 and are to be complete with a thermoplastic liner.
- .6 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.

3.02 SHUT OFF VALVES

- .1 Provide shut-off valves at:
 - .1 all equipment connections
 - .2 base of all piping risers;
 - .3 branch piping connection from mains (branch piping serves two or more fixtures);
 - .4 where shown on the drawings.
- .2 Provide minimum 1/4" (6mm) full port ball valves in the pressure class required by the application for isolation of instrumentation components such as pressure gauges, thermometers, and other similar types of devices.

3.03 STRAINERS

- .1 Provide line size strainers in the following locations:
 - .1 On inlet side of water meters
 - .2 at the suction side of each pump;
 - .3 immediately upstream of each pressure reducing valve;
 - .4 immediately upstream of each entering side of a plate and frame heat exchanger;
 - .5 immediately upstream of each control valve;
 - .6 where shown on the Drawings and the Details

- .2 Install strainers in horizontal or down flow (Y (wye) pattern only) piping with clearance for removal of basket.
- .3 Supply strainers with extra construction screens and remove after systems have been thoroughly cleaned.
- .4 Equip each strainer 2" (50 mm) and smaller in size with plugged blow off tappings.
- .5 Equip each strainer 2 ½" (75mm) and larger in size with blow off tapping connection complete with shut off valve and blow off piping with same pressure and temperature rating of strainer. Terminate blow off piping in downward vertical position. Size blow off piping and valve the same size as the blow off tapping.
- .6 Ensure that each strainer can be isolated from piping systems with isolating valves on each side of strainer, and which are not more than 10 ft (3 metres) upstream or downstream from strainer.
- .7 Clean strainer baskets after piping system flushing and cleaning is complete, and before water quantity balancing commences.

3.04 DRAIN VALVES

- .1 Provide a drain valve at the bottom of domestic water piping risers, at all other piping low points, and wherever else shown.
- .2 Locate drain valves so that they are easily accessible

3.05 DOMESTIC HOT WATER PIPING FLOW BALANCING VALVES

- .1 Provide line size flow balancing valves in domestic hot water recirculation piping where shown on the drawings and where required by TAB Trades.
- .2 Locate each valve such that it is easily accessible.

3.06 DOMESTIC WATER BOOSTER PUMP PACKAGE

- .1 Install pumps in accordance with manufacturer's requirements.
- .2 Mount domestic water pressure booster pump package on a 100mm (4") housekeeping pad.
- .3 Make piping and electrical connections to pump and motor assembly and controls as indicated.
- .4 Mechanical Trades to provide conduit and wiring from the supply pressure sensor to the pump control package.
- .5 Provide drains for bases and stuffing boxes piped to and discharging into floor drains
- .6 Support piping adjacent to pump such that no weight is carried on pump casings.
- .7 Support suction guide and discharge elbow from a floor stand with rubber and shear sandwich pad isolators or from above with hangers and spring isolators
- .8 Check motor and pump lubrication points, fill oil reservoir on in-inline of pumps
- .9 Provide vibration isolated pipe hangers (resilient support) next to pumps on piping.
- .10 Start-Up of Domestic Water Pressure Booster Pump Package:
 - .1 The service of a factory-trained representative shall be made available on the job site to verify the installation and Start-Up and instruct operating personnel.
 - .2 Confirm pump rotation is correct.
 - .3 Set up and adjust all controls.

3.07 DOMESTIC HOT WATER RECIRCULATING PUMP

- .1 Install pumps in accordance with manufacturer's requirements.
- .2 Make piping and electrical connections to pump and motor assembly and controls as indicated.
- .3 Ensure pump and motor assembly do not support piping.
- .4 Confirm pump rotation is correct.
- .5 Set up and adjust all controls.

- .6 Provide, ball or butterfly valve, union or flange, as applicable, and strainer on pump discharge piping connections.
 - .1 Provide pressure gauges piped up to measure pressure at pump suction, pump discharge and across strainer.
- .7 Provide, ball or butterfly valve, union or flange, as applicable, check valve and on pump discharge piping connections
 - .1 Check valves in pump discharge shall be swing type with external lever and adjustable weight.
- .8 The service of a factory-trained representative shall be made available on the job site to verify the installation and Start-Up and instruct operating personnel.

3.08 TESTING OF POTABLE WATER SYSTEMS

- .1 Application of Tests
 - .1 After a section of a potable water system has been completed, and before it is placed in operation, a water pressure test shall be conducted, except that an air pressure test may be used during ambient test conditions below 39°F (4°C).
 - .2 A pressure test may be applied to each section of the system or to the system as a whole.
 - .3 Where a pre-fabricated system is assembled off the building site in such a manner that it cannot be inspected and tested on site, off site inspections and pressure tests shall be conducted, and in the presence of the Authorities Having Jurisdiction, or the Consultant, when requested.
 - .4 Where a prefabricated system is installed as part of a water system,
 - .1 All other plumbing work shall be tested and inspected, and
 - .2 The complete system shall be pressure tested when requested by the Authorities Having Jurisdiction, or the Consultant.
- .2 Pressure Tests of Potable Water Systems
 - .1 Except as required in Sentence (4) below, every potable water system shall be capable of:
 - .1 withstanding, without leaking, a water pressure that is at least equal to 1.5 times the maximum anticipated in-service pressure in potable water piping systems designed for operating pressures in excess of 80 psi (560 kPa), but in no case less than 145 psi (1000 kPa), for at least 60 minutes, or
 - .2 withstanding, without leakage, a water pressure that is at least 145 psi (1000 kPa) for systems designed for operating pressures less than 80 psi (560 kPa), for at least 60 minutes, or
 - .3 withstanding, for at least 120 minutes without a drop in pressure, an air pressure that is at least 100 psi (700 kPa) for systems designed for operating pressures less than 80 psi (560 kPa).
 - .2 Where a water pressure test is made, all air shall be expelled from the system before fixture shut-off valves or faucets are closed for system testing.
 - .3 Only potable water shall be used to test a potable water system.
 - .4 If a piping, or piping system component manufacturer states that an air pressure test is not recommended, a water pressure test shall be performed.

3.09 FLUSHING AND DISINFECTION OF PIPING

- .1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.
- .2 Flushing:
 - .1 Before disinfecting, the mechanical contractor shall flush all foreign matter from the pipeline.
 - .2 Flush piping until all foreign materials have been removed and the flushed water is clear.

- .3 Provide hoses, pumps, temporary pipes as required to dispose of flushing water without causing damage to the building or adjacent properties. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.
- .4 The flushing velocities shall be at least 2.5 FPS.
- .5 For large diameter pipe, where it is impractical or impossible to flush the pipe at 2.5 FPS velocity, the pipeline shall be cleaned in place from the inside by brushing and sweeping, then flushing the line at a lower velocity.
- .3 Disinfection:
 - .1 Pipes intended to carry potable water shall be disinfected before being placed in service.
 - .2 Disinfection procedures shall conform to AWWA C601 and AWWA C651 as hereinafter modified or expanded, and the requirements of any governing agency having jurisdiction.
- .4 Disinfection Mixture:
 - .1 The mechanical contractor shall prepare the disinfection mixture with a chlorine-water solution having a free chlorine residual of 40 - 50 PPM.
 - .2 The disinfection mixture shall be prepared by injecting calcium or sodium hypochlorite and water into the piping and allowing it to flow at a measured rate so that water-chlorine solution is of the specified strength.
 - .3 If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a one percent solution (10,000 PPM Chlorine).
 - .4 If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a one percent solution.
- .5 Point of Application:
 - .1 The chlorine mixture shall be injected into the piping to be treated at the beginning of the line, and through a corporation stop or suitable tap in the top of the line.
 - .2 Water from the existing system or other approved sources shall be controlled so as to flow slowly into the newly installed pipe during the application of chlorine.
 - .3 The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 40-50 PPM of free available chlorine.
 - .4 Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water.
 - .5 Check valves shall be used if deemed necessary.
 - .6 The chemical treatment representative shall analyze and record the free chlorine residual at the farthest fixtures from the injection point.
- .6 All valves, fixtures and other appurtenances shall be operated during disinfection to ensure that the disinfection mixture is dispersed into all parts of the line, including dead ends, new services and similar areas that otherwise may not receive the treated water.
- .7 Retention Period:
 - .1 Treated water shall be retained in the pipeline long enough to destroy all nonspore-forming bacteria.
 - .2 With proper flushing and the specified solution strength, 24 hours is adequate.
 - .3 At the end of the 24-hour period, the disinfection mixture shall have a strength of at least 25 PPM of chlorine.
 - .4 The chemical treatment representative shall analyze and record the free chlorine residual at the farthest fixtures from the injection point.
- .8 The above procedure shall be repeated at the mechanical contractor's expense if the free chlorine level drops below the minimum requirements.

- .9 After chlorination, the water from the line shall be flushed until it meets health department requirements.
- .10 Disposal of Disinfection Water:
 - .1 Disposal of disinfecting water shall be done in an approved manner.
 - .2 Disinfecting water should not be allowed to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level.
- .11 Where stainless steel piping is used for domestic water applications, piping systems shall be annealed, de-greased and pickled and will be subject to formal cleaning and disinfecting along with all other parts and components of the domestic water system as per ASTM A-380.

3.10 EQUIPMENT WATER SERVICE CONNECTIONS

- .1 Provide all potable water service piping connection requirements required for Owner's Fixture, Furniture and Equipment (FF&E) supplied under other Sections of the Work.
- .2 Where required by the Documents, or the Authorities having Jurisdiction (AHJs), provide appropriate Back Flow Preventer (BFP) on equipment water service equipment connections to protect potable water supply(ies).
- .3 Provide all pipe fittings, valves, strainers, vacuum breakers, backflow preventers, unions, piping insulation any other ancillaries as indicated, specified or as recommended by Equipment Manufacturer.
- .4 Arrange for rough-in and piping connections to equipment, as recommended by Equipment Manufacturer.
- .5 Provide chrome plated uninsulated piping and piping components exposed to view, unless otherwise indicated. Provide chrome plate escutcheons at wall and floor penetrations.
- .6 Connect Equipment requiring plumbing connections.
- .7 Piping servicing Equipment shall be neatly racked together with heating pipes and shall be minimum of 12" (300 mm) above floor.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 SCOPE OF WORK

- .1 Provision of sanitary drainage piping, vent piping, sanitary sump pumps, and valves.
- .2 Provision of storm drainage piping, storm water sump pumps, and valves.
- .3 Provision of waste effluent drainage piping for Owner's Fixture, Furniture and Equipment (FF&E) connection requirements;

1.03 QUALITY ASSURANCE

- .1 Execute work of this Section only by skilled tradesmen regularly employed in the installation of plumbing and drainage piping systems, and related equipment.

1.04 SUBMITTALS

- .1 Submit the following Shop Drawings:
 - .1 Valves.

1.05 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Proponent is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the successful Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the Bid Price.

PART 2 - PRODUCTS

2.01 STORM AND SANITARY DRAINAGE AND VENT PIPING

- .1 PVC Sewer: SDR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.
- .2 Copper- Solder Joint: Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.
- .3 Cast Iron: cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.
- .4 Copper-Victaulic Coupling Joint: Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings.

2.02 SHUT-OFF VALVES

- .1 Ball Valves: Class 600, 4140 kPa (600 psi) WOG rated full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, and blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle. Valves in insulated piping are to be complete with stem extensions.
- .2 Butterfly Valves - Flanged Joint: Non-corrosive, minimum 1200 kPa (175 psi) cold water pressure rated, resilient seated butterfly valves, each complete with a coated cast ductile iron lug type body, stainless steel shaft, bronze disc, and EPDM seat, and each suitable for domestic water bubble-tight dead end service with the valve in position and either side of the connecting piping removed. Butterfly valves to and including 100 mm (4") dia. are to be equipped with lever handles. Butterfly valves larger than 100 mm (4") dia. are to be equipped with worm gear operators.

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2.03 CHECK VALVES

- .1 Horizontal: Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
- .2 Vertical: Bronze, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

2.04 BACKWATER VALVES

- .1 In-line backwater valves equal to Watts model BV-200 epoxy coated cast iron backwater valve with gasketed cover and removable bronze seat and flapper.

2.05 BACKWATER VALVES

- .1 Provide access to backwater valve seat and flapper through minimum 48" (1200mm) diameter pre-cast concrete maintenance access chamber with flat 24" (610mm) free diameter, gasketed water tight steel frame, and solid maintenance hole cover; pit depth to suit.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Install drainage and drainage pumping systems in accordance with Manufacturer's requirements and the requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.

3.02 EXCAVATION, TRENCHING, BEDDING AND BACKFILL

- .1 Perform excavation, trenching, bedding, backfill and related work required to complete the Mechanical scope of work. Ensure all services are buried a minimum of 5 ft. (1500mm) where piping is located outside the building perimeter walls.
- .2 Where excavation and backfill is required outside perimeter foundation walls, provide all required layout of mechanical services trenches.
- .3 Perform carving and trimming of final 150 mm (6") of trench bottom excavation.
- .4 Perform bedding, installation of services, backfilling and testing to 300 mm (12") above uppermost buried service.
- .5 Grade the bottom of the pipe trench excavation as required.
- .6 In firm undisturbed soil, lay pipes directly on the soil and shape soil to fit the lower segment of all pipes and pipe bells. Ensure even bearing along the barrels.
- .7 In rock and shale excavate to 150mm (6") below and a minimum of 200mm (8") to either side of the pipe. Fill back with a bedding of 12mm (1/2") crushed stone or granular 'A' gravel.
- .8 Prepare new bedding under pipe in unstable soil, in fill, and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, at manholes and catch basins. Compact to maximum possible density and support the pipe by 200mm (8") thick concrete cradle, spanning full length between firm supports. Install reinforcing steel in cradle and construct piers every 2400mm (8 ft.) or closer, down to solid load bearing strata. Provide a minimum of one pier per length of pipe. Use the same method where pipes cross.
- .9 Where excavation is necessary in proximity to and below the level of any footing, bed with 14,000 kPa (2000 psi) concrete to the level of the highest adjacent footing. Proximity is determined by the angle of repose as established by the Project Structural Engineer.
- .10 Provide support over at least the bottom one third segment of the pipe in all bedding methods.
- .11 Do not open trench ahead of pipe laying and bedding more than weather will permit. Break up rocks and boulders and remove by drilling and wedging. Do not use blasting unless specifically approved.

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- .12 Perform all, or required portions of backfilling as specified in Section 31 23 33 in 150mm (6") layers with clean selected materials acceptable to the Consultant.
- .13 Backfill and compact to the following standard Proctor percentages:
 - .1 Sodded area: 85%
 - .2 Under paving: 95%
 - .3 Under Floor slabs: 100%
- .14 Dispose of excavated material as directed by the Contractor.

3.03 DRAIN, WASTE AND VENT PIPING INSTALLATION

- .1 For underground pipe inside the building and to points 1.5 m (5') outside the building lines - rigid PVC sewer pipe, minimum 75mm (3") diameter;
- .2 For pipe inside the building and above ground in sizes to and including 65mm (2½") diameter - type DWV copper;
- .3 For pipe inside the building and above ground in sizes 75mm (3") diameter and larger - cast iron;
 - .1 for piping in Hospital Diagnostic Imaging Suites where material may be subject to magnetic fields (CT Scan and similar), provide DWV piping for size required;
- .4 For drainage pump discharge pipe connections from the pump to and including shut-off and check valve connections - Type "DWV" copper with grooved fittings and couplings, or Schedule 40 galvanized steel with grooved fittings and couplings.
- .5 Unless otherwise specified, slope horizontal drainage piping above ground in sizes to and including 75 mm (3") diameter 25mm (1") in 1.2 m (4'), and pipe 100mm (4") diameter and larger 25mm (1") in 2.4 m (8').
- .6 Install and slope underground drainage piping to inverts or slopes indicated on the drawings to facilitate straight and true gradients between the points shown. Verify available slopes before installing the pipes.
- .7 Unless otherwise specified, slope horizontal branches of vent piping down to the fixture or pipe to which they connect with a minimum pitch of 25mm (1") in 1.2 m (4'-0").
- .8 PVC drainage waste and vent piping that penetrates a fire separation shall be sealed at the penetration by a fire stop that has an FT rating not less than the fire-resistance rating of the fire separation in accordance with fire test method in CAN/ULC-S115.
- .9 Extend vent stacks up through the roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above the roof (including roof parapets) in vent stack covers as per CSA.
- .10 Provide proper dielectric unions at connections between copper pipe and ferrous pipe or equipment.

3.04 TESTING OF DRAINAGE AND VENT PIPING SYSTEMS

- .1 Except in the case of an external leader, after a section of a drainage system or a vent piping system has been roughed in, and before any fixture is installed or piping is covered, a water pressure test or an air pressure test shall be conducted.
- .2 After every fixture is installed and before any part of the drainage system or vent piping system is placed in operation, a final test shall be carried out when requested.
- .3 Where a prefabricated system is assembled off the building site in such a manner that it cannot be inspected and tested on site, off-site inspections and tests shall be conducted.
- .4 Where a prefabricated system is installed as part of a drainage system or venting system, all other plumbing work shall be tested and inspected and a final test shall be carried out on the complete system when requested.
- .5 When requested, a ball test shall be made to any pipe in a drainage system.
- .6 Tests of Pipes in Drainage Systems:

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- .1 Pipes in a drainage system, except an external leader or fixture outlet pipe, shall be capable of withstanding, without leakage, a water pressure test, air pressure test, and final test.
- .2 Pipes in a drainage system shall be capable of meeting a ball test.
- .7 Tests of Venting Systems:
 - .1 Venting systems shall be capable of withstanding, without leakage, a water pressure test, air pressure test and final test.
- .8 Water Pressure Tests:
 - .1 A water pressure test shall consist in applying a pressure of at least 4.5 psi (10.ft.wg, or 3m water column) to all joints.
 - .2 In making a water pressure test:
 - .1 Every opening, except the highest, shall be tightly closed with a testing plug or a screw cap, and
 - .2 The system, or the section, shall be kept filled with water for 15 minutes.
- .9 Air Pressure Tests
 - .1 Air pressure tests shall be conducted in accordance with the manufacturer's instructions for each piping material, and
 - .1 Air shall be forced into the system until a pressure of 35 kPa is created, and
 - .2 This pressure shall be maintained for at least 15 minutes without a drop in pressure.
 - .2 The addition of a non-toxic indicating substance, such as an aerosol, a fluorescent dye, smoke or an odorant, to an air pressure test may be used to identify the location of a leak, however, the additive must be compatible with the piping material being tested and in no way adversely affect the integrity of the plumbing system.
- .10 Final Tests
 - .1 Where a final test is made:
 - .1 every trap shall be filled with water,
 - .2 the bottom of the system being tested shall terminate at a building trap, test plug or cap,
 - .3 except as provided in Sentence (.10.2) below, smoke from smoke generating machines shall be forced into the system,
 - .4 when the smoke appears from all roof terminals, they shall be closed, and
 - .5 a pressure equivalent to a 1 in.wg (25 mm water column) shall be maintained for 15 minutes without the addition of more smoke.
 - .2 The smoke referred to in Clauses (.10.1.3) and (.10.1.4) above is permitted to be omitted, provided the roof terminals are closed and the system is subjected to an air pressure equivalent to 1 in.wg (25 mm water column) maintained for 15 minutes without the addition of more air.
- .11 Final Tests General Procedures:
 - .1 Fill all traps to their minimum water seal
 - .2 Plug the building drain through the main cleanout where the drain leaves the building
 - .3 All future connections are capped with permanent caps.
 - .4 One General Final Test Procedure is successfully completed.
 - .5 A final visual is done for the plumbing fixtures and trim.
 - .6 General Final Test Procedure #1

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- .1 Smoke (or air) is forced into the system through the main cleanout or other convenient connection.
- .2 When the smoke appears at the vent terminal it shall be closed.
- .3 Smoke will continue to be added until a pressure of 1 in.wg (25 mm water column) is achieved.
- .4 This pressure will then be maintained for a minimum of 15 minutes without the addition of more smoke.
- .5 If this pressure cannot be maintained, the leak shall be located and repaired. Once this is complete the procedure shall be repeated until the test passes.
- .6 The test equipment is removed, the main drain unplugged, and the caps on the vent terminals removed. All traps are to have their trap seals replenished if necessary.
- .7 General Final Test Procedure #2

Note: General Final Test Procedure #2 is intended to require no pressure gauges and will exert a pressure equal to or greater than 1 in.wg (25 mm water column).

 - .1 A toilet bowl is filled slowly with water, until the level in the bowl rises to the underside of the bowl rim.
 - .2 If the system is air tight, the level of the water in the bowl will remain at the underside of the bowl rim. The pressure that is created by the head of the water is equal to the air pressure in the plumbing system. This proves the system air tight.
 - .3 If the water level drops slowly, a small leak in the system is evident. If the water will not rise at all, then a large leak is evident. The leak must be located and repaired. The final test must then be repeated.
 - .4 Once the water level has remained constant for 15 minutes, a cleanout will be opened or the plug in the main drain pulled. At this time the toilet bowl will flush and the traps may siphon.
 - .5 The caps on the vent terminals are to be removed and the water seal replenished on all fixtures.
- .12 Ball Tests:
 - .1 Where a ball test is made, a hard ball, dense enough not to float, shall be rolled through the pipe.
 - .2 The diameter of the ball shall be not less than
 - .3 2" (50 mm) where the size of the pipe is 3" (75 mm) or more, or
 - .4 1" (25 mm) where the size of the pipe is less than 3" (75 mm).
 - .5 Ball Testing Procedure:
 - .1 The test ball shall be placed at the high end of the pipe, and allowed to roll through the pipe to the low end of the pipe.
 - .2 If there are not obstructions and the pipe is graded correctly, the test ball shall be caught and removed.
 - .3 The piping then passes the ball test.
 - .4 If the test ball doesn't roll all the way through, the Consultant will allow one 5 Imperial gallon bucket of water to be poured into the drain.
 - .5 If this does not dislodge the test ball and cause it to roll through the piping then the piping does not pass the ball test.
 - .6 The ball will have to be retrieved and test procedure repeated again until a pass is achieved.

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- .7 For newly installed plastic piping, the solvent used is heavily corrosive towards billiard balls. Ensure the solvent is given sufficient time to cure prior to conducting the test.

3.05 BACKWATER VALVES

- .1 Provide access to backwater valve seat and flapper through minimum 48" (1200mm) diameter pre-cast concrete maintenance access chamber with flat 24" (610mm) free diameter, gasketed water tight steel frame, and solid maintenance hole cover; pit depth to suit.

3.06 EQUIPMENT DRAINAGE CONNECTIONS

- .1 Provide all waste effluent drainage piping required for Owner's Fixture, Furniture and Equipment (FF&E) connection requirements.

3.07 EQUIPMENT WASTE WATER SERVICE CONNECTIONS

- .1 Provide all waste effluent drainage service piping connection requirements required for Owner's Fixture, Furniture and Equipment (FF&E) supplied under other Sections of the Work.
- .2 Provide all waste water fittings, valves, strainers, vacuum breakers, unions, piping insulation any other ancillaries as indicated, specified or as recommended by Equipment Manufacturer.
- .3 Arrange for rough-in and piping connections to equipment, as recommended by Equipment Manufacturer.
- .4 Provide chrome plated uninsulated waste water drainage piping and piping components exposed to view, unless otherwise indicated. Provide chrome plate escutcheons at wall and floor penetrations.
- .5 Connect Equipment requiring waste water drainage piping connections.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 10 50 Basic Materials and Methods.

1.02 SCOPE OF WORK

- .1 Provide all labour, materials, products, equipment and services to supply, install and commission compressed air system including all equipment, distribution piping and outlets.

1.03 REFERENCES

- .1 American Society of Mechanical Engineers ("ASME")
 - .1 ASME Boiler and Pressure Vessel Code ("BPVC") Section VIII Pressure Vessels.
 - .1 BPVC-VIII B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 1.
 - .2 BPVC-VIII-2 B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 2 - Alternative Rules.
 - .3 BPVC-VIII-3 B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 3 - Alternative Rules High Press Vessels.
 - .2 ASME B16.5, Pipe Flanges and Flanged Fittings
 - .3 ASME 16.9, Factory-Made Wrought Buttwelding Fittings
 - .4 ASME B16.11, Forged Fittings, Socket-Welding and Threaded
 - .5 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
 - .6 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .7 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
 - .8 ASME B31.1, Power Piping
 - .9 ASME B31.3, Process Piping
- .2 American Society for Testing and Materials International ("ASTM")
 - .1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - .2 ASTM A181/A181M, Standard Specification for Carbon Steel Forgings for General Purpose Piping
 - .3 ASTM B88, Standard Specification for Seamless Copper Water Tube
 - .4 ASTM B828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
- .3 American Welding Society Inc. ("AWS")
 - .1 AWS A5.8M/A5.8 Specification for Filler Metals for Brazing and Braze Welding.
- .4 Canadian Standards Association International ("CSA")
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .5 Health Canada Workplace Hazardous Materials Information System ("WHMIS")
 - .1 Material Safety Data Sheets (MSDS).

1.04 SUBMITTALS

- .1 Submit shop drawings for all compressed air system Products Specified in this Section of the Specifications except for pipe and fittings.

- .2 Submit engineering design data to confirm products proposed meet requirements specified in this Section. Include certified power and control wiring diagrams where applicable.
- .3 Submit copies of all test and inspection reports, including test reports supplied by authority making the inspection, for all inspections specified in this Section. Complete and submit TSSA "Piping Systems Installation and Test Data Report", and submit all other documents required by TSSA.
- .4 Submit a letter from Air Compressor Manufacturer, or Manufacturer's designated representative, certifying air compressor set installation is in accordance with requirements specified in Part 3 of this Section.
- .5 Submit valid and up-to-date qualification certificates for tradesmen performing the work, all as specified in this Section.

1.05 QUALITY CONTROL

- .1 The work shall be carried out in accordance with the Specifications and, where applicable, in accordance with the manufacturer's instructions by Trades experienced in this type of work.
- .2 Trades performing registered pressure piping work to be licensed in accordance with the requirements of the Authorities Having Jurisdiction (AHJs).
- .3 Prior to submitting shop drawings/product data sheets for any system governed by the Boilers and Pressure Vessels Act, review Contract Documents for conformance with CSA B51 and related standards, and immediately report any discrepancies so as not to delay the work. This review is intended to avoid installation of materials and/or products that may later be rejected by AHJs.
- .4 Employ a subcontractor approved by AHJs (Boiler and Pressure Vessels Division), who has a Quality Plan filed with AHJs to complete the work of this Section.
- .5 Work is to be performed only by certified welders in accordance with requirements of Section entitled Basic Mechanical Materials and Methods, and by certified journeyman pipe fitters and licensed petroleum mechanics. Maintain copies of each registered tradesman's certificate on-site for examination upon request.
- .6 Install all work required to be registered under Boiler and Pressure Vessels Act in accordance with requirements of this Section and CSA B51, including related Codes and Standards.
- .7 Schedule, pay costs, and obtain reports for inspections by governing authority at regular intervals including but not limited to pre-construction material inspection, demonstration of welding procedures, general installation inspections, and any other inspection(s) requested by governing authority.

1.06 VIBRATION ISOLATION GENERAL REQUIREMENTS

- .1 All vibration isolators and bases shall be supplied by an approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.
- .2 Provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The drawings shall bear the stamp and signature of the responsible supplier's technical representative.
- .3 All vibration isolators shall have either known undeflected heights or other markings so that after adjustment, when carrying their load, the deflection under load can be verified to confirm the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the requirements.
- .4 All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and shall be linear over a deflection range of 50 percent above the design deflection.
- .5 The ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 2.0.

PART 2 - PRODUCTS

2.01 PIPING, JOINTS AND FITTINGS

- .1 Copper Piping:

- .1 Provide Type "L" hard-drawn copper piping conforming to ASTM Standard B88 for compressed air piping sizes up to NPS ¾" (20 mm).
- .2 Provide wrought copper braze joint fittings. Do not use cast fittings.
- .3 Make connection to piping of a different material with dielectric fittings.
- .4 Brazing Alloys:
 - .1 Provide silver type brazing alloys with a melting point of approximately 1100°F (593°C) and a tensile strength of 90,000 psi (621 MPa) minimum, cadmium free, requiring no flux for installation. Silver brazing alloy shall be Aircosil 45.
- .2 Black Steel Piping:
 - .1 Provide ASTM A53/A53M, seamless black steel.
 - .2 NPS 2" (50mm) and smaller:
 - .1 ASME 16.9, Schedule 40, welded joints
 - .2 ASME B16.11, Schedule 80 steel, threaded joints.
 - .3 NPS 2½" (65 mm) and larger:
 - .1 ASME 16.9, Schedule 80, welded joints
 - .2 ASME B16.11, Schedule 80, socket welded joints.
 - .4 Where welding is employed wall thickness to match pipe thickness
 - .5 Where threaded is employed for sizes NPS 2" (50mm) and smaller:
 - .1 Threaded malleable iron fittings, Class 150 to ANSI B16.3,
 - .2 150 psi (1030 kPa) black malleable iron, bronze face, ground joint unions.
 - .6 Couplings: To ASME B16.11, socket welded or threaded half coupling type.
 - .7 Unions: Malleable iron with brass-to-iron ground seat.
 - .8 Dissimilar metal junctions: Use di-electric unions.
 - .9 Flanges:
 - .1 NPS 2" (50mm) and smaller:
 - .1 Class 150 to ASME B16.5, forged steel, raised face and socket welded.
 - .2 NPS 2½" (65 mm) and larger:
 - .1 Class 150 to ANSI B16.5, forged steel raised face and slip-on or weld neck.
 - .2 Gaskets to ANSI B16.21, ANSI B16.20 or ANSI A21.11 of heavy duty graphite impregnated compressed sheet 1/16" (1.6 mm) thick
 - .10 Studs, bolts and nuts:
 - .1 to ANSI B18.2.1, ANSI 18.2.2 and ASTM A194, "high strength" type
 - .11 Jointing compound for screwed pipe:
 - .1 pulverized lead paste.

2.02 SHUT-OFF VALVES

- .1 Three-piece design or top entry for ease of in-line maintenance.
- .2 Black Steel Piping Service:
 - .1 To ASTM A181/A181M, Class 70, carbon steel body socket welded ends, carbon steel ball and associated trim suitable for compressed air application.
 - .2 To withstand 600 psig (4135 kPa) maximum pressure.
- .3 Copper Piping Service:

- .1 Provide for valves 2" (50 mm) and smaller, bronze ball valves ASME rated for non-shock cold water pressure of 600 psig (4135 kPa).
- .2 Provide for valves 2½" (65 mm) and larger, bronze solder and globe valves.

2.03 PRESSURE REDUCING VALVE STATIONS

- .1 Provide pilot operated pressure reducing valve stations complete with isolation valves where indicated on the Drawings. Pressure reducing valves shall be suitable for an operating pressure range from 150 psi (1035 kPa) inlet and an outlet pressure of 20 psi (140 kPa).
- .2 Provide pressure reducing valve stations at each piece of equipment indicated on the drawings. Station shall be complete with isolation valves, ¼" (6 mm) female quick detachable coupling and pressure gauge. Valve shall be suitable for an inlet pressure of 150 psi (1035 kPa) and an outlet pressure of 75 psi (515 kPa).

2.04 PRESSURE GAUGES

- .1 Provide 1½" (38 mm) pressure gauges complete with shutoff cocks and snubbers. Select gauges with 0-200 psig (0-1380 kPa) range.

2.05 OUTLET STATIONS

- .1 Provide, at each compressed air outlet station, 8 ft. (2440 mm) long by 3/8" (10 mm) internal dia. heavy duty neoprene standard service station hose, complete with plug hose stem to snap onto the female detachable coupling. Provide female hose barb for the other end of the hose.

2.06 COUPLERS/CONNECTORS

- .1 Industrial interchange series, full-bore coupling, ¼" (6 mm) female Quick-Connect Air Hose Fittings unless noted otherwise.
- .2 Maximum rated inlet pressure: 300 psi (2070 kPa).
- .3 Inlet temperature range: -40°F to +250°F (-40°C to +121°C)
- .4 Valve seat: moulded nylon.
- .5 Body: **brass/ stainless steel**.
- .6 Threads: NPT.

2.07 CONTROLS

- .1 Pressure switch shall be capable to initiate compressor start at 95 psi (655 kPa) and to stop at a pressure of 150 psi (1035 kPa); pressure start and stop setpoints shall be field adjustable.
- .2 For duplex or multi-plex systems, provide electrical alternation set to operate each compressor for 12 hours period and automatically alternate to the second compressor at the pre-set timeframe. In the event one compressor fails or is unable to supply the necessary demand, the stand by compressor automatically starts to maintain air pressure. Controls shall be integral to each individual compressor unit and be configured to communicate between compressor units.
- .3 Manual control with Hand-Off-Auto ("H-O-A") starter switch.
- .4 Provide panel suitable for 600V/3ph/60Hz cycle electric power supply and complete with external hinged metal cover with tamperproof lock concealing start/stop buttons and other instruments.
- .5 Provide all required motor control wiring.
- .6 Provide a remote status panel complete with 3" (75 mm) alarm bell, flashing red light, alarm silence button, all in 5¼" x 19" (135 mm x 485 mm) long enclosure arranged for electronic rack installation.
- .7 Provide auxiliary contacts at compressor control panel to enable BAS status and alarm connection.

2.08 AIR COMPRESSOR

- .1 Provide Atlas Copco GA-series, or equivalent, oil-injected rotary screw, full feature, floor-mounted air compressors complete with ASME rated receiver tank.
- .2 Maximum working pressure to be 150 psig (1035 kPa).

- .3 This unit to also be complete with matched set V-belt drive, pressure switch for automatic start/stop, check valve, air cooled after cooler, drain valve, belt guard, silenced inlet filler and pre-wired automatic drain.
- .4 Provide pressure reducing valves assemblies where noted on the drawings, and complete with pressure gauges on high and low pressure side of valve.
- .5 Safety relief valves: safety relief valves shall be provided in accordance with the requirements of the Authorities Having Jurisdiction. Provide relief vent piping to atmosphere with termination at roof level.
- .6 Motor: standard protected, 10 HP, 600V/3ph/60Hz.
- .7 Control:
 - .1 Manual control with H-O-A starter switch.
 - .2 Pressure switch to cut out at 115 psi (800 kPa) (adjustable) and with minimum differential pressure.
 - .3 Provide all required motor control wiring.
- .8 Accessories: Belt guard and pressure gauges.
- .9 Air intakes: Complete with bird screen, replaceable cartridge type intake filter and silencer.
- .10 Capacity: Refer to mechanical equipment schedules.
- .11 Vibration isolation: 95% minimum efficiency.

2.09 AIR RECEIVER

- .1 Provide vertical 120 gallon receiver built to CSA B51 Provincial regulations for working pressure of 200 psi (1378 kPa). Flange or screw inlet and outlet connections.
- .2 Fittings shall include adjustable pressure regulator, safety valve, pressure gauge, drain cock and automatic condensate drain.
- .3 Tank finish shall be shop primed.
- .4 Tank to have valid CRN Registration.

2.10 AIR COMPRESSOR FLEXIBLE CONNECTORS

- .1 Provide flexible stainless steel metal pipe connectors in discharge piping from each compressor. Flexible connectors shall have a minimum burst pressure of four times operating pressure. Pipe sizes through 2" (50 mm) ID shall be furnished with Hex male nipple fittings and pipe sizes 2½" (65 mm) ID and larger shall be furnished with fixed steel flanges both sides.

2.11 REFRIGERATED AIR DRYER

- .1 Provide refrigerated air dryer integral with air compressor package, or as an accessory as part of a built-up compressor package.
- .2 Provide non-cycling air dryer of self-contained mechanical refrigeration type.
- .3 Dryer shall be capable of achieving 37°F (3°C) dew point.

2.12 COMBINATION FILTER-REGULATOR

- .1 Factory assembled, heavy-duty with mounting bracket and low pressure side relief valve.
- .2 Maximum inlet pressure: 115 psi (800 kPa).
- .3 Operating temperature: 0°F to 125°F (-18°C to 52°C).
- .4 Filter element: 40 micron. Bowls: Polycarbonate.
- .5 Pressure range in regulator: 5 psi (34 kPa) to 115 psi (800 kPa).
- .6 Gauge range: 0 to 160 psi (1100 kPa).

2.13 COMPRESSED AIR FILTERS

- .1 Provide general purpose coalescing filter downstream of the refrigerant dryers capable of reducing water/oil aerosol to 0.1 PPM and particulates of 0.01 micron.
- .2 Provide an active carbon filter removing hydrocarbon odors to 0.003 PPM and shall be down stream of the refrigerant dryers.
- .3 Provide a general particulate filter upstream of the refrigerant dryer capable of 99% efficiency as it relates to particulate removal.

PART 3 - EXECUTION

3.01 COMPRESSED AIR SYSTEM INSTALLATION

- .1 Provide interconnecting compressed air piping including fittings, valves and auxiliaries required to achieve a fully functional compressed air generation and distribution system.
- .2 Piping joints and fittings:
 - .1 Up to NPS $\frac{3}{4}$ " (20 mm): copper with brazed fittings
 - .1 Connections between steel and copper pipe to made up with dielectric unions or brass adapters, or brass valves.
 - .2 NPS 2" (50 mm) and smaller: steel pipe, threaded with threaded fittings made up with joint compound.
 - .3 NPS $2\frac{1}{2}$ " (65 mm) and larger: steel pipe, welded with butt weld or socket weld fittings.
- .3 Provide tees in lieu of elbows at changes in direction of piping. Install plug in open ends of tees.
- .4 Make all branch takeoffs from top of main.
- .5 Grade compressed air piping not less than 1% (1" in 8 ft. or 10mm in 1m) to dirt pocket with drain.
- .6 Install full size dirt pockets not less than 6" (150 mm) long at the bottom of each riser and elsewhere where dirt or condensate may accumulate each complete with drain valve connection with drain piping extended to nearest drain. Do not exceed 100 ft. (30 m) between drain points.
- .7 Provide check valves on compressor discharge piping.
- .8 Provide shut-off valves at all outlets, each main, branch and riser, and in locations as indicated in the Documents. Install valves with stems upright or horizontal.
- .9 Provide quick-coupler chucks and pressure gauges on drop pipes.
- .10 Weld steel piping in accordance with Section 20 10 50 Basic Mechanical Materials and Methods and;
 - .1 To ASME code and requirements of Authorities Having Jurisdiction (AHJs).
 - .2 Weld concealed and inaccessible piping regardless of size.
- .11 Connections to equipment:
 - .1 Provide shut-off valves at each equipment connection.
 - .2 Make connections to equipment using steel pipe with screwed unions up to NPS 2" (50 mm), and flanges for NPS $2\frac{1}{2}$ " (65 mm) and larger to permit removal or replacement.

3.02 PIPE LEAKAGE TESTING

- .1 Meet testing requirements of all Authorities Having Jurisdiction (AHJs). Obtain certification and certify tests not required by AHJs. Perform not less than the following tests.
- .2 Complete pipe leakage in accordance with the Mechanical Contractors Association of America (MCAA) "Guide to Pressure Testing Safety".
- .3 Complete pipe leakage testing in accordance with the requirements of ASTM A1047 / A1047M-05 "Standard Test Method for Pneumatic Leak Testing of Tubing", as follows:
- .4 Pneumatic Pipe Leakage Testing:

- .1 A preliminary pneumatic test not to exceed 25 psig may be applied, prior to other methods of leak testing, as a means of locating major leaks for piping subject to ASME B31.1 and/or ASME B31.3.
- .2 For piping subject to ASME B31.1 and/ or ASME B31.1, perform a pneumatic pressure test.
- .3 For piping subject to ASME B31.1, the pneumatic test pressure shall be not less than 1.2 nor more than 1.5 times the design pressure of the piping system, but shall not exceed the maximum test pressure for any vessel, compressor, valve, or other component in the system under test.
- .4 For piping subject to ASME B31.3, the pneumatic test pressure shall be not less than 1.1 times the design pressure of the piping system
- .5 Pressurize test circuit with air or nitrogen to a gage pressure, which is the lesser of one-half the test pressure or 25 psig.
- .6 After reaching one-half the test pressure, gradually increase pressure in steps of one-tenth the test pressure until the test pressure is reached.
- .7 Test without pressure drop for a period of not less than 10 minutes at the maximum test pressure, then reduce to the design pressure, and hold for a period that allows for a complete visual inspection of the piping systems under test, however, for a period not less than 4 hours. Pneumatic leakage testing shall be repeated until no leaks are found.
- .8 Examination for leakage shall be conducted using soap bubble or equivalent detection methods, shall be made of all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Wipe joints clean after test.
- .5 Perform tests before piping is covered or concealed.
- .6 Eliminate leaks or remove and refit defective parts. Do not caulk threaded or welded joints.
- .7 Remove all components which will not withstand test pressure following any remedial work after testing.
- .8 After pressure testing is completed, adjust and put all parts of the system into proper working order. Leave the complete job ready for regular operation, all to the satisfaction of the Consultant.
- .9 After the testing period, drain the system, and compressed air is introduced into the system, clean out all dirt pockets and strainers.
- .10 The final test and acceptance shall not be made until the work is fully completed.

3.03 INSTALLATION OF COMPRESSORS

- .1 Install compressor(s) in accordance with manufacturer's written instructions, and all requirements of the Authorities having Jurisdiction (AHJs).
- .2 Install compressor(s) on vibration isolators set on 4" (100mm) high concrete housekeeping pad.

3.04 MAIN AIR PRESSURE REGULATORS

- .1 Install compressed air pressure regulating stations where noted on the drawings, and in accordance with drawing details.
- .2 Install pressure regulators in three valve by-pass arrangements.

3.05 INSTALLATION OF COMPRESSED AIR FILTERS

- .1 Install filters in accordance with Manufacturer's Installation requirements.
- .2 Install a general particulate filter upstream of the refrigerant dryer.
- .3 Install general purpose coalescing filter downstream of the refrigerant dryers.
- .4 Install an active carbon filter downstream of the refrigerant dryers.
- .5 Install filters in three valve by-pass arrangements.

3.06 EQUIPMENT TESTING

- .1 Have manufacturer of products Supplied under this Section review work involved in handling, installation, application, protection, and cleaning of their products and submit written reports, in acceptable format, to verify compliance with the operation of their product.
- .2 Provide manufacturer's commissioning services, consisting of periodic site visits for inspection of product installation, product use recommendations and, operating and service training of Owner's designated personnel.
- .3 Schedule site visits to review work at stages listed:
 - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
 - .4 Operator training of Owner's service personnel.
- .4 Submit reports within three (3) days of manufacturer's site attendance.

3.07 SYSTEM START-UP

- .1 Thoroughly clean the compressed air system before and after testing to ensure that all dirt, water and moisture are removed.
- .2 Demonstrate the condition and operation of the complete compressed air installation to the satisfaction of the Consultant.
- .3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .4 Warrant the system to be completely oil free.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with requirements of Section 20 10 10 Plumbing Piping and Pumping Systems.

1.02 SCOPE OF WORK

- .1 Provision of plumbing equipment and specialties as described in this Section.

1.03 QUALITY ASSURANCE

- .1 Execute the Work of this Section only by skilled tradesmen regularly employed in the manufacture and installation of plumbing equipment and specialties.

1.04 SUBMITTALS

- .1 Submit the following Shop Drawings:
 - .1 Floor drain trap seal primers;
 - .2 Pressure reducing valves;
 - .3 Water hammer arrestors;
 - .4 Domestic hot water storage tanks;
 - .5 Hydro-pneumatic tanks;
 - .6 Backflow preventers;
 - .7 Water meters;

PART 2 - PRODUCTS

2.01 TRAP SEAL PRIMERS

- .1 Primer Valve Type: Precision Plumbing Products Inc. Model P2-500, or equal, trap primer valve, constructed of brass, adjustable to high or low water pressures and complete with "O" ring seals, 12 mm (½") threaded inlet and outlet connections, and, for priming two traps from the same primer, a DU-2 dual outlet distribution unit.
- .2 Primer Valve Type with Manifold: Precision Plumbing Products Inc. Model P1-500, or equal, trap primer valve constructed as specified above for the Model P2-500 primer valve, complete with a Model DU-3 or DU-4, 3 or 4 outlet distribution unit for priming 3 or 4 traps, and at Model "YS-8" supply tube with combinations of Model DU-3 and DU-4 distribution units for priming from 5 to 6 traps.
- .3 Electronic Type: Precision Plumbing Products #PT Series, or equal, surface wall mounting, CSA certified, 115 volt, 1 phase, 60 Hz., electronic, automatic trap priming manifolds, each sized to suit the number of drain traps or interceptors serviced, and each complete with:
 - .1 a galvanized steel cabinet with door;
 - .2 20 mm (¾") dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;
 - .3 a solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with 12 mm (½") dia. compression type copper tube connections on 40 mm (1½") centres with quantity to suit the number of items to be primed;
 - .4 a control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.

2.02 BACFLOW PREVENTERS

- .1 Reduced pressure zone ("RPZ") style dual check valve design backflow preventers in accordance with CAN/CSA B64 (including supplements), each of bronze or epoxy coated cast iron bronze fitted construction depending on size, and complete with inlet strainer, inlet and outlet shut-off valves, an intermediate relief valve, ball valve type test cocks, and a proper air gap fitting.

2.03 TRAP SEAL PRIMERS

- .1 Equal to Precision Plumbing Products (PPP) model PTS electronic trap seal trap priming assembly shall automatically maintains a constant water seal in floor drain traps configured to accommodate 4 to 30 connections. Electronic trap seal primer assembly shall be as follows:
 - .1 Surface mounted NEMA-1 metal cabinet with cover plate: 12" x 12" x 4" deep (305mm x 305mm x 102mm deep)
 - .2 Domestic water inlet: ¾" (20mm) shut-off valve with female threaded connection to ANSI/ASME BI.20.1.
 - .3 Outlet: ½" (12mm) compression fitting(s) to SAEJ512.
 - .4 Manifold: ¾" (20mm) Type "L" copper tubing to ASTM B88.
 - .5 Soldered joints: 95-5 lead free containing lead not in excess of 0.2%.
 - .6 Electrical components: 2 Amp circuit breaker, manual over-ride switch/test button, timer, solenoid valve marked as UL listed.
 - .7 Backflow prevention: Anti-Siphon atmospheric vacuum breaker meets American Society of Sanitary Engineering (ASSE) Standard 1001 and CSA.
 - .8 Temperature rating: 32°F to 125°F (0°C to 51.7°C)
 - .9 Pressure rating: 20 psi to 150 psi (140 kPa to 1035 kPa).
 - .10 Electrical Specifications: 120V/1ph/60Hz; Watts: 6; Holding: 16 VA; In-rush: 34 VA

2.04 WATER HAMMER ARRESTORS

- .1 Piston type, 304 stainless steel, pressurized water hammer arrestors, each complete with a nesting type bellows and a casing of sufficient displacement volume to dissipate the kinetic energy generated in the piping system, a male treaded nipple connection, suitable for either vertical or horizontal installation, and each sized to suit the connecting potable water pipe and equipment it is provided for.

2.05 PRESSURE REDUCING VALVES

- .1 For piping 65 mm (2-1/2") diameter and larger, non-corrosive pilot operated pressure reducing valve to CAN/CSA B356, factory set at the required pressure, field adjustable, and complete with a bronze body and trim, screwed or flanged connections, and brass body pilot valve with stainless steel seat.

2.06 PLUMBING SYSTEM PRESSURE SAFETY RELIEF VALVES

- .1 Valve: to ASME Section IV.
- .2 Body Construction: brass.
- .3 Adjustable Pressure Setting: 8 to 25 psig (55 to 172 kPa).
- .4 Maximum Operating Differential Pressure From Open To Close:
 - .1 3 psig (20 kPa).
- .5 Acceptable Manufacturers:
 - .1 Bell & Gossett;
 - .2 Watts;
 - .3 Or Approved Equivalent

2.07 WATER MAKE-UP PRESSURE REDUCING VALVES

- .1 Iron body water pressure regulator with:

- .1 Low inlet pressure check valve;
- .2 fast fill /purge lever;
- .3 Removable stainless steel strainer, and;
- .4 Iron body diaphragm operated relief valve
- .2 Adjustable Low Pressure: 0.8 to 25 psig (55 to 172 kPa).
- .3 Acceptable Manufacturers:
 - .1 Bell & Gossett;
 - .2 Watts - No.1450F series
 - .3 A.W. Cash Valve - Type CBL
 - .4 Or Approved Equivalent

2.08 DOMESTIC HOT WATER STORAGE TANKS

- .1 Tank(s) shall be NSF 61 certified for use in potable water applications and have interior coated with a high temperature porcelain enamel, or glass lined (alkaline borosilicate composition) permanently fused to steel and furnished with magnesium anode rod(s) rigidly supported.
- .2 Heavy gauge steel jacket with baked enamel finish.
- .3 Storage tank(s) shall be constructed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors.
- .4 Tank(s) shall have a working pressure rating of 160 psi.
- .5 Tank(s) shall be insulated with a minimum of 50mm (2") of rigid polyurethane foam insulation; minimum R 12.5 thermal insulating value.
- .6 Storage tank(s) shall be covered by a five (5) year limited warranty against tank leaks.
- .7 Acceptable Manufacturers:
 - .1 Rheem- Ruud;
 - .2 A.O. Smith;
 - .3 PVI Industries;
 - .4 Or Approved Equivalent.

2.09 HYDRO-PNEUMATIC TANKS FOR POTABLE WATER SYSTEMS

- .1 Bladder type tank for Hydro-pneumatic applications for potable water system. The Domestic Cold Water shall not come into contact with the steel tank.
- .2 Capacity: As indicated on drawings.
- .3 Tanks shall be welded steel construction, ASME Section VIII, Division 1 suitable for a working pressure upto 250 psig (1722.5 kPa) and a temperature of 240°F (115°C).
- .4 Air shall be pre-charged at 40 psig (275.6 kPa). Tank shall be complete with an air charging valve.
- .5 Bladder shall be made of heavy duty Butyl Bladder.
- .6 All internal parts shall comply with the requirements of ANSI/NSF 61, FDA, Canadian Water Quality Association and Health Canada requirements.
- .7 Tanks shall be supported by steel legs or base for floor installations and shall be supported by adequate straps and hangers for ceiling installations.
- .8 Acceptable Manufacturers:
 - .1 Amtrol Well-X-Trol Series;
 - .2 Armstrong WX-L Series;
 - .3 HG Spec Expanflex AFX Series;

- .4 Or Approved Equivalent.

2.10 HYDRO-PNEUMATIC TANK FITTINGS

- .1 Expansion tank air control fitting.
- .2 Working Pressure: 125 psig (860 kPa).
- .3 Adjustable vent tube and built in manual vent valve.
- .4 Acceptable Manufacturers:
 - .1 Amtrol;
 - .2 Bell and Gossett;
 - .3 Or Approved Equivalent.

2.11 WATER SOFTENER SYSTEMS

- .1 Softener to have performance as noted on the Drawing Schedules.
- .2 Provide a complete automatic packaged and matched commercial water softening system comprised of resin tanks complete with following components:
 - .1 Softener Tank(s):
 - .1 Tanks to be sized for 100% of make-up requirements.
 - .2 Electrical welded pressure vessel, low carbon steel construction rated for 689.5 kPa (100 psi) working pressure and a minimum design pressure of 1.2 times working pressure amount. Tanks to be capable of withstanding testing with pressure fluctuations from 0 to 827 kPa (0 to 120 psi) for a minimum of 30,000 cycles.
 - .3 Each tank to be equipped with openings for mineral filling and periodic inspection.
 - .4 Tank finish to be a rust inhibiting primer.
 - .5 Tank supports to be structural steel legs that permit skid mounting. If required, comply with seismic zone 4 loading requirements.
 - .2 Fully integrated programmable microprocessor driven electronic controller to automatically cycle main operating valve through regeneration cycle.
 - .3 Audible alarm capable of emitting a tone of ~70 dBA and able to be disabled.
 - .4 Easily removable flow sensor with accuracy to 1% over full range and repeatability to +/- 0.5% of full range.
 - .5 Ion exchange resin capable of removing 30,000 grains of hardness with 6.8 kg (15 lb) of salt.
 - .6 Complete set of instructions, installation and operating manuals.
 - .7 Field service availability to supervise, inspect and provide operator training.
 - .8 Warranty covering workmanship and materials.
 - .9 Acceptable manufacturers are:
 - .1 Culligan Canada;
 - .2 Petwa Ltd;
 - .3 WaterMart;
 - .4 WaterGroup Companies Inc.

2.12 POTABLE WATER SEDIMENT FILTRATION SYSTEMS

- .1 Provide Judo model Profimat-Plus-ATP, or equal, protective potable water sediment filters with automatic backwash (time and differential pressure controlled) with performance and capacity as noted on the Drawing Schedules, and as follows:

- .1 Suitable for installation in horizontally and vertically orientation,
- .2 Complete with silver coated, stainless steel filter screen and high-efficiency point rotation system.
- .3 Suitable for drinking water temperature up to 86°F (30°C)
- .4 Operating pressure range: 20 - 230 psi (1.5 - 16 bar) for systems up to 2" (50mm) line size,
- .5 20 – 145 psi (1.5 - 10 bar) for sizes 2 ½" – 4" (65 – 100mm),
- .6 Plastic filter housing,
- .7 Servomotor,
- .8 Rotary flange with bayonet brass connection,
- .9 Threaded connections (up to 2" [50mm]) line size,
- .10 Automatic time-controlled and differential pressure-dependent backwash cycle,
- .11 Backwashing based on point rotation system with simultaneous cleaning of the inspection bell,
- .12 Adjustable backwash differential pressure up to maximum 1.5 psi (0.1 bar),
- .13 Electronic controller with function and fault display (light diode and buzzer), including:
 - .1 plug-in power supply,
 - .2 timer controlled backwash,
 - .3 settings: hourly, daily, weekly, monthly,
 - .4 manual backwash start-up button.

2.13 ULTRA-VIOLET POTABLE WATER STERILIZER SYSTEMS

- .1 Provide Pure-Aqua Inc. Series UVI, or equal, ultra-violet (UV) potable water sterilizer systems with performance and capacity as noted on the Drawing schedules.
- .2 UV potable water sterilizer systems shall employ ultraviolet generator technology. Untreated water shall enter the reaction chamber, circulate around a low-pressure mercury vapor lamp emitting ultraviolet light energy at 235.7nm wavelength to disrupt DNA of any microbiological (bacteria, viruses, ozone, chlorine, total organic carbon, and other micro-organisms) contaminants prior to discharge.
- .3 UV potable water sterilizer systems shall be constructed as follows:
 - .1 Electrical supply: 100-240V/50-60Hz,
 - .2 Maximum Operating Pressure: 100 psi (6.9 bar),
 - .3 Ambient Temperature: 32-104°F (0-40°C),
 - .4 Flow meter,
 - .5 Dynamic flow restrictor,
 - .6 Temperature management valve,
 - .7 Solenoid valve,
 - .8 Sensor reading output (4-20mA) UV sensor,
 - .9 Low-pressure high-output lamps (LPHO),
 - .10 Lamp status visual indicator,
 - .11 System hours of operation,
 - .12 Lamp out audible and visual alert (LOA),
 - .13 Remote start/stop (HOA),
 - .14 304 stainless steel control cabinet,
 - .15 316L stainless steel treatment reaction chamber,
 - .16 Ra 15 internal surface finish,
 - .17 EPDM elastomers,
 - .18 UV monitoring package: UV intensity reading with NIST certified sensor,
 - .19 Cool touch fan,

- .20 Control panel:
 - .1 UL type 4X or UL type 12,
 - .2 sloped top,
 - .3 4-20mA sensor reading output signal with UV monitoring option.

2.14 WATER METERS

- .1 Provide Neptune, or equal, municipal type water meter in accordance with sizes shown on the drawings and meeting City of Toronto requirements for accuracy and repeatability.
- .2 Provide dry contact type pulsed output with one pulse every 10 liters, or in units as otherwise noted on the Submittal, suitable for interface with the Building Automation System ("BAS"). Output to BAS shall provide instantaneous and totalized flow.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Install plumbing equipment and specialties in accordance with Manufacturer's requirements and the requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.

3.02 PRESSURE REDUCING VALVES

- .1 Provide domestic water pressure reducing valves in piping where required. Install so that each valve is readily accessible. Whenever possible, provide pressure reducing valves factory pre-set to required pressures.
- .2 Check and test operation and adjust as required.

3.03 TRAP SEAL PRIMERS

- .1 Prime all traps as required by Code and the Authorities having Jurisdiction (AHJs).
- .2 Prime all traps where called for in the design documents, such as fuel fired appliance flue vent drainage piping connections.
- .3 Install unit plumb and true with suitable access above finished floor.
- .4 Allow 1 ft. (300mm) of elevation for every 20 ft. (6m) of distance ran for floor drain make up line.
- .5 Coordinate with Electrical Trades suitable power source to provide power to electronic trap seal primer.

3.04 WATER HAMMER ARRESTORS

- .1 Provide accessible water hammer arrestors in domestic water piping in locations as follows:
 - .1 in headers at groups of plumbing fixtures;
 - .2 at the top of risers;
 - .3 at ends of long horizontal runs of piping;
 - .4 in piping connecting solenoid valves or equipment with integral solenoid valves;
 - .5 wherever else shown or required by Code.
- .2 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with the manufacturer's published instructions and details.

3.05 BACKFLOW PREVENTERS

- .1 Provide a backflow preventer in each direct domestic cold water connection to equipment other than plumbing fixtures and fittings.

- .2 Do not group make-up water connections to hydronic systems on a common backflow preventer. Provide a dedicated backflow preventer in the make-up water line to each system.
- .3 Locate each backflow preventer on a wall and above the floor such that it is easily accessible for maintenance and testing in accordance with Code requirements. Equip each backflow preventer with an air gap fitting and pipe the reduced pressure zone water outlet to drain.
- .4 Test operation of each backflow preventer in accordance with requirements of CAN/CSA B64 by personnel certified for such testing by governing authorities, and submit signed test results and a properly and clearly identified and marked inspection and test record card for each backflow preventer.
- .5 Provide drains to nearest floor drain on all back flow preventers.

3.06 INSTALLATION OF WATER SOFTENER

- .1 Provide a package type water softener assembly and secure in place on a concrete housekeeping pad.
- .2 Install equipment and components supplied loose with softener in accordance with softener manufacturer's instructions. Provide required valved piping, including drain piping terminated at a funnel floor drain combination.
- .3 Provide low voltage control wiring required in accordance with softener manufacturer's certified control wiring schematics. Install control wiring in conduit in accordance with requirements of electrical work specification.
- .4 Install initial charge of softener salt. Hand spare salt and soap test kit to Owner at site and store where directed.
- .5 Refer to General Mechanical requirements for equipment/system start-up requirements.
- .6 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements. Submit a copy of the letter prior to Substantial Performance of the Work.
- .7 Include for 4 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.07 INSTALLATION OF POTABLE WATER SEDIMENT FILTRATION SYSTEMS

- .1 Install potable water sediment filtration system in accordance with manufacturer's requirements, and all requirements of the Authorities Having Jurisdictions (AHJs.)
- .2 Provide isolation valves on the inlet and discharge piping connections to each potable water sediment filtration system.
- .3 Provide bypass valve around each potable water sediment filtration system with locking mechanism to allowing for valve to be locked in the closed position.

3.08 INSTALLATION OF ULTRA-VIOLET WATER STERILIZER SYSTEMS

- .1 Install Ultra-violet (UV) water sterilizer system in accordance with manufacturer's requirements, and all requirements of the Authorities Having Jurisdictions (AHJs.)
- .2 Provide isolation valves on the inlet and discharge piping connections to each UV water sterilizer system.
- .3 Provide bypass valve around each UV water sterilizer system with locking mechanism to allowing for valve to be locked in the closed position.

3.09 WATER METERS

- .1 Install water meter in accordance with Municipal requirements, manufacturer's instructions, and with isolation valves on inlet and discharge, and with lockable bypass valve around entire water meter assembly.

- .2 If water meter is not immediately available, provide spool pieces and filler connection. Remove filler pieces and install meter when available. Provide stanchion supports within {150 mm} [6"] of water meter inlet and outlet.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .2 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .3 Comply with requirements of Section 20 11 10 Plumbing Piping and Pumping Systems.
- .4 Comply with requirements of Section 22 13 10 Sanitary and Storm Water Piping and Pumping Systems.
- .5 Comply with requirements of 22 30 10 Plumbing Equipment and Specialties.

1.03 SCOPE OF WORK

- .1 Provision of plumbing fixtures, roof drains, floor drains and cleanouts as described in this Section.

1.04 QUALITY ASSURANCE

- .1 Execute the Work of this Section only by skilled tradesmen regularly employed in the manufacture and installation of plumbing fixtures.

1.05 SUBMITTALS

- .1 Submit the following Shop Drawings:
 - .1 All plumbing fixtures specified.
 - .2 All roof drains specified
 - .3 All floor drains specified
 - .4 All cleanouts specified

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Trade Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Trade Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- .1 All plumbing fixtures provided shall comply with applicable Codes and Standards, and the requirements of the Authorities Having Jurisdiction ("AHJs").

2.02 PLUMBING FIXTURE DATA SHEETS

- .1 Reference the following plumbing fixture data sheets appended to this Section:
 - .1 Water closets
 - .2 Lavatories
 - .3 Showers
 - .4 Service sinks
 - .5 Emergency showers
 - .6 Emergency eyewash
 - .7 Floor drains

- .8 Cleanouts
- .2 Each lavatory, shower, and bathtub plumbing fixture shall be provided with a pressure balanced mixing valve to limit the hot water supply temperature to 49°C (120°F) in accordance with Ontario Building Code requirements whether one has been indicated on the plumbing fixture data sheets or not.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Installation of plumbing fixtures, roof drains, floor drains, and cleanouts shall comply with applicable Codes and Standards, and the requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Installation of plumbing fixtures, roof drains, floor drains, and cleanouts shall be in accordance with Manufacturer's requirements.

3.02 INSTALLATION OF PLUMBING FIXTURES

- .1 Make all required water piping, drain piping and vent piping connections to plumbing fixtures.
- .2 Each barrier free lavatory fixture that incorporates a horizontal offset drain connection at the base of the bowl shall have the incline angle of drain piping checked to ensure installation provides positive waste flow to drain. Correct drain incline until satisfactory positive waste flow is achieved.
- .3 In residential suites with washroom groups comprised of multiple plumbing fixtures, a common pressure balanced mixing valve may be provided in lieu of individual plumbing fixture mixing valves provided piping distribution from the outlet of the common mixing valve to the hot water connection at each fixture is limited to no more than 2 m (6 ft.).

3.03 INSTALLATION OF DRAINS AND CLEANOUTS

- .1 Make all required drain and vent piping connections to drain and cleanout bodies.
- .2 Prime all drainage traps as required by applicable Code(s) and Standards.
- .3 Provide 6 mil polyethylene under each drainage strainer and cleanout cover to prevent dirt from entering the system during construction. Remove polyethylene prior to Substantial Performance.
- .4 Coordinate all drain and cleanout provisions with affected Trades and the Architect.
- .5 Coordinate installation of roof drains and floor drains with all Trades to ensure location provides positive slope to drain, and to ensure proper integration of drain with any integral membrane layer.

END OF SECTION

PRODUCT SPECIFICATION INFORMATION

PROJECT NAME

**York Region - North District Road Facility
Expansion**

PROJECT LOCATION

**3252 Baseline Road, Sutton West,
Georgina, ON L0E 1R0
Georgina, Ontario
Canada**

DATE

2024/09/03

PREPARED BY



Toronto Office



LAV-1

Washfountain - Multi-Lav

SloanStone® 2-Station Wall-Mounted
Gradient Sink

To be specified

Sloan - Faucet



*CAD \$1,118.60

☑ **EBF-650-BAT-TEE-CP-0.35GPM-MLM-IR-FCT** OPTIMA®, Counter mounted, Automatic no-touch, Optional hardwired power (battery as a back-up), 24 VAC power harness connector supplied, Lavatory faucet, Polished chrome finish, 102 mm (4") centerset, Brass spout, 1.3 LPM (0.35 GPM) maximum flowrate, Multi-laminar spray outlet, Fixed Fixed spout, 116 mm (4-9/16") spout reach, 92 mm (3-5/8") high, Self-adapting infrared sensor, Dual inlet filter assembly with 9.5 mm (3/8") compression brass cap for tempered water included, Wireless bluetooth status view, setting adjustment and diagnostic via Sloan Connect App?®, Integral water supply shut off.

Sloan - Faucet and Flush Valve Power Kit



*CAD \$256.10

☑ **SL-EAF-70-A** For faucet

Lawler - Mixing Valve



*CAD \$287.30

☑ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

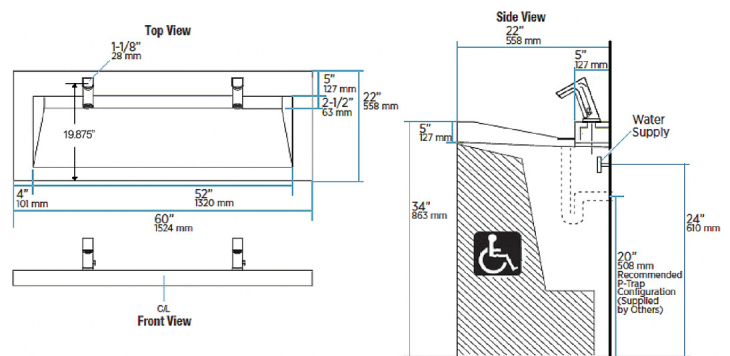
Sloan- Washfountain - Multi-Lav

☑ **ELGR-82000 (WH)**



Easily repairable and non-porus SloanStone solid surface material. Wall mounted, 559 mm (22") wide, 1524 mm (60") long, 127 mm (5") high, number of stations: Two stations, Single molded basins.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 162417
Product Reference: 19386509; 19117146;
7071148; 7018383; 7028883; 9737641; 7333913;
7038263

Estimated Total: **Not available**
***List Price is intended for budgetary purposes only. Actual costs may vary.**



LAV-1

Washfountain - Multi-Lav

SloanStone® 2-Station Wall-Mounted Gradient Sink

American Standard - Fixture Drain



*CAD \$79.00

☒ **2411.015.002** Open grid drain, For sinks, Brass construction, Chrome finish, 6-3/8" (162 mm) height, With overflow holes, 32 mm (1-1/4") tailpiece

McGuire - Supply



☒ **LFBV170** CONVERTIBLE™ Commercial Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key/triangle handle, Quarter turn ball valve, Angle stop, Brass ball valve, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush,

Compliances and certifications: AB 100 compliant, ASME A112.18.1 compliant, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

McGuire - P-Trap



*CAD \$412.10

☒ **PW2125WC** Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy white, With cleanout

Note:

Spec Reference: 162417
Product Reference: 19386509; 19117146;
7071148; 7018383; 7028883; 9737641; 7333913;
7038263

Estimated Total: **Not available**
*List Price is intended for budgetary purposes only. Actual costs may vary.



LAV-1

Washfountain - Multi-Lav

SloanStone® 2-Station Wall-Mounted
Gradient Sink

Watts - Carrier



*CAD \$1,620.00

☒ **CA-431-1** Floor mounted plate type lavatory/Water Cooler carrier, Wall Plate, integral welded feet, Universal steel hangar support plate, Heavy gauge steel offset uprights, Plated hardware.

Note:

Spec Reference: 162417
Product Reference: 19386509; 19117146;
7071148; 7018383; 7028883; 9737641; 7333913;
7038263

Estimated Total: **Not available**
***List Price is intended for budgetary purposes only. Actual costs may vary.**



LAV-2

Washfountain - Multi-Lav

SloanStone® 3-Station Wall-Mounted Gradient Sink

To be specified

Sloan - Faucet



*CAD \$1,118.60

☑ **EBF-650-BAT-TEE-CP-0.35GPM-MLM-IR-FCT** OPTIMA®, Counter mounted, Automatic no-touch, Optional hardwired power (battery as a back-up), 24 VAC power harness connector supplied, Lavatory faucet, Polished chrome finish, 102 mm (4") centerset, Brass spout, 1.3 LPM (0.35 GPM) maximum flowrate, Multi-laminar spray outlet, Fixed Fixed spout, 116 mm (4-9/16") spout reach, 92 mm (3-5/8") high, Self-adapting infrared sensor, Dual inlet filter assembly with 9.5 mm (3/8") compression brass cap for tempered water included, Wireless bluetooth status view, setting adjustment and diagnostic via Sloan Connect App?®, Integral water supply shut off.

Sloan - Faucet and Flush Valve Power Kit



*CAD \$256.10

☑ **SL-EAF-70-A** For faucet

Lawler - Mixing Valve



*CAD \$287.30

☑ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

Note:

Spec Reference: 162417
Product Reference: 19117050; 19117146;
7071148; 7018383; 7028883; 9737641; 7333913;
7038263

Estimated Total: Not available
***List Price is intended for budgetary purposes only. Actual costs may vary.**

Sloan- Washfountain - Multi-Lav

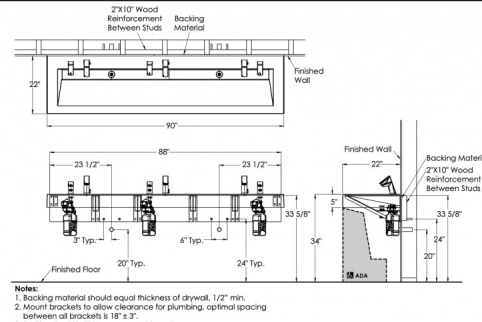
☑ **ELGR-83000 (WH)**



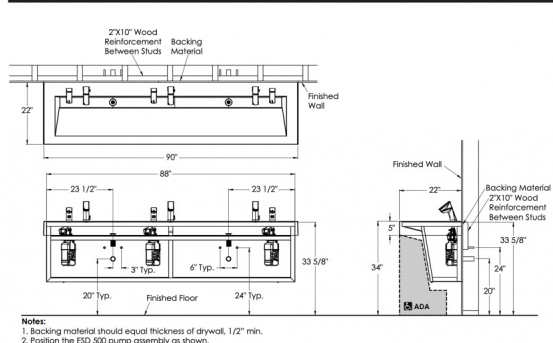
Easily repairable and non-porus SloanStone solid surface material. Wall mounted, 559 mm (22") wide, 2286 mm (90") long, 127 mm (5") high, number of stations: Three stations, Single molded basins.

Refer to the product specification sheet for complete information

Rough-In (Three Station); Bracket Mounting Option



Rough-In (Three Station); Enclosure Mounting Option





LAV-2

Washfountain - Multi-Lav

SloanStone® 3-Station Wall-Mounted Gradient Sink

American Standard - Fixture Drain



*CAD \$79.00

☒ **2411.015.002** Open grid drain, For sinks, Brass construction, Chrome finish, 6-3/8" (162 mm) height, With overflow holes, 32 mm (1-1/4") tailpiece

McGuire - Supply



☒ **LFBV170** CONVERTIBLE™ Commercial Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key/triangle handle, Quarter turn ball valve, Angle stop, Brass ball valve, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush,

Compliances and certifications: AB 100 compliant, ASME A112.18.1 compliant, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

McGuire - P-Trap



*CAD \$412.10

☒ **PW2125WC** Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy white, With cleanout

Note:

Spec Reference: 162417
Product Reference: 19117050; 19117146;
7071148; 7018383; 7028883; 9737641; 7333913;
7038263

Estimated Total: **Not available**
***List Price is intended for budgetary purposes only. Actual costs may vary.**



LAV-2

Washfountain - Multi-Lav

SloanStone® 3-Station Wall-Mounted
Gradient Sink

Watts - Carrier



*CAD \$1,620.00

☒ **CA-431-1** Floor mounted plate type lavatory/Water Cooler carrier, Wall Plate, integral welded feet, Universal steel hangar support plate, Heavy gauge steel offset uprights, Plated hardware.

Note:

Spec Reference: 162417
Product Reference: 19117050; 19117146;
7071148; 7018383; 7028883; 9737641; 7333913;
7038263

Estimated Total: **Not available**
***List Price is intended for budgetary purposes only. Actual costs may vary.**



LAV-3

POP

Undermount Lavatory
Vitreous china

To be specified

Sloan - Faucet



*CAD \$1,118.60

☒ **EBF-650-BAT-TEE-CP-0.35GPM-MLM-IR-FCT** OPTIMA®, Counter mounted, Automatic no-touch, Optional hardwired power (battery as a back-up), 24 VAC power harness connector supplied, Lavatory faucet, Polished chrome finish, 102 mm (4") centerset, Brass spout, 1.3 LPM (0.35 GPM) maximum flowrate, Multi-laminar spray outlet, Fixed Fixed spout, 116 mm (4-9/16") spout reach, 92 mm (3-5/8") high, Self-adapting infrared sensor, Dual inlet filter assembly with 9.5 mm (3/8") compression brass cap for tempered water included, Wireless bluetooth status view, setting adjustment and diagnostic via Sloan Connect App?®, Integral water supply shut off.

Sloan - Faucet and Flush Valve Power Kit



*CAD \$256.10

☒ **SL-EAF-70-A** For faucet

Lawler - Mixing Valve



*CAD \$287.30

☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

DXV- Basin

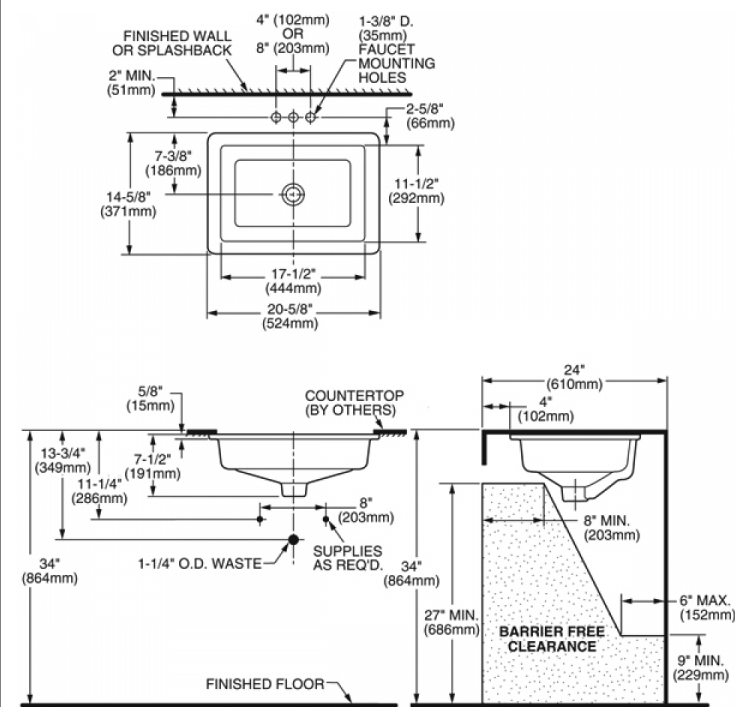
☒ **D20050000.415**

*CAD \$397.00

Undermount Lavatory, Vitreous china, Canvas white finish, Front overflow, Undercounter mounting kit included,

Overall Dimensions: 530 mm (20-7/8") long, 371 mm (14-5/8") wide, 191 mm (7-1/2") high
Bowl Dimensions: Left bowl is 451mm (17-3/4") long and right bowl is 270mm (10-5/8") long, 292 mm (11-1/2") wide, 140 mm (5-1/2") deep
Weight:

Refer to the product specification sheet for complete information




Note:

Spec Reference: 162417

Product Reference: 62183; 19117146; 7071148;
7018383; 7028883; 9737641; 7333913

Estimated Total: Not available

*List Price is intended for budgetary purposes
only. Actual costs may vary.

	LAV-3	Undermount Lavatory Vitreous china
	POP	

American Standard - Fixture Drain



*CAD \$79.00

☒ **2411.015.002** Open grid drain, For sinks, Brass construction, Chrome finish, 6-3/8" (162 mm) height, With overflow holes, 32 mm (1-1/4") tailpiece

McGuire - Supply



☒ **LFBV170** CONVERTIBLE™ Commercial Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key/triangle handle, Quarter turn ball valve, Angle stop, Brass ball valve, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush,

Compliances and certifications: AB 100 compliant, ASME A112.18.1 compliant, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

McGuire - P-Trap



*CAD \$412.10

☒ **PW2125WC** Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy white, With cleanout

Note:

Spec Reference: 162417
Product Reference: 62183; 19117146; 7071148; 7018383; 7028883; 9737641; 7333913

Estimated Total: **Not available**
***List Price is intended for budgetary purposes only. Actual costs may vary.**

To be specified

Centoco - Seat



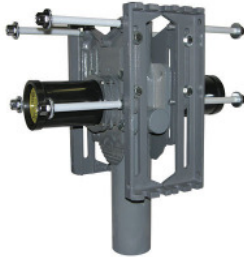
*CAD \$43.74

☒ **500STSCCFE-001** FAST-N-LOCK, For elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish,

FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel,

Dimensions:25 mm (1") high, 473 mm (18-5/8") long, 371 mm (14-5/8") wide

Watts - Carrier



☒ **ISCA-141-4-D** Vertical, Industry Standard Back-to-Back Thin Wall Closet Carrier, 500 lb (227 kg), Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") or 102 mm (4") vent connection, patented compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple,

Codes and Compliances: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb. (227 kg.) static load.

American Standard- Toilet

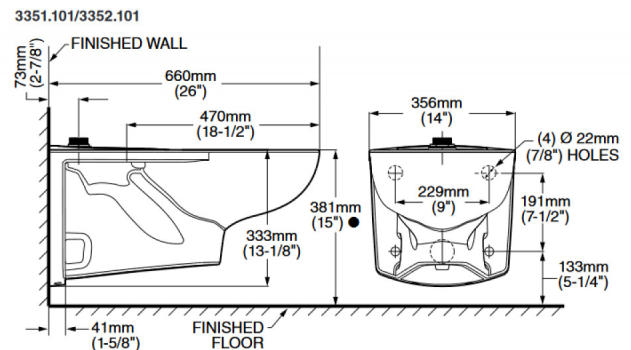
☒ **3351101.020**



*CAD \$457.00

Toilet, Wall-hung with wall outlet, Toilet operates in the range of 4.2 to 6.0 LPF (1.1 - 1.6 GPF), White finish Vitreous china, EverClean® antimicrobial surface, Elongated bowl, Concealed trapway design, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, Fully-glazed 54 mm (2-1/8") trapway, Static load rating of 454 kg (1000 lb), this product is not recommended for bariatric use, Condensation channel, Toilet seat not included, Consisting of:
Overall Dimensions: 356 mm (14") wide, 660 mm (26") from finished wall, Water Surface: 254 x 305 mm (10" x 12") water surface area
Map Score: >=1000 MaP® flush score (when use with proper flush valve)
Compliances: ASME A112.19.2 compliant, CSA B45.1 compliant.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 162417
Product Reference: 222296; 7039973; 7310156; 7303925; 7314169

Estimated Total: Not available
***List Price is intended for budgetary purposes only. Actual costs may vary.**



WC-1

Toilet - Wall-hung

AFWALL® MILLENNIUM™ FloWise®

Champion - Coupling



☒ **MI-XHUB** Connects to Type 300 stainless steel shield painted red for easy identification, Neoprene gasket,

Compliances and certifications:

Sloan - Flush Valve



☒ **ECOS 8111-1.28/1.1** ECOS® Automatic no-touch Exposed Water closet flushometer, 38 mm (1-1/2") spud coupling For top spud toilet, Battery powered, constructed from Semi-red brass, Polished chrome finish, Dual flush 4.2/4.8 LPF (1.1/1.28 GPF), Chloramine resistant PERMEX® synthetic rubber diaphragm, Smart Sense Technology™ self-adaptive infrared sensor, Sensor located on engineered metal cover with replaceable lens window, Courtesy Flush® electrical override button, Flush tube for 292 mm (11-1/2") rough-in, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, 25 mm (1") supply pipe, Cast wall flange with set screw, No external volume adjustment, Four (4) AA-size alkaline batteries included, Pressure Range:

Compliances:

Note:

Spec Reference: 162417
Product Reference: 222296; 7039973; 7310156;
7303925; 7314169

Estimated Total: **Not available**
*List Price is intended for budgetary purposes
only. Actual costs may vary.

American
Standard

WC-2 (Barrier Free)

Toilet - Wall-hung

AFWALL® MILLENNIUM™ FloWise®

To be specified

Centoco - Seat



*CAD \$43.74

☒ **500STSCCFE-001** FAST-N-LOCK, For elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish,

FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel,

Dimensions: 25 mm (1") high, 473 mm (18-5/8") long, 371 mm (14-5/8") wide

Franke Commercial - Backrest



*CAD \$466.00

☒ **CM-16104-WM** wall mounting, back rest, solid core plastic laminate panel back, Antique white, 305 mm (12") wide, 102 mm (4") high, 137 mm (5-3/8"), 18 gauge stainless steel bar with #4 gloss with flanges and covers, concealed snap flanges and mounting hardware included, Provide adequate backing in wall for support and comply to local codes for barrier free requirements

American Standard- Toilet

☒ **3351101.020**



*CAD \$457.00

Toilet, Wall-hung with wall outlet, Toilet operates in the range of 4.2 to 6.0 LPF (1.1 - 1.6 GPF), White finish Vitreous china, EverClean® antimicrobial surface, Elongated bowl, Concealed trapway design, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, Fully-glazed 54 mm (2-1/8") trapway, Static load rating of 454 kg (1000 lb), this product is not recommended for bariatric use, Condensation channel, Toilet seat not included,

Consisting of:

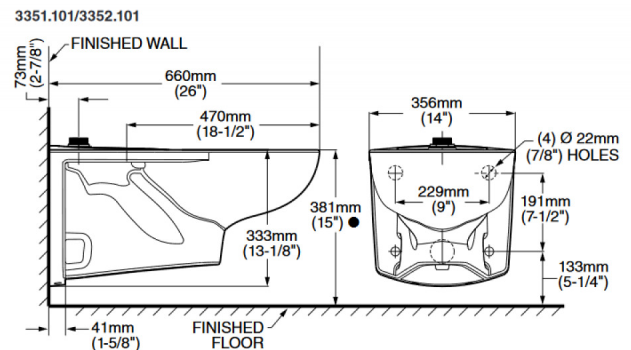
Overall Dimensions: 356 mm (14") wide, 660 mm (26") from finished wall,

Water Surface: 254 x 305 mm (10" x 12") water surface area

Map Score: >=1000 MaP® flush score (when use with proper flush valve)

Compliances: ASME A112.19.2 compliant, CSA B45.1 compliant.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 162417

Product Reference: 222296; 7039973; 7039293;
7310156; 7303925; 7314169

Estimated Total: **Not available**

*List Price is intended for budgetary purposes
only. Actual costs may vary.



WC-2 (Barrier Free)

Toilet - Wall-hung

AFWALL® MILLENNIUM™ FloWise®

Watts - Carrier



☒ **ISCA-141-4-D** Vertical, Industry Standard Back-to-Back Thin Wall Closet Carrier, 500 lb (227 kg), Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") or 102 mm (4") vent connection, patented compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple,

Codes and Compliances: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb. (227 kg.) static load.

Champion - Coupling



☒ **MI-XHUB** Connects to Type 300 stainless steel shield painted red for easy identification, Neoprene gasket,

Compliances and certifications:

Note:

Spec Reference: 162417
Product Reference: 222296; 7039973; 7039293;
7310156; 7303925; 7314169

Estimated Total: **Not available**
***List Price is intended for budgetary purposes only. Actual costs may vary.**

*American
Standard*

WC-2 (Barrier Free)

Toilet - Wall-hung

AFWALL® MILLENNIUM™ FloWise®

Sloan - Flush Valve



☒ **ECOS 8111-1.28/1.1** ECOS® Automatic no-touch Exposed Water closet flushometer, 38 mm (1-1/2") spud coupling For top spud toilet, Battery powered, constructed from Semi-red brass, Polished chrome finish, Dual flush 4.2/4.8 LPF (1.1/1.28 GPF), Chloramine resistant PERMEX® synthetic rubber diaphragm, Smart Sense Technology™ self-adaptive infrared sensor, Sensor located on engineered metal cover with replaceable lens window, Courtesy Flush® electrical override button, Flush tube for 292 mm (11-1/2") rough-in, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, 25 mm (1") supply pipe, Cast wall flange with set screw, No external volume adjustment, Four (4) AA-size alkaline batteries included, Pressure Range:
Compliances:

Note:

Spec Reference: 162417
Product Reference: 222296; 7039973; 7039293;
7310156; 7303925; 7314169

Estimated Total: **Not available**
*List Price is intended for budgetary purposes
only. Actual costs may vary.



KS-1

Type 304 Stainless steel

Double compartment,
Counter mounted, Drop-in
Commercial sinks

To be specified

American Standard - Faucet



*CAD \$263.00

☒ **7500140.002** MONTERREY, Counter mounted, Manual, Two handles, Sink/lavatory faucet, Polished chrome finish, 102 mm (4") centerset, Lead free compliant, Solid brass construction, 1/4 turn ceramic cartridges, 5.7 LPM (1.5 GPM) maximum flowrate, Pressure compensating aerator, Rigid/swing Gooseneck spout, 130 mm (5") spout reach, 273 mm (10-3/4") high, Vandal-resistant lever handles, 13 mm (1/2") male threaded inlet shanks with brass coupling nut.

Lawler - Mixing Valve



*CAD \$287.30

☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

Franke Commercial- Sink

☒ **ALBD6406P-1-1**



*CAD \$1,021.00

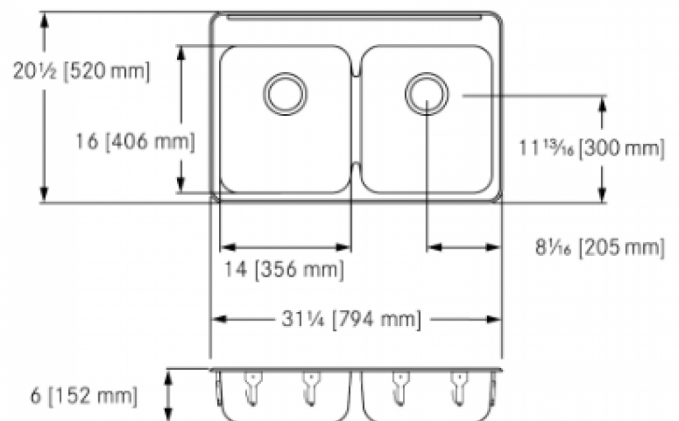
Single hole centerset, With faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance,

Codes and Compliances: ANSI A117.1 compliant, ASME A112.19.3 compliant, CSA B45.4 compliant,

Bowl Dimension: Left bowl is 356 mm (14") long and right bowl is 356 mm (14") long, Left bowl is 406 mm (16") wide and right bowl is 406 mm (16") wide, Left bowl is 127 mm (5") deep and right bowl is 127 mm (5") deep,

Overall Dimension: 794 mm (31-1/4") long, 521 mm (20-1/2") wide, 152 mm (6") high.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 162417
Product Reference: 7032651; 7305010;
7018383; 30308533; 7017077

Estimated Total: **Not available**
***List Price is intended for budgetary purposes only. Actual costs may vary.**



KS-1

Type 304 Stainless steel

Double compartment,
Counter mounted, Drop-in
Commercial sinks

McGuire - Supply



☒ **LFCK170** ICV DEFENDER Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Wheel handle (standard), Full turn, Angle stop, Spring actuated integral check valve, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush,

Compliances and certifications: AB 100 compliant, ASME A112.18.3, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

McGuire - P-Trap



*CAD \$131.80

☒ **8912CB** Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

Note:

Spec Reference: 162417
Product Reference: 7032651; 7305010;
7018383; 30308533; 7017077

Estimated Total: **Not available**
*List Price is intended for budgetary purposes
only. Actual costs may vary.

To be specified

Chicago Faucets - Faucet



***CAD \$335.10**

☑ **897-RCF** Wall-hung, Manual, Two handles, Mop sink faucet, Rough chrome plated finish, 194 - 213 mm (7-5/8" to 8-3/8") adjustable centerset, Round wall escutcheons, Brass construction, Adjustable supply arms, 1/4 turn ceramic cartridge, No flow restrictor, Threaded hose end, Fixed Spout with pail hook, 146 mm (5-3/4") spout reach, 273 mm (10-3/4") high, Top brace, 60 mm (2-3/8") lever handle with indexed buttons, Atmospheric vacuum breaker is not intended for continuous pressure applications.

Lawler - Mixing Valve



***CAD \$287.30**

☑ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

Stern Williams- Sink

☑ **SB-900-T-35-T-40-BP**



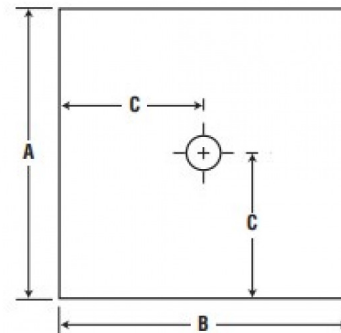
***CAD \$1,069.60**

Without faucet ledge, Precast terrazzo Pearl grey marble chips and white portland cement, 76 mm (3") pipe size, cast integrally and provides for a caulked lead connection not less than 25 mm (1") deep to a 76 mm (3") pipe, flat stainless steel strainer, Without tiling flange, With stainless steel cap, Hose and wall hook, Mop hanger, Splash catcher,

Bowl Dimension: 546 mm (21-1/2") long, 546 mm (21-1/2") wide, 254 mm (10") deep,

Overall Dimension: 610 mm (24") long, 610 mm (24") wide, 305 mm (12") high.

Refer to the product specification sheet for complete information



SERIES	A		B		C	
	INCHES	MM	INCHES	MM	INCHES	MM
900	24	610	24	610	12	305
800	24	610	24	610	12	305
700	32	813	32	813	16	406
600	32	813	32	813	16	406
500	36	914	36	914	18	457
400	36	914	36	914	18	457

Note:

Spec Reference: 162417
Product Reference: 9056493; 7018472; 7018383

Estimated Total: **CAD \$1,692.00**
***List Price is intended for budgetary purposes only. Actual costs may vary.**

**American
Standard**

UR-1

**WASHBROOK® FLOWISE® - Top
spud**

**Flush valve urinal Top
spud**

To be specified

Sloan - Flush Valve



☑ **ROYAL 186 ESS-0.125-DBP-OR-HW** ROYAL® Automatic no-touch Exposed Urinal flushometer, 19 mm (3/4") spud coupling For top spud urinal, Hardwired, constructed from Semi-red brass, Polished chrome finish, High Efficiency 0.5 LPF (0.125 GPF), Chloramine resistant PERMEX® synthetic rubber diaphragm, OPTIMA® EL-1500 self-adaptive infrared sensor, Sensor located on fixed wall sensor plate, Courtesy Flush® electrical override button, Flush tube for 292 mm (11-1/2") rough-in, Adjustable tailpiece, 19 mm (3/4") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered fixed bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, Inlet located right of valve (standard), 19 mm (3/4") supply pipe, Cast wall flange with set screw, Non-hold-open, no external volume adjustment, fixed volume accuracy is controlled by CID™ technology, 24 VAC input/output, With indicator light, Requires transformers 0345154 or 0345999, Pressure Range: 103 - 552 kPa (15 - 80 PSI) operating water pressure
Compliances: cUPC compliant.

Sloan - Faucet and Flush Valve Power Kit



*CAD \$106.30

☑ **SL-EL-154** For flush valve

American Standard- Urinal

☑ **6590001.020 7301242-100-0020A**



*CAD \$604.00

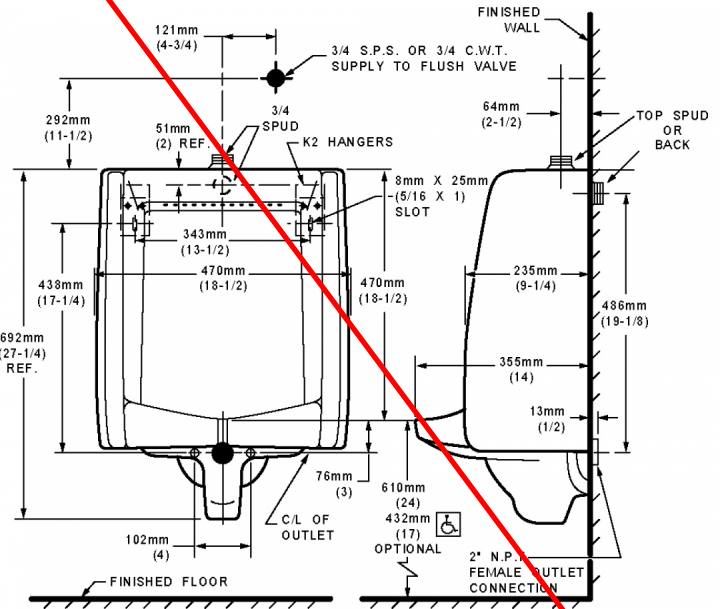
WASHBROOK® FLOWISE®, Wall-hung, Flush valve urinal, Top spud, Vitreous china, White finish, Urinal operates in the range of 0.5 to 3.8 LPF (0.125 - 1.0 GPF), Powerful washdown flush action, 51 mm (2") NPT female outlet, 19 mm (3/4") spud connection, The flush valve can be installed either on left or right side, Chrome-plated non-metallic strainer,

Overall dimensions: 359 mm (14-1/8") projection from the wall, 479 mm (18-7/8") wide, 664 mm (26-1/8") high,

Pressure rating: 552 kPa (80 PSI) operating pressure, 1.7 bar (25 psi) working pressure,

Compliances and certifications: CSA B45.4-08 compliant, ANSI A117.1 compliant, ASME A112.19.2 compliant.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 162417
Product Reference: 7320147; 7309672;
7303565; 7007619; 7303432; 7303925

Estimated Total: Not available
***List Price is intended for budgetary purposes only. Actual costs may vary.**

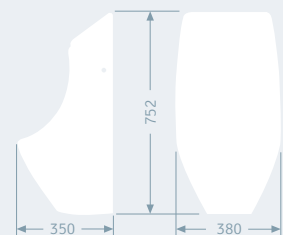
URIMAT compactplus	URIMAT compactvideo	URIMAT ceramic20	URIMAT ceramicC2	URIMAT ceramicC2-CS
14001	14981	12220	12401	12402
● white	● white	● white	● white	● white
3,5 kg	4,5 kg	21 kg	17 kg	19 kg
passive advertising display	with LCD video display			
	WiFi and USB			
x	x	✓	✓	✓

Model range ceramic

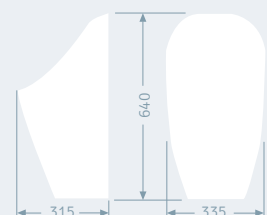
Elegance meets technology. The complete absence of a flushing rim and sharp edges in the vitreous china urinals from URIMAT actively avoid any build-up of deposits. The non-porous glaze of the URIMAT ceramic bowl ensures that no residues are left. No water, no chemicals, no odour. The patented mechanical drain trap and the microbiological cleaning agents guarantee trouble-free, odourless operation.

Dimensions (in mm)

ceramic20



ceramicC2



Mounting frames

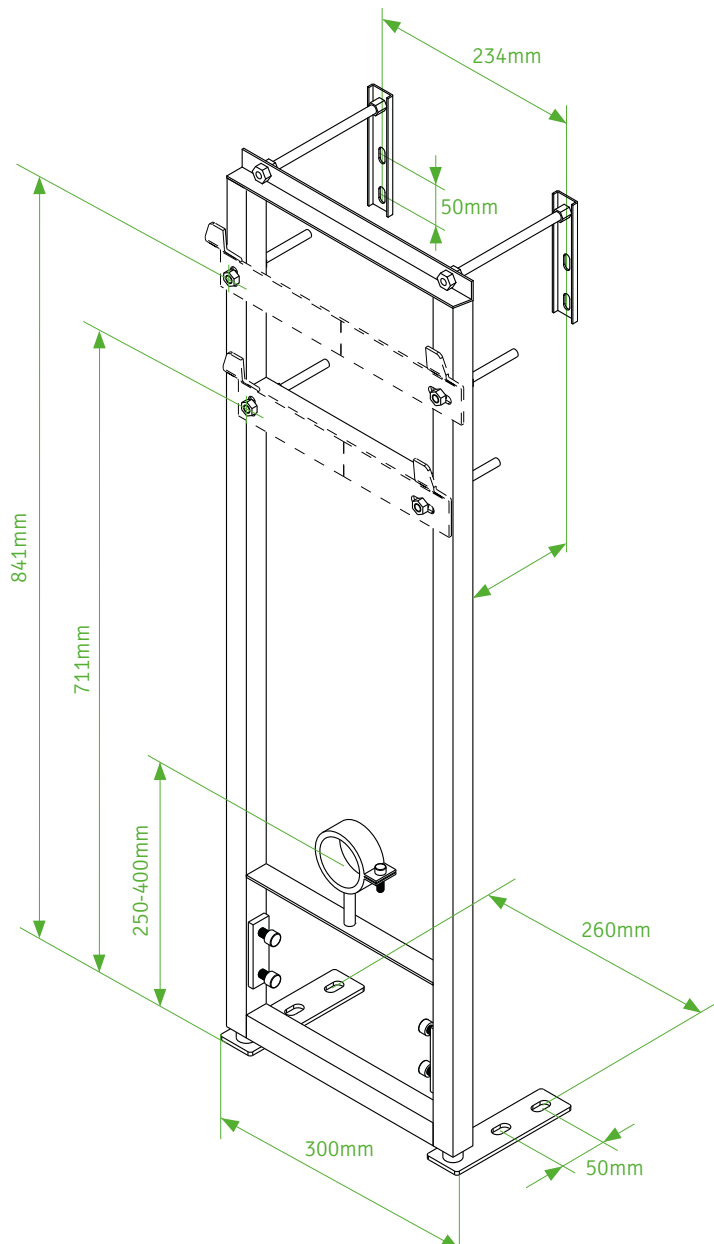
The practical mounting element for new installation and renovation

URIMAT mounting frames ensure the accurate fit and simple assembly using just four fixing screws.

The four mounting brackets ensure highly secure installation and enable precise horizontal and vertical alignment.

URIMAT KeraFix is highly recommended in dry construction and when installing ceramic urinals.

When installing our high tech plastic urinals URIMAT MakroFix is the perfect solution.



Watts - Carrier



*CAD \$1,243.00

☒ **CA-321** epoxy coated, Floor Mounted Urinal Carrier with Bearing Plate, Wall Plate, welded feet, Universal steel hangar support plate, bottom bearing plate, Heavy gauge steel offset uprights, integral mounting brackets, Plated hardware.

Watts - Cleanout



☒ **CO-380-RD** Non-adjustable Wall cleanout, Cast iron, No-hub outlet, Round Stainless steel access cover, Removable gas tight gasketed brass cleanout plug for urinal.

Champion - Coupling



☒ **MI-XHUB** Connects to Type 300 stainless steel shield painted red for easy identification, Neoprene gasket,

Compliances and certifications:

Note:

Spec Reference: 162417
Product Reference: 7320147; 7309672;
7030565; 7007619; 7303432; 7303925

Estimated Total: **Not available**
*List Price is intended for budgetary purposes
only. Actual costs may vary.

To be specified

Pipe Size

- ☐ Unsize pipe
☒ 51 mm (2") pipe size
☐ 76 mm (3") pipe size

Grate

- ☐ Copenhagen grate

BLÜCHER- Floor Drain

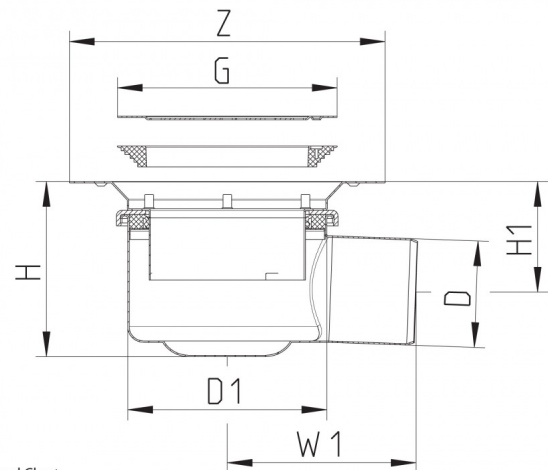
☒ **BSR-702**



AISI type 304 stainless steel, Shower floor drain, Round 222 mm (8-3/4") diameter top with vienna grating, 51 mm (2") pipe size, Side outlet, Membrane clamp,

Certification and Compliances include: ASME A112.6.3 compliant, NSF/ANSI/3A 14159-1 compliant.

Refer to the product specification sheet for complete information



Dimensional Chart







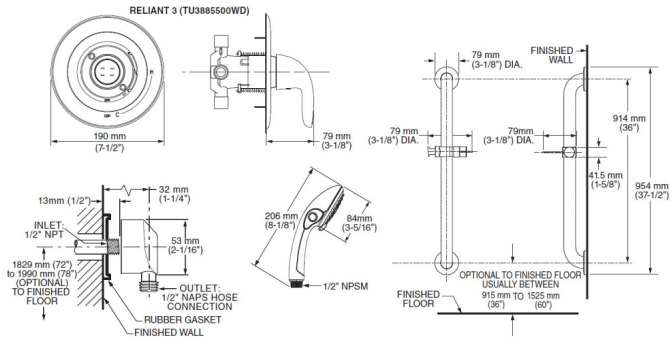
Model	Pipe Size D	D1	Top Size Z	G	H Adjustable	H1 Adjustable	W1
BSR-702	2"(50)	5-1/2"(140)	8-3/4"(222)	6-1/8"(155)	4-3/4"(120) - 5-1/8"(130)	2-3/8"(60) - 2-13/16"(70)	5"(127)
BSR-703	3"(75)	5-1/2"(140)	8-3/4"(222)	6-1/8"(155)	4-7/8"(123) - 6-1/16"(153)	3-1/8"(78) - 4-5/16"(108)	5-1/4"(133)

Global Ref. # 210.200.XXX

Note:

Spec Reference: 162417
Product Reference: 9148914

Estimated Total: Not available
***List Price is intended for budgetary purposes only. Actual costs may vary.**

	<div>SH-1</div> <div> 1.5 Gpm Hand Shower And Valve Trim For Flash Rough Valve With Slide-Grab Bar  </div>	<div>Complete Shower Trim</div>
<div>To be specified</div> <div>American Standard - Diverter Valve Trim</div>  <div>*CAD \$151.00</div> <div> <input checked="" type="checkbox"/> T722430.013 ESTATE®, In-wall diverter, Brass construction, Polished nickel finish, Stamped brass escutcheon, Less valve, Valve trim only, 13 mm (1/2") NPT connection on mixed water inlet and two (R422/R422S) or three (R433/R433S) outlets, Lever handle, Cannot be used as a shut-off valve </div>	<div>American Standard- Complete Shower Trim</div> <div><input checked="" type="checkbox"/> TU662SG211.002</div>  <div>*CAD \$397.00</div> <div> Polished chrome finish, Hand shower and valve trim kit, 3-function hand shower with non-positive shut off (1660.766), 5.7 LPM (1.5 GPM) handshower flowrate, 59" (1500 mm) shower hose (8888.035), Metal lever handle, Pressure balance valve, Adjustable high temperature limit stop, Valve trim with metal handle and escutcheon, 914 mm (36") slide grab bar (1662.236), Combination of ceramic disc mixing valve and a ceramic balancing spool in a one-piece cartridge, Washerless ceramic discs provide smooth handle movement and are unaffected by harsh water conditions, Ceramic balancing spool maintains constant output temperature in response to changes in relative hot and cold supply pressure, WaterSense® certified, ADA, ASSE 1016, ASME A112.18.1016, CSA B125.16, ASME A112.18.1, CSA B125.1 </div> <div>Refer to the product specification sheet for complete information</div>	
<div>American Standard - Hand Shower</div>  <div> <input checked="" type="checkbox"/> 1660.608.002 w/ 95866 MINIMALIST, Hand shower, Polished chrome finish, 1.8 GPM (6.8 LPM) maximum flowrate., 25 mm (1") wide, 191 mm (7-1/2") height, Brass handle, Includes check valve to prevent cross flow of hot and cold water </div>		
<div>American Standard - Slide Bar</div>  <div>*CAD \$184.00</div> <div> <input checked="" type="checkbox"/> 1662.236.002 Concealed screw mounting system, Commercial, COMMERCIAL shower SYSTEMS, SLIDE/GRAB BAR, Polished chrome finish, 38 mm (1-1/2") diameter stainless steel bar, 914 mm (36") stainless bar, Chrome-plated hand shower holder, Chrome-plated adjustable slide mechanism, Includes mounting screws and anchors </div>		

<div>Note:</div>	<div>Spec Reference: 162417</div> <div>Product Reference: 7312430; 22667487; 28215752; 24232; 7333377</div>	<div>Estimated Total: Not available</div> <div>*List Price is intended for budgetary purposes only. Actual costs may vary.</div>
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SH-1

Complete Shower Trim

1.5 Gpm Hand Shower And
Valve Trim For Flash Rough
Valve With Slide-Grab Bar



American Standard - Wall Supply



*CAD \$114.00

☒ **8888038.002** Round, WALL SUPPLY, Polished chrome finish, Includes check valve, Supply outlet with 1/2" NPT female threads integral bracket holds the handshower at a convenient angle, Supply outlet with 1/2" NPT female threads integral bracket holds the handshower at a convenient angle

Note:

Spec Reference: 162417
Product Reference: 7312430; 22667487;
28215752; 24232; 7333377

Estimated Total: **Not available**
*List Price is intended for budgetary purposes
only. Actual costs may vary.



FD-1

Medium Duty (MD) - Floor
drain

For Finished area application

To be specified

Pipe Size

- ☒ Unsize pipe
☐ 51 mm (2") pipe size
☐ 76 mm (3") pipe size
☐ 102 mm (4") pipe size
☐ 152 mm (6") pipe size

Connection Type

- ☒ To be determined
☐ No-hub outlet
☐ Push-on outlet
☐ Threaded outlet
☐ Inside caulk outlet
☐ Socket outlet (ABS or PVC)

Optional Body Material

- ☒ Standard body material
☐ PVC body (socket outlet)
☐ ABS body (socket outlet)

Strainer

- ☐ Unsize strainer
☒ 127 mm (5") diameter nickel bronze strainer
☐ 152 mm (6") diameter nickel bronze strainer
☐ 178 mm (7") diameter nickel bronze strainer
☐ 203 mm (8") diameter nickel bronze strainer

Funnel

- ☐ 102 mm (4") round cast iron funnel
☐ 102 mm (4") round nickel bronze funnel
☐ 152 mm (6") round nickel bronze funnel
☐ 102 x 229 mm (4" x 9") oval cast iron funnel
☐ 102 x 229 mm (4" x 9") oval nickel bronze funnel

Options

- ☐ Sediment bucket
☐ Vandal-proof
☐ Trap primer tapping
☐ Backwater valve
☐ Galvanized top
☐ All galvanized
☐ Strainer extension (DD-50)
☐ Special epoxy from 3M range
☐ Side outlet
☐ Elastomeric flange

Watts- Floor Drain

☒ **FD-100-C-A5-1**



Epoxy coated cast iron, Floor drain, Adjustable Round 6 mm (1/4") thick top, 127 mm (5") diameter nickel bronze strainer, Anchor flange, Trap primer tapping, Reversible membrane clamp, Collar with primary and secondary weepholes, 52 cm² (8 sq. in) free area,

Certification and Compliances include: ASME A112.21.1M compliant.

Refer to the product specification sheet for complete information

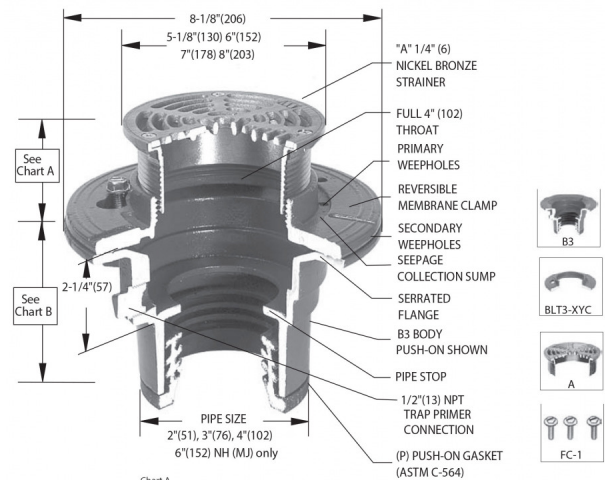


Chart A				
Str. Dia.	Min.	Max.	Load Rating	Free Area Sq. In.
5"(127)	13/16"(21)	2-1/2"(64)	*MD	8
6"(152)	7/8"(22)	2-3/4"(70)	*MD	9
7"(178)	11/16"(17)	2-1/2"(64)	*MD	12
8"(203)	7/8"(22)	2-7/8"(73)	*MD	18

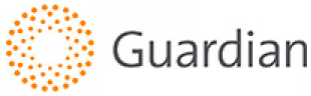
* The load classifications are in accordance with the American National Standards ASME A112.21.1M
ASME Ratings are as follows:
MD - Safe Live Load 2000-4999 lbs.(900-2250kg)
The above categories are given as a guide only.
Please consult factory.

Chart B					
Pipe Size	Std. No Hub	P Push On	T Female Thread	X Inside Caulk	60/61 PVC/ABS
2"(51)	3-5/8"(92)	4-1/4"(108)	4-1/4"(108)	4-1/2"(114)	3-3/4"(95)
3"(76)	3-5/8"(92)	4-1/4"(108)	4-1/4"(108)	4-1/2"(114)	3-3/4"(95)
4"(102)	3-5/8"(92)	4-1/4"(108)	4-1/4"(108)	4-1/2"(114)	4"(102)
6"(152)	3-1/2"(89)				

Note:

Spec Reference: 162417
Product Reference: 19595789

Estimated Total: **Not available**
***List Price is intended for budgetary purposes only. Actual costs may vary.**



EW-1

Eye wash

Emergency Equipment
Eye wash with stainless
steel bowl

To be specified

Lawler - Mixing Valve



*CAD \$1,625.10

☑ **911E/F-Unit 84908** Emergency mixing valve, Thermostatic High-low master water mixing valve, The control mechanism shall employ a liquid-filled thermostatic motor to drive the valve without additional power requirements. The control mechanism shall employ a stainless steel sliding piston control device with reverse seat closure and both fixed and variable cold water bypass.

Watts - Floor Drain



☑ **FD-100-C-A-6-7** Epoxy coated cast iron, Floor drain, Adjustable Round 6 mm (1/4") thick top, Anchor flange, Trap primer tapping, Reversible membrane clamp, Collar with primary and secondary weepholes, 52 cm² (8 sq. in.) free area (for 127 mm (5") diameter strainer), 58 cm² (9 sq. in.) free area (for 152 mm (6") diameter strainer), 77 cm² (12 sq. in.) free area (for 178 mm (7") diameter strainer), 116 cm² (18 sq. in.) free area (for 203 mm (8") diameter strainer), Vandal-proof, Trap primer tapping,

Certification and Compliances include: ASME A112.21.1M compliant.

Note:

Spec Reference: 162417
Product Reference: 9063334; 7302201;
20514801



*CAD \$737.10

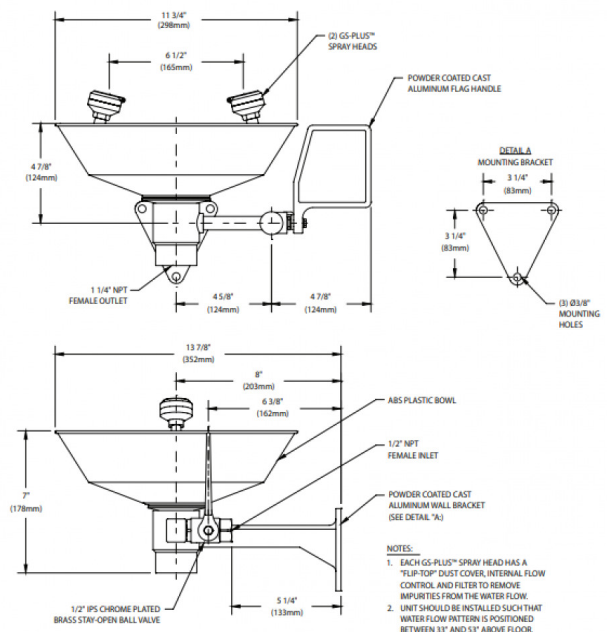
Guardian- Emergency Equipment

☑ **G1814**

Wall-hung, Eye wash, constructed from Type 304 brushed stainless steel finish, 283 mm (11-1/8") Ø bowl size, Corrosion resistant powder coated finish finish. Two GS-Plus spray heads with flip top dust cover each, 13 mm (1/2") Ø IPS Chrome plated brass stay open ball valve, 13 mm (1/2") Ø NPT female inlet supply inlet, 32 mm (1-1/4") Ø NPT female outlet,

Codes and Compliances:, ANSI compliant.

Refer to the product specification sheet for complete information



Estimated Total: **Not available**
*List Price is intended for budgetary purposes only. Actual costs may vary.



FFD-1

- Floor drain

For Funnel application

To be specified

Pipe Size

- ☒ Unsize pipe
☐ 51 mm (2") pipe size
☐ 76 mm (3") pipe size
☐ 102 mm (4") pipe size
☐ 152 mm (6") pipe size

Connection Type

- ☒ To be determined
☐ No-hub outlet
☐ Push-on outlet
☐ Threaded outlet
☐ Inside caulk outlet
☐ Socket outlet (ABS or PVC)

Optional Body Material

- ☒ Standard body material
☐ PVC body (socket outlet)
☐ ABS body (socket outlet)

Strainer

- ☒ Unsize strainer
☐ 127 mm (5") diameter nickel bronze strainer
☐ 127 mm (5") diameter cast iron strainer

Options

- ☐ Sediment bucket
☐ Vandal-proof
☐ Backwater valve
☐ Galvanized top
☐ All galvanized
☐ Strainer extension (DD-50)
☐ Special epoxy from 3M range
☐ Side outlet
☐ Elastomeric flange

Watts- Floor Drain

☒ **FD-100-C-EG**



Epoxy coated cast iron, Floor drain, Adjustable Anchor flange, Reversible membrane clamp, 102 x 229 mm (4" x 9") "EG" elongated oval nickel bronze funnel, Collar with primary and secondary weepholes, 32 cm² (5 sq. in.) free area.

Refer to the product specification sheet for complete information

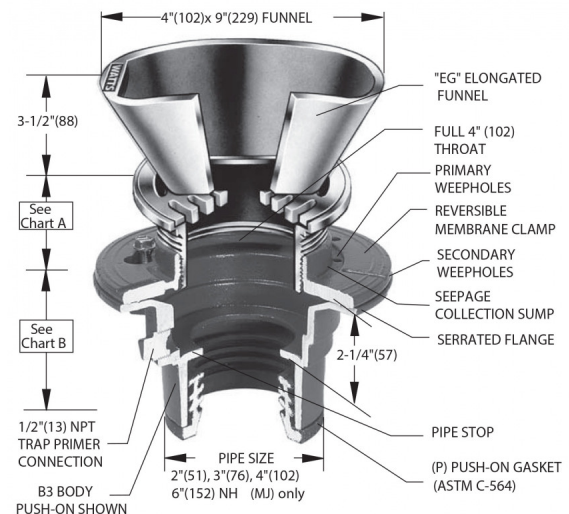


Chart A

Str. Dia.	Min.	Max.	Load Rating	Free Area Sq. In.
5"(127)	13/16"(21)	2-1/2"(64)	NOT APPLICABLE	5

Chart B

Pipe Size	Std. No Hub	P Push On	T Female Thread	X Inside Caulk	60/61 PVC/ABS
2"(51)	3-5/8"(92)	4-1/4"(108)	4-1/4"(108)	4-1/2"(114)	3-3/4"(95)
3"(76)	3-5/8"(92)	4-1/4"(108)	4-1/4"(108)	4-1/2"(114)	3-3/4"(95)
4"(102)	3-5/8"(92)	4-1/4"(108)	4-1/4"(108)	4-1/2"(114)	4"(102)
6"(152)	3-1/2"(89)				

Note:

Spec Reference: 162417
Product Reference: 7301429

Estimated Total: **Not available**
*List Price is intended for budgetary purposes only. Actual costs may vary.



SK-1

Type 304 Stainless steel

Double compartment, Wall-hung,
Surgeon scrub-up sink

To be specified

Chicago Faucets - Faucet



☒ **116.104.AB.1** HYTRONIC®, Wall-hung, Automatic no-touch, Hardwired, Sink/lavatory faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant, ECAST® brass construction, Stainless steel hoses included, 1.9 LPM (0.5 GPM) maximum flowrate, Pressure compensating non-aerated laminar spray outlet, includes optional 5.7 LPM (1.5 GPM) insert, Rigid/swing Gooseneck spout, 138 mm (5-3/8") spout reach, 305 mm (12") high, Dual infrared sensor, 12 volt AC transformer required (to be ordered separately).

Chicago Faucets - Faucet and Flush Valve Power Kit



*CAD \$117.40

☒ **243.260.00.1/242.340.00.1** Hardwired AC transformer, Transformer and wire

Lawler - Mixing Valve

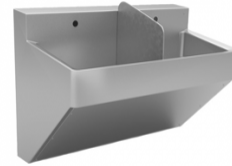


*CAD \$287.30

☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

Franke Commercial- Sink

☒ **SSU2-2040-7MOD**



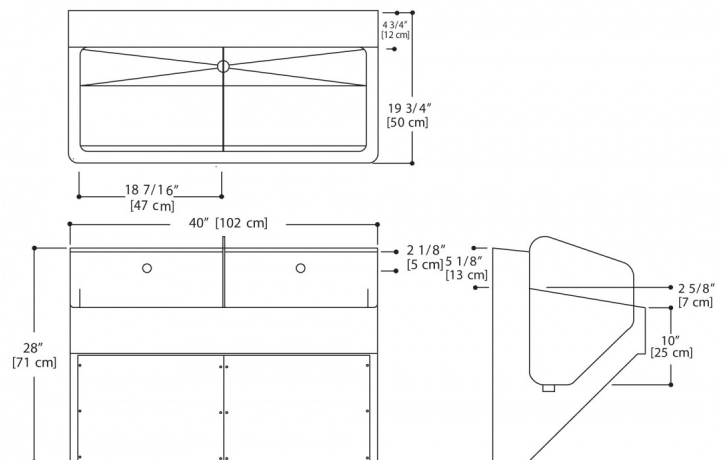
Anti-Microbial Coating, Without faucet ledge, 16 gauge Type 304 Stainless steel Polished to #4 satin finish, With backsplash, Radius coved bowl corners, Access panel for service and maintenance, Includes wall hanger brackets, Center waste location, 38 mm (1-1/2"-16) threaded tailpiece with special integral waste design to prevent use of waste plug,

Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant,

Bowl Dimension: 953 mm (37-1/2") long, 343 mm (13-1/2") wide, 254 mm (10") deep,

Overall Dimension: 1016 mm (40") long, 502 mm (19-3/4") wide, 711 mm (28").

Refer to the product specification sheet for complete information



Note:

Spec Reference: 162417
Product Reference: 13834919; 7073924;
7073649; 7018383

Estimated Total: **Not available**
*List Price is intended for budgetary purposes only. Actual costs may vary.



AD-1

Extra Heavy Duty (XD) -
Floor drain

For Area application

To be specified

Pipe Size

- ☒ Unsize pipe
☐ 51 mm (2") pipe size
☐ 76 mm (3") pipe size
☐ 102 mm (4") pipe size

Options

- ☐ Vandal-proof grate
☐ Nickel bronze top
☐ Threaded outlet

Watts- Floor Drain

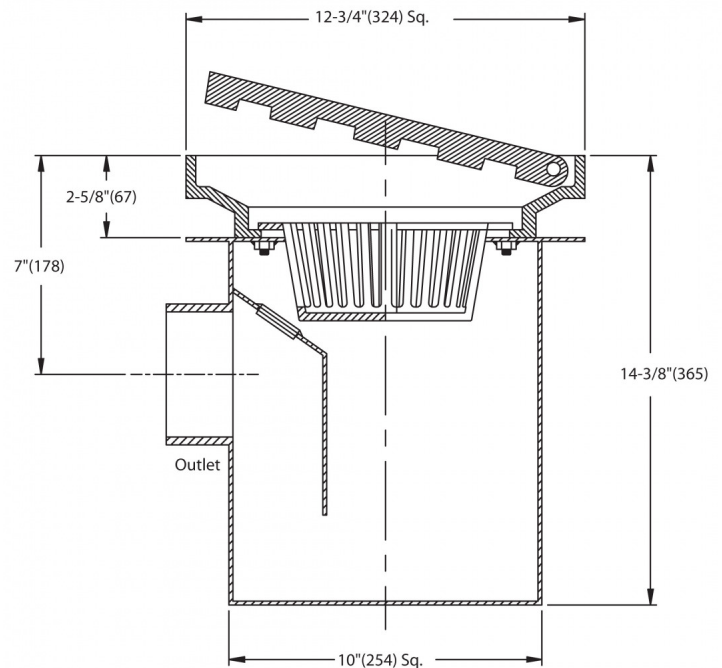
☒ **FD-430**



Epoxy coated fabricated steel, Floor drain, Square Side outlet, Epoxy coated heel proof ductile iron hinged grate, Membrane clamping flange, Membrane clamping cast iron frame, Integral trap with cleanout plug, With sediment bucket, 265 cm² (41 sq. in.) free area,

Certification and Compliances include: ASME A112.21.1M compliant.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 162417
Product Reference: 7301700

Estimated Total: **Not available**
*List Price is intended for budgetary purposes only. Actual costs may vary.

CONTENTS

PART 1 - GENERAL

- 1.01 GENERAL REQUIREMENTS**
- 1.02 DESCRIPTION**
- 1.03 WORK PERFORMED BY THIS SECTION**
- 1.04 QUALITY ASSURANCE**
- 1.05 AUTHORITY FIELD APPROVALS**
- 1.06 SUBMITTALS**
- 1.07 SITE VISIT**
- 1.08 NATURAL GAS SERVICE**

PART 2 - PRODUCTS

- 2.01 NATURAL GAS SYSTEM**

PART 3 - EXECUTION

- 3.01 INSTALLATION OF GAS PIPING SYSTEMS**
- 3.02 EQUIPMENT GAS SERVICE CONNECTIONS**

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .2 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.03 WORK PERFORMED BY THIS SECTION

- .1 Provision of natural gas, propane and fuel oil piping systems.

1.04 QUALITY ASSURANCE

- .1 Execute work of this Section only by skilled tradesmen regularly employed in the manufacture and installation of natural gas, propane, and fuel oil and piping systems and related equipment.
- .2 Comply with all requirements of the Authorities Having Jurisdiction ("AHJs"). Carry out all testing and perform all remedial Work required to the satisfaction of the AHJs.

1.05 AUTHORITY FIELD APPROVALS

- .1 Submit application for and pay costs associated with TSSA variance approval and field inspection for the following elements of work:
 - .1 use design specifications schematic drawing(s), plan drawing(s) and section drawing(s).

1.06 SUBMITTALS

- .1 Submit the following Shop Drawings:
 - .1 Natural gas piping;
 - .2 Natural gas piping system fittings;

1.07 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the Bid Price.

1.08 NATURAL GAS SERVICE

- .1 Extend new natural gas line from the site service provided at the Building exterior by the Site Utility Trades.
- .2 Provide main gas meter and sub-meters as follows:
 - .1 Meters and sub-meters shall be certified for producing invoicing under Canada Weights and Measures Act;
 - .2 Meters and sub-meters shall be complete with a pulse metering head for monitoring instantaneous and totalized flow at the Building Automation System ("BAS").
- .3 Provide regulating valves and associated accessories to suit required downstream distribution pressure.

PART 2 - PRODUCTS

2.01 NATURAL GAS SYSTEM

- .1 Provide complete natural gas system, to CGA requirements.

- .2 Provide pressure reducing, regulating and relief valving required for compatibility between equipment and building natural gas distribution system.
- .3 Above Grade Steel Pipe: Schedule 40 ERW or CW black carbon steel pipe conforming to ASTM A53 Grade B, seamless as follows:
 - .1 NPS ½" to 1½" (12mm to 38mm) Exposed, Threaded Ends.
 - .2 NPS ½" to 1½" (12mm to 38mm) Concealed, Bevelled Ends.
 - .3 NPS 2" to 10" (50mm to 250mm), Bevelled Ends.
- .4 Below Grade Polyethylene Pipe: Series 125 polyethylene pipe certified to CAN/CSA B137.4-M with a smooth finish, free from imperfections such as grooves and ripples.
- .5 Jointing Material:
 - .1 Flange Gaskets: Nitrile binder flat ring type of 1/16" (1.6 mm) thickness to ANSI B16.21, ANSI B16.20 or ANSI A21.11. Flange gaskets shall be made of either neoprene or other similar material which shall be resistant to any action of gas. Natural rubber or asbestos shall not be utilized.
- .6 Fittings:
 - .1 Pipe fittings, screwed, flanged or welded shall be as follows:
 - .1 Screwed Fittings: Class 150 black malleable iron screwed fittings conforming to ASTM A197 and ANSI/ASME B16.9.
 - .2 Steel Pipe Flanges and Flanged Fittings: Class 150 forged carbon steel raised face slip-on or welding neck type conforming to ASTM A81 Grade 1 and ANSI/ASME B16.5. Remove raised face when connecting to valves or equipment having a flat faced flange.
 - .3 Welded Fittings: Schedule 40 carbon steel butt welding fittings conforming to ASTM A234 WPB Grade B and ANSI/ASME B16.9.
 - .2 Piping or fitting threads in accordance with ANSI B1.120.1.
 - .3 Unions: Class 250 black malleable iron "Dart" type with brass to brass seat.
 - .4 Bolts and Nuts: Hex head machine bolts with hexagon nuts, both of semi-finished carbon steel conforming to ASTM A307 Class A.
 - .5 Nipples, Schedule 40: to ASTM A53-82.
 - .6 For polyethylene pipe provide Series 125 polyethylene socket welding type, being compatible with the pipe material, certified to CAN/CSA B137.4-M. Join pipe and fittings using a heat fusion method as recommended and described in the pipe manufacturers installation manuals. Install in accordance with CSA Z184-M and Z184S1.
- .7 Flexible Gas Piping:
 - .1 The fuel gas piping system shall consist of corrugated semi-rigid stainless steel tubing with brass mechanical attachment fittings terminating in NPT pipe fittings for easy attachment to traditional black iron pipe systems and direct connections to gas appliances.
 - .2 Tubing is acceptable up to 2" (50mm) in size.
 - .3 The 300 series stainless steel tubing shall be jacketed with a non-metallic cover.
 - .4 The jacket shall be marked at intervals with the amount of tubing left on the reel, for quick measurement.
 - .5 Provide protection devices where flexible piping passes through studs, joists and other building materials. Provide a striker plate made from stamped steel that is specially hardened to resist penetration from screws and pneumatic nail guns.
 - .6 Acceptable Manufacturers: Omega Flex Trac Pipe.
- .8 Ball Valves:

- .1 Up to 2" (50mm) threaded valves.
- .2 Rated to 125 psig natural gas, bronze body, 2 piece, full port, complete with chrome plated bronze ball, TFE seats, adjustable or double O ring packing.
- .3 Stamped CSA and CGA 3.16 on the body.
- .4 Acceptable Manufacturers: Kitz 58, Toyo 5044A, Crane, Jenkins, Grinnell
- .9 Gate Valves:
 - .1 NPS 2½" (65mm) and Larger:
 - .1 CGA approved, Class 175 lubricated plug valve with semi steel body, flat faced flanged ends drilled to Class 125, tapered plug with lever operator for valves NPS 4 and smaller and worm gear handwheel operator for valves NPS 6 and larger.
- .10 Pressure Reducing Stations:
 - .1 Provide gas pressure reducing station(s) where required to reduce building distribution system pressures to appliance operating pressure ranges.
 - .2 Pressure regulators shall be spring-loaded self-operated design and shall be tight closing with replaceable orifices and discs and concealed accessible manual adjustment. Valve bodies shall be cast iron rated for {1034 kPa} [150 psig] gas pressure and all valve materials shall be epoxy painted to resist corrosive ambient conditions.
- .11 Pressure Relief Stations:
 - .1 Provide gas pressure relief stations downstream of all pressure reducing stations.
 - .2 Provide relief valves of spring-loaded design with throttling characteristics to reduce system pressure surges. Valve bodies shall be cast iron rated for {1034 kPa} [150 psig] gas pressure with replaceable orifices and discs and concealed accessible manual adjustment. All valve materials shall be epoxy painted to resist corrosive ambient conditions.

PART 3 - EXECUTION

3.01 INSTALLATION OF GAS PIPING SYSTEMS

- .1 Install natural gas service to meet CGA, and The Ontario Gas Utilization Regulations and all Authorities Having Jurisdiction ("AHJs").
- .2 Gas Piping:
 - .1 Install natural gas piping in accordance with CAN1-B149.1.
 - .2 Unless otherwise indicated, connect to equipment in accordance with manufacturer's instructions.
 - .3 Slope piping down in direction of flow to low points.
 - .4 Use eccentric reducers at pipe size change installed to provide positive drainage.
 - .5 Provide clearance for access for maintenance of equipment, valves and fittings.
 - .6 Ream pipes clean of scale and dirt, inside and out.
 - .7 Cap open ends during construction to prevent entry of foreign material.
 - .8 Make connection to equipment with unions or flanges. Install piping to minimize pipe dismantling for equipment removal.
 - .9 Provide vents for all gas piping shafts in accordance to Code.
 - .10 Pipe mounted outdoors shall be painted in its entirety.
 - .11 Natural gas pipe mounted on the roof shall be installed as indicated on the installation detail included on the drawings.
- .3 Purging:
 - .1 Purge after pressure testing in accordance with applicable Codes.

- .4 Gas Valves:
 - .1 Valves that are 2" (50mm) and smaller shall be ball valves. Valves 2½" (65mm) and larger shall be lubricated plug gate valves.
 - .2 Install valves with stems upright or horizontal unless approved otherwise.
 - .3 Install valves at all branch take-offs to isolate each piece of equipment, and as indicated.
- .5 Gas Connections to Equipment:
 - .1 Connect gas piping to all gas fired equipment.
- .6 Painting and Identification:
 - .1 Paint gas service piping to meet code requirements.
- .7 Testing
 - .1 Test gas piping system in accordance with applicable Codes and the requirements of the Authorities Having Jurisdiction ("AHJs").

3.02 EQUIPMENT GAS SERVICE CONNECTIONS

- .1 Provide all natural gas service piping connection requirements required for Owner's Fixture, Furniture and Equipment (FF&E) supplied under other Sections of the Work.
- .2 Provide all pipe fittings, valves, strainers, vacuum breakers, unions and any other ancillaries as indicated, specified or as recommended by Equipment Manufacturer.
- .3 Connect Equipment requiring natural gas connections.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with requirements of Section 20 08 10 Mechanical Commissioning

1.02 SCOPE OF WORK OF THIS SECTION

- .1 Provision of HVAC system water piping systems, pumping systems, heat exchangers and all related ancillaries.

1.03 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the installation of pressure piping and pumping systems for hydronic heating and cooling applications.
- .2 All combustible piping to be ULC labelled and listed for flame spread rating of less than 25 and smoke classification of less than 50.
- .3 Pressure testing of HVAC Hydronic Piping Systems shall be completed in accordance with ASTM E 1003 "Standard Test Method for Hydrostatic Leak Testing"

1.04 SYSTEM PRESSURE AND TEMPERATURE REQUIREMENTS

- .1 Application:
 - .1 The requirements of ASME B31.9 Building Services Piping Code apply generally to industrial, institutional, commercial, and public buildings, and multi-unit residences, which does not require the range of sizes, pressures, and temperatures covered in ASME B31.1 Power Piping Code.
 - .1 The requirements of ASME B31.9 Building Services Piping Code shall apply to the following HVAC piping systems:
 - .1 steam and condensate up to a maximum pressure of 15 psig (103 kPa gage)
 - .2 non-flammable heat transfer fluids up to a maximum 160 psig (1103 kPa gage) pressure, and maximum 250°F (121°C) temperature as follows:
 - .1 water and glycol solutions for heating and cooling
 - .2 condensing water
 - .3 other nontoxic heat transfer liquids
 - .2 The requirements of ASME B31.9 Building Services Piping have the following piping material and piping size limitations:
 - .1 carbon steel: NPS 48 in. (DN 1200 mm) and 0.50 in.(12.7 mm) wall thickness
 - .2 stainless steel: NPS 24 in. (DN 600 mm) and 0.50 in.(12.7 mm) wall thickness
 - .3 copper: NPS 12 in. (DN 300 mm) and 12.125 in. (308 mm) O.D. for copper tubing
 - .4 thermoplastics: NPS 24 in. (DN 600 mm)
 - .2 The requirements of ASME B31.1 Power Piping Code shall apply to the following high-temperature, high-pressure HVAC piping systems:
 - .1 steam and condensate in excess of 15 psig (103 kPa gage), and

- .2 non-flammable heat transfer fluids in excess of 160 psig (1103 kPa gage) pressure, and/or temperatures exceeding 250°F (120°C).
- .2 **Bronze valves** in HVAC piping systems shall be provided with construction classifications consistent with the anticipated maximum operating pressure and temperature of the system(s) generally as follows:

Max. Temperature	Pressure Ratings According to ASME/ANSI Standards (psig)		
	Bronze (ASTM B62)		Bronze (ASTM B61)
	Class 125 (Threaded)	Class 150 (Threaded)	Class 300 (Threaded)
100° F	200	300	600
150° F	200	300	600
200° F	185	270	560
250° F	170	240	525
300° F	155	210	490
350° F	140	180	450
400° F	---	---	410
406° F	125	150	---
450° F	---	---	375
500° F	---	---	340
550° F	---	---	300

- .3 **Gray (Cast) Iron and Ductile Iron valves** in HVAC piping systems shall be provided with construction classifications consistent with the anticipated maximum operating pressure and temperature of the system(s) as follows:

Max. Temp.	Pressure & Temperature Ratings According to ASME Construction Standards by Pipe Size								
	Gray (Cast) Iron (ASTM A126)				Ductile Iron (ASTM A395)				
	Class 125			Class 250		Class 150		Class 300	
	2 ½" to 12"	14" to 24"	30" to 48"	2 ½" to 12"	14" to 24"	2 ½" to 12"	14" to 24"	2 ½" to 12"	14" to 24"
	65 to 300mm	350 to 600mm	750 to 1200mm	65 to 300mm	350 to 600mm	65 to 300mm	350 to 600mm	65 to 300mm	350 to 600mm
100° F	200	150	150	500	300	250	250	640	640
150° F	200	150	150	500	300				
200° F	190	135	115	460	280	235	235	600	600
225° F	180	130	100	440	270				
250° F	175	125	85	415	260				

Max. Temp.	Pressure & Temperature Ratings According to ASME Construction Standards by Pipe Size								
	Gray (Cast) Iron (ASTM A126)					Ductile Iron (ASTM A395)			
	Class 125			Class 250		Class 150		Class 300	
	2 ½" to 12"	14" to 24"	30" to 48"	2 ½" to 12"	14" to 24"	2 ½" to 12"	14" to 24"	2 ½" to 12"	14" to 24"
	65 to 300mm	350 to 600mm	750 to 1200mm	65 to 300mm	350 to 600mm	65 to 300mm	350 to 600mm	65 to 300mm	350 to 600mm
275 F	170	120	65	395	250				
300° F	165	110	50	375	240	215	215	565	565
325° F	155	105	---	355	230				
350° F	150	100	---	335	220				
375° F	145	---	---	315	210				
400° F	140	---	---	290	200	200	200	525	525
425° F	130	---	---	270	---				
450° F	125	---	---	250	---				
500° F	---	---	---	---	---	170	170	495	495

- .4 Water, Oil, Gas ("WOG") indicates the maximum pressure, in PSIG, allowed at ambient temperatures between 20°F and 100°F (-29°C to 38°C).
- .5 Working Steam Pressure ("WSP") indicates the upper-temperature limitation at the steam pressure noted in PSIG.
- .6 Cold Working Pressure ("CWP"): represents the maximum pressure, in PSIG, allowed at ambient temperatures between 20°F and 100°F.

1.05 SUBMITTALS

- .1 Submit shop drawings for the following Products:
 - .1 Non-slam wafer type check valves;
 - .2 Flow Balancing valves;
 - .3 Air vents
 - .4 Safety and Relief valves;
 - .5 Pressure reducing valves;
 - .6 Expansion Tanks
 - .7 Air Separators

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 HVAC HYDRONIC PIPING SYSTEMS

- .1 Piping:
 - .1 Working service pressure up to and including 875 kPa (125 psi): Schedule 40 ASTM specification A53 seamless Grade B wrought steel black pipe with standard black malleable steel threaded fittings rated at 1380 kPa (200 psi) WOG for pipe sizes 50mm (2") and smaller.
 - .2 Working service pressure up to and including 875 kPa (125 psi): Schedule 40 ASTM specification A53 seamless Grade B wrought steel black pipe with schedule 40 black steel welding fittings rated at 1380 kPa (200 psi) WOG for pipe sizes 65mm (2½") and larger.
 - .3 Type L copper to ASTM B88 with 95/5 soldered wrought copper pressure fittings to ANSI B22.18 for piping system rated at 1380 kPa (200 psi) WOG for pipe sizes up to and including 50mm (2").
 - .4 Working service pressures over 875 kPa (125 psi) and up to 2100 kPa (300 psi) black steel pipe which meets ASTM A106 Grade B (seamless) and the following:
 - .1 For sizes {12 mm to 50 mm} [1/2" to 2"] - Schedule 40, threaded or plain end.
 - .2 For sizes {65 mm} [2-1/2"] and over - Schedule 40, bevel end.
- .2 Fittings for pipe 50mm (2") and smaller:
 - .1 Working service pressure up to 875 kPa (125 psi) WSP Soldered: Wrought bronze or cast copper, ASTM B32, solder joint fittings, ANSI/ASME B16.18 or B16.22.
 - .2 Working service pressure up to 875 kPa (125 psi) WSP Threaded: Banded black cast iron, ASTM A126, threaded, ANSI/ASME B16.4, Class 125, ASTM A126
 - .3 Working service pressure up to 1035 kPa (150 psi) WSP Threaded: Galvanized malleable iron, threaded, ANSI/ASME B16.3, Class 150.
- .3 Fittings for pipe 65mm (2 1/2") and larger:
 - .1 Welded: Black steel, butted welded, ASTM A234/A234M, ANSI/ASME B16.9, each stamped by manufacturer for conformance and working pressure.
 - .2 Up to 860 kPa (125 psi) WSP Flanged: Cast iron flanged fittings, ANSI/ASME B16.1, Class 125.
 - .3 Flanges: Provide either flat-face or raised-face flanges as required to match flange faces on valves and equipment.
 - .4 Up to 860 kPa (125 psi) WSP Threaded: Threaded cast iron flanges, ANSI/ASME B16.1, Class 125.
 - .5 1035 kPa (150 psi) WSP: Weld neck or slip-on steel flanges, ASTM A181/A181M, Class 60, ANSI/ASME B16.5, Class 150.
- .4 Grooved End Couplings:
 - .1 Grooved End Couplings shall be manufactured by Victaulic unless an alternative manufacturer is proposed by the Contractor and accepted by the Consultant. Meet the practices described in current Victaulic literature.
 - .2 Grooved End Couplings:
 - .1 Victaulic grooved end couplings for glycol piping systems shall only be used on 2" (50mm) to 8" (200mm) piping.
 - .2 Grooved End Coupling pipe joints may be used in accessible areas only.
 - .3 Grooved End Couplings shall be rigid Victaulic Style 107 QuickVic couplings for sizes 2" (50mm) to 8" (200mm), Style 07 "Zero-Flex" rigid couplings for sizes 10" (250 mm) to 12" (300 mm), and Style W07 AGS rigid couplings for sizes 14"

(350mm) to 60" (1525mm). For glycol systems use Style 107 Victaulic QuickVic couplings only.

- .5 Meet hanger requirements in accordance with pipe joint manufacturer's recommendations as a minimum, otherwise meet Section 20 01 50 "Basic Materials and Methods" pipe hanger requirements.
- .6 Flange Bolts:
 - .1 Working service pressure up to 875 kPa (125 psi) WSP: ASTM A307, Grade B, square-head machine bolts with heavy hex-nuts.
- .7 Unions for pipe sizes 50mm (2") and smaller:
 - .1 Working service pressure up to 875 kPa (125 psi) WSP Soldered: Wrought bronze or copper, ground joint, solder end unions.
 - .2 Working service pressure up to 1035 kPa (150 psi) WSP Threaded: ASTM A197/A197M, ANSI/ASME B16.39, Galvanized malleable iron unions with ground joints, brass seat, threaded ends.

2.02 PIPING CORROSION PREVENTION

- .1 Provide V line insulating piping dielectric couplings as supplied for prevention of galvanic corrosion at specific points where connections are required between copper, brass or bronze and black or galvanized steel piping.
- .2 Acceptable manufacturers:
 - .1 H & G Specialties Limited;
 - .2 EPCO;
 - .3 Watts;
 - .4 Or equivalent.

2.03 GATE VALVES

- .1 Size ½" (12mm) to 2" (50mm), screw-in-bonnet, rising stem, solid wedge disc, **Class 125** cast bronze gate valve, equal to Kitz model 24 (threaded ends), or model 44 (soldered ends), as follows:
 - .1 Standards:
 - .1 End connections: ANSI B1.20.1 (threaded ends), ANSI B16.18 (soldered ends);
 - .2 Design: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. MSS SP-80, TYPE 2
 - .2 Pressure and Temperature:
 - .1 125 psi – Saturated steam to 353°F
 - .2 125 psi – fluid to 406°F
 - .3 **200 psi non-shock cold WOG**
 - .3 Materials:
 - .1 Body: ASTM B62, cast bronze
 - .2 Bonnet: ASTM B62, cast bronze
 - .3 Stem: ASTM B62, cast bronze
 - .4 Disc: ASTM B62, cast bronze
 - .5 Packing nut: ASTM B283, grade C37700 cast bronze
 - .6 Gland: ASTM B16 brass rod
 - .7 Gland packing: Aramid fibers with graphite
 - .8 Hand wheel: ASTM B86 zinc die-cast for sizes ½" (12mm) to 1" (25mm); ASTM B85 aluminum die-cast for sizes 1 ¼" (32mm) to 3" (75mm)

- .9 Wheel nut: ASTM B16 brass rod
- .2 Size 2 ½" (65mm) to 14" (350mm), outside screw-and-yoke, bolted bonnet, bronze mounted, solid wedge disc, **Class 125** cast iron gate valve, equal to Kitz model 72, as follows:
 - .1 Standards:
 - .1 End to end: ANSI B16.10, Class 125 "Face-to-Face and End-to-End Dimensions of Valves"
 - .2 End connections: ANSI B16.1, Class 125 "Cast Iron Pipe Flanges and Flanged Fittings"
 - .3 Design: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. MSS SP-70, TYPE 1
 - .2 Pressure and Temperature:
 - .1 125 psi – Saturated steam to 353°F
 - .2 125 psi – fluid to 406°F
 - .3 **200 psi non-shock cold WOG for sizes 2" (50mm) to 12" (300mm)**
 - .4 **150 psi non-shock cold WOG for size 14" (350mm)**
 - .3 Materials:
 - .1 Body: ASTM A126, Class B, cast iron
 - .2 Bonnet: ASTM A126, Class B, cast iron
 - .3 Stem: ASTM B124, grade C37700 forged brass
 - .4 Disc: ASTM A126, Class B, cast iron
 - .5 Gland: ASTM A395 ductile iron
 - .6 Gland packing: non-asbestos packing
 - .7 Hand wheel: ASTM A126, Class B, cast iron for sizes 2" (50mm) to 10" (250mm); ASTM A395 ductile iron for sizes 12" (300mm) to 14" (350mm)
 - .8 Wheel nut: ASTM A307, grade B carbon steel
 - .9 Gasket: non-asbestos sheet
 - .10 Body seat ring: ASTM B62, cast bronze
 - .11 Bonnet nut: ASTM A307, grade B carbon steel
 - .12 Gland nut: ASTM A307, grade B carbon steel
 - .13 Bonnet bolt: ASTM A307, grade B carbon steel
 - .14 Gland bolt: ASTM A307, grade B carbon steel
 - .15 Yoke sleeve: ASTM B62, cast bronze
 - .16 Wheel washer: ASTM B62, cast bronze
 - .17 Yoke: ASTM A126, Class B, cast iron for sizes 10" (250mm) to 14" (350mm)
 - .18 Yoke nut: ASTM A307, grade B carbon steel for sizes 10" (250mm) to 14" (350mm)
 - .19 Yoke bolt: ASTM A307, grade B carbon steel for sizes 10" (250mm) to 14" (350mm)
 - .20 Disc seat ring: ASTM B62, cast bronze

2.04 GLOBE VALVES

- .1 Size ½" (12mm) to 2" (50mm), screw-in-bonnet, inside screw, rising stem, integral seat, solid wedge disc, **Class 125** cast bronze globe valve, equal to Kitz model 11 (threaded ends), or model 12 (soldered ends), as follows:
 - .1 Standards:

- .1 End connections: ANSI B1.20.1 (threaded ends), ANSI B16.18 (soldered ends);
- .2 Design: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. MSS SP-80, TYPE 2
- .2 Pressure and Temperature:
 - .1 125 psi – Saturated steam to 353°F
 - .2 125 psi – fluid to 406°F
 - .3 **200 psi non-shock cold WOG**
- .3 Materials:
 - .1 Body: ASTM B62, cast bronze
 - .2 Bonnet: ASTM B283, grade C37700 forged brass for sizes ½" (12mm) to 2"; ASTM B62 cast bronze for sizes 2 ½" (65mm) to 3" (75mm)
 - .3 Stem: ASTM B62, cast bronze
 - .4 Disc: ASTM B62, cast bronze
 - .5 Lock nut: ASTM B124, grade C37700 cast bronze
 - .6 Packing nut: ASTM B283, grade C37700 cast bronze
 - .7 Gland: ASTM B16 brass rod
 - .8 Gland packing: Aramid fibers with graphite
 - .9 Hand wheel: ASTM B86 zinc die-cast for sizes ½" (12mm) to ¾" (19mm); ASTM B85 aluminum die-cast for sizes 1" (25mm) to 3" (75mm)
 - .10 Wheel nut: ASTM B16 brass rod
- .2 Size 2 ½" (65mm) to 8" (200mm), outside screw-and-yoke, bolted bonnet, bronze mounted, beveled wedge disc, **Class 125** cast iron globe valve, equal to Kitz model 76 (125FCJ), as follows:
 - .1 Standards:
 - .1 End to end: ANSI B16.10, Class 125 "Face-to-Face and End-to-End Dimensions of Valves"
 - .2 End connections: ANSI B16.1, Class 125 "Cast Iron Pipe Flanges and Flanged Fittings"
 - .3 Design: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. MSS SP-85, TYPE 1
 - .2 Pressure and Temperature service:
 - .1 125 psi – Saturated steam to 353°F
 - .2 125 psi – fluid to 406°F
 - .3 **200 psi non-shock cold WOG**
 - .3 Materials:
 - .1 Body: ASTM A126, Class B, cast iron
 - .2 Bonnet: ASTM A126, Class B, cast iron
 - .3 Stem: ASTM B124, grade C37700 forged brass
 - .4 Disc: ASTM B62, cast bronze for size 2" (50mm); ASTM A126, Class B, cast iron for sizes 2 ½" (65mm) to 8" (200mm)
 - .5 Lock nut: ASTM B62, cast bronze
 - .6 Gland: ASTM A395 ductile iron
 - .7 Gland packing: non-asbestos packing

- .8 Hand wheel: ASTM A126, Class B, cast iron for sizes 2" (50mm) to 6"(200mm); ASTM A395 ductile iron for size 8" (200mm)
- .9 Wheel nut: ASTM A307, grade B carbon steel
- .10 Gasket: non-asbestos sheet
- .11 Body seat ring: ASTM B62, cast bronze
- .12 Bonnet nut: ASTM A307, grade B carbon steel
- .13 Gland nut: ASTM A307, grade B carbon steel
- .14 Bonnet bolt: ASTM A307, grade B carbon steel
- .15 Gland bolt: ASTM A307, grade B carbon steel
- .16 Yoke bush: ASTM B62, cast bronze
- .17 Lock plate: ASTM A167, type 304 stainless steel
- .18 Disc seat ring: ASTM B62, cast bronze
- .3 Size ¼" (6mm) to 2" (50mm), unibonnet, PTFE disc, rising stem, **Class 150** cast bronze globe valve, equal to Kitz model 09 (threaded ends), or model 10 (soldered ends), as follows:
 - .1 Standards:
 - .1 End connections: ANSI B1.20.1 (threaded ends), ANSI B16.18 (soldered ends);
 - .2 Design: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. MSS SP-80, TYPE 2
 - .2 Pressure and Temperature:
 - .1 150 psi – Saturated steam to 366°F
 - .2 150 psi – fluid to 406°F
 - .3 **300 psi non-shock cold WOG**
 - .3 Materials:
 - .1 Body: ASTM B62, cast bronze
 - .2 Bonnet: ASTM B283, Grade C37700 forged brass for sizes ½" (12mm) to 2"; ASTM B62 cast bronze for sizes 2 ½" (65mm) to 3" (75mm)
 - .3 Stem: ASTM B62, cast bronze
 - .4 Disc: G/F PTFE
 - .5 Packing nut: ASTM B283, Grade C37700 cast bronze
 - .6 Gland: ASTM B16 brass rod
 - .7 Gland packing: Aramid fibers with graphite
 - .8 Hand wheel: ASTM B86 zinc die-cast for size ½" (12mm); ASTM B85 aluminum die-cast for sizes ¾" (19mm) to 2 ½" (65mm), ASTM A536 ductile iron for size 3" (75mm)
 - .9 Wheel nut: ASTM B16 brass rod
 - .10 Bonnet ring: ASTM B62, cast bronze for sizes ½" (12mm) to 2" (50mm)
 - .11 Disc holder: ASTM B62, cast bronze
 - .12 Disc nut: ASTM B16 brass rod for sizes ½" (12mm) to ¾" (19mm); ASTM B283, grade C37700 forged brass for sizes 1" (25mm) to 3" (75mm)
 - .13 Split pin: copper
 - .14 Gasket: Aramid fiber sheet
 - .15 Bonnet nut: ASTM B16 brass rod

- .16 Bonnet bolt: carbon steel
- .4 Globe valves in grooved end piping systems may be substituted with globe valves from Victaulic, or similar grooved end piping system ancillaries manufacturer, provided it can be demonstrated that all pressure, temperature, and other performance metrics can be maintained for the useful life expectancy of the piping system.

2.05 BRASS BALL VALVES

- .1 Size ¼" (6mm) to 2" (50mm), forged brass, two piece, **full port**, chrome plated, PTFE seat, ball valves, equal to Kitz model 58 (AKSZA) threaded end, or model 59 (CSZA) soldered end, as follows:
 - .1 Standards:
 - .1 Threaded ends: ANSI B1.20.1, Class 150
 - .2 Soldered ends: ANSI B16.18
 - .3 MSS SP-110
 - .2 Pressure and Temperature:
 - .1 **600 psi service non-sock cold WOG**
 - .2 150 psi saturated steam to 366°F
 - .3 Materials:
 - .1 Body: ASTM B283, Grade C37700 forged brass
 - .2 Body Cap: ASTM B283, Grade C37700 forged brass
 - .3 Stem: ASTM B16 brass rod, nickel (Ni) plated
 - .4 Ball: ASTM B283, Grade C37700 forged brass, chrome (Cr) plated
 - .5 Handle: Carbon steel, zinc electroplated with plastic covering
 - .6 Handle nut: Carbon steel
 - .7 Ball seats: PTFE
 - .8 O-rings: FPM
 - .9 Thrust washer: PBT
- .2 Size 2 ½" (65mm) to 4" (100mm), forged brass, two piece, **full port**, chrome plated, PTFE seat, ball valves, equal to Kitz model 58 (AKSZA) threaded end, or model 59 (CSZA) soldered end, as follows:
 - .1 Standards:
 - .1 Threaded ends: ANSI B1.20.1, Class 150
 - .2 Soldered ends: ANSI B16.18
 - .3 MSS SP-110
 - .2 Pressure and Temperature:
 - .1 **400 psi service non-sock cold WOG**
 - .2 150 psi saturated steam to 366°F
 - .3 Materials:
 - .1 Body: ASTM B62, cast bronze
 - .2 Body Cap: ASTM B62, cast bronze
 - .3 Stem: ASTM B16 brass rod, nickel (Ni) plated
 - .4 Ball: ASTM B283, Grade C37700 forged brass, chrome (Cr) plated for size 2 ½" (65mm); cast brass for sizes 3" (75mm) and 4" (100mm)
 - .5 Handle: Carbon steel, zinc electroplated with plastic covering for size 2 ½" (65mm); ductile iron for sizes 3" (75mm) and 4" (100mm)

- .6 Handle nut: Carbon steel
- .7 Washer: Carbon steel for size 2 ½" (65mm)
- .8 Ball seats: PTFE
- .9 O-rings: FPM
- .10 Thrust washer: PTFE
- .3 Ball valves in grooved end piping systems may be substituted with ball valves from Victaulic, or similar grooved end piping system ancillaries manufacturer, provided it can be demonstrated that all pressure, temperature, and other performance metrics can be maintained for the useful life expectancy of the piping system.

2.06 BUTTERFLY VALVES

- .1 Size 2" (50mm) to 8" (200mm), **ductile iron body**, extended neck, bi-directional, molded seat, butterfly valve, equal to Kitz model 5123 (wafer style), or model 6123 (lug style), as follows:
 - .1 Standards:
 - .1 End connections: ANSI Class 125/150 flanges;
 - .2 MSS SP-67
 - .3 API-609, Cat. A
 - .4 NSF/ANSI – 372 suitable for drinking water
 - .2 Pressure and Temperature:
 - .1 **200 psi differential pressure** service
 - .2 -30°F to 275°F with EPDM seat
 - .3 Materials:
 - .1 Body: ASTM A536, Grade 65-45-12 ductile iron
 - .2 Stem: ASTM A276, Type 410 stainless steel (line scribed on top of stem to indicate valve position)
 - .3 Disc: Aluminum bronze, Grade C95400
 - .4 Handle bolt: Carbon steel
 - .5 O-rings: NBR/EPDM
 - .6 Bearing: Polyacetal
 - .7 Stem bearing: G/F PTFE for sizes 2" (50mm) to 5" (125mm); Metal backed PTFE for sizes 6" (150mm) and 8" (200mm)
 - .8 Plug: Zinc die-cast, chrome plated
 - .9 Cap: PVC for sizes 2" (50mm) to 6" (150mm)
 - .10 Index plate: Carbon steel
 - .11 Set bolt: Carbon steel
 - .12 Nut: Carbon steel
 - .13 Bottom stem: ASTM A276, Type 410 (ANSI Type 329) stainless steel
 - .14 Seat rubber: NBR/EPDM vulcanized to body
 - .15 Spring washer: Carbon steel
- .2 Size 10" (250mm) to 12" (300mm), **ductile iron body**, extended neck, bi-directional, square drive, molded seat, butterfly valve, equal to Kitz model 5123 (wafer style), or model 6123 (lug style), as follows:
 - .1 Standards:

- .1 End connections: ANSI Class 125/150 flanges;
 - .2 MSS SP-67 & SP-25
 - .3 API-609
- .2 Pressure and Temperature:
 - .1 **200 psi differential pressure** service
 - .2 -30°F to 275°F with EPDM seat
- .3 Materials:
 - .1 Body: ASTM A536, Grade 65-45-12 ductile iron
 - .2 Stem: ASTM A276, Type 410 stainless steel (line scribed on top of stem to indicate valve position)
 - .3 Disc: Aluminum bronze, Grade C95400
 - .4 Endplate bolts: Carbon steel
 - .5 Gland plate bolt: Stainless steel
 - .6 O-rings: NBR/EPDM
 - .7 Bearing: Polyacetal
 - .8 Steam bearing: Metal backed PTFE
 - .9 Set bolt: Carbon steel
 - .10 Bottom stem: ASTM A276, Type 410 (ANSI Type 329) stainless steel
 - .11 Seat rubber: NBR/EPDM vulcanized to body
 - .12 Gland plate: Carbon steel
 - .13 Spring washer: Carbon steel
 - .14 End plate: Carbon steel
- .3 Unless noted otherwise, butterfly valve sizes 2" (50mm) to 4" (100mm) shall have aluminum die-cast lever operated handle with ten (10) position throttling plate; butterfly valve sizes 6" (150mm) and larger shall have aluminum die-cast gear operated handle.
- .4 Butterfly valves in grooved end piping systems may be substituted with butterfly valves from Victaulic, or similar grooved end piping system ancillaries manufacturer, provided it can be demonstrated that all pressure, temperature, and other performance metrics can be maintained for the useful life expectancy of the piping system.
- .5 Victaulic Vic-300 grooved end valves may be substituted in grooved-end piping systems up to 300 psi (2100 kPa) as follows:
 - .1 To 175 psi (1225 kPa) working pressure, use Fig. 660L.
 - .2 To 225 psi (1575 kPa) working pressure, use Fig. 632-L648.
 - .3 To 250 psi (1750 kPa) working pressure, use Fig. Bhp-L1 meeting ANSI B16.5 as follows:
 - .1 285 psi (1995 kPa) to 100°F (38°C)
 - .2 265 psi (1885 kPa) to 212°F (100°C)
 - .3 250 psi (1750 kPa) to 250°F (121°C)
 - .4 Above 300 psi (2100 kPa) working pressure, use Bhp-L2 meeting ANSI B16.5 as follows:
 - .1 770 psi (5180 kPa) to 100°F (38°C)
 - .2 500 psi (3500 kPa) to 380°F (193°C)
 - .3 300 psi (2100 kPa) to 725°F (440°C)

2.07 FLOW BALANCING VALVES

- .1 Flow balancing valves ½" (12mm) to 2" (50 mm) provide Tour and Anderson series 786H (soldered end), series 787H (threaded end) or acceptable equivalent.
 - .1 Small bore flow balancing valves shall be suitable for working pressure up to **400 psi** for operating temperature range between -4°F to +248°F, with built-in drain connection with shut off valve and protective caps, and integral valve insulation.
- .2 Flow balancing valves from 2 ½" (65 mm) to 16" (400 mm) provide Tour and Anderson series 788 (flanged end), or series 789 (grooved end), or acceptable equivalent, Y-pattern style, cast iron body.
 - .1 Big bore flow balancing valves shall be suitable for working pressure up to **250 psi (grooved end connections), or 350 psi (flanged end connections)** for operating temperature range between -4°F to +248°F.
- .3 For each Tour and Anderson flow balancing valve, or acceptable equivalent, provide:
 - .1 vernier type handwheel settings for precision flow balancing
 - .2 positive shut off valve with no drip seat and plug type stem with teflon disc
 - .3 tamper proof hidden memory feature
 - .4 positive shut off metering valves with connections for portable meter
- .4 Select flow balancing valve size at 100% open to provide a pressure drop not to exceed a maximum pressure drop of 3.5 ft.wg. (10.5 kPa) under design flow conditions.
- .5 Flow balancing valves in grooved end piping systems may be substituted with flow balancing valves from Victaulic, or similar grooved end piping system manufacturer, provided it can be demonstrated that all pressure, temperature, and other performance metrics can be maintained for the useful life expectancy of the piping system.

2.08 SWING TYPE CHECK VALVES

- .1 Size ½" (12mm) to 2" (50mm), **Class 125 cast bronze**, screw cap, integral seat, PTFE seat, horizontal swing type check valve, equal to Kitz model 22T (AKYRT) threaded end, or model 23T (CYRT) soldered end, as follows:
 - .1 Standards:
 - .1 Threaded ends: ANSI B1.20.1, Class 125
 - .2 Soldered ends: ANSI B16.18
 - .3 MSS SP-80, Type 3
 - .2 Pressure and Temperature:
 - .1 **200 psi service non-sock cold WOG** at 150°F (65°C)
 - .2 125 psi fluids to 406°F
 - .3 125 psi saturated steam to 353°F
 - .3 Materials:
 - .1 Body: ASTM B62 cast bronze
 - .2 Cap: ASTM B283, Grade C37700 forged brass
 - .3 Disc: PTFE
 - .4 Disc holder: ASTM B62 cast bronze
 - .5 Disc nut: ASTM B16 brass rod for sizes ½" (12mm) to 1" (25mm); ASTM B283, Grade C37700 forged brass for sizes 1 ¼" (32mm) to 2" (50mm)
 - .6 Hinge pin: copper
 - .7 Plug: ASTM B16 brass rod
- .2 Size 2 ½" (65mm) to 10" (250mm), **Class 125 cast iron** swing type check valve, equal to Kitz model 78 (125FCO), as follows:

- .1 Standards:
 - .1 End to end: ASME B16.10, Class 125
 - .2 End connections: ASME B16.1, Class 125;
- .2 Pressure and Temperature:
 - .1 **200 psi service non-sock cold** WOG at 150°F (65°C)
 - .2 125 psi fluids to 406°F
 - .3 125 psi saturated steam
- .3 Materials:
 - .1 Body: ASTM A126, Class B cast iron
 - .2 Cover: ASTM A126, Class B cast iron
 - .3 Disc: ASTM B62 cast bronze for size 2" (50mm) to 4" (100mm); ASTM A216, Class B cast iron for sizes 5" (125mm) to 10" (250mm)
 - .4 Dis nut: ASTM A307, Grade B carbon steel
 - .5 Split pin: ASTM A580, Type 304 stainless steel
 - .6 Hinge pin: ASTM B124, Grade C37700 forged brass
 - .7 Plug: ASTM A36 carbon steel
 - .8 Gasket: Non-asbestos sheet
 - .9 Body seat ring: ASTM B62 cast bronze
 - .10 Cover nut: ASTM A36 carbon steel
 - .11 Cover bolt: ASTM A36 carbon steel
 - .12 Disc seat ring: ASTM B62 cast bronze
 - .13 Arm: ASTM A536, Grade 60-40-18 ductile iron
 - .14 Washer: ASTM A36 carbon steel
 - .15 Disc bolt: ASTM A307, Grade B carbon steel
 - .16 Spring pin: ASTM A686, Type W1
- .3 Check valves in grooved end piping systems may be substituted with check valves from Victaulic, or similar grooved end piping system ancillaries manufacturer, provided it can be demonstrated that all pressure, temperature, and other performance metrics can be maintained for the useful life expectancy of the piping system.

2.09 VERTICAL LIFT CHECK VALVES

- .1 Size ½" (12mm) to 2" (50mm), silent type, spring loaded, **cast bronze**, vertical lift type check valve, with renewable FPM disc, equal to Kitz model 36 (AKAF) threaded end, or model 26 (CAF) soldered end, as follows:
 - .1 Standards:
 - .1 Threaded ends: ANSI B1.20.1
 - .2 Soldered ends: ANSI B16.18
 - .2 Pressure and Temperature:
 - .1 **250 psi service** non-sock cold WOG
 - .2 175 psi fluids to 176°F
 - .3 Materials:
 - .1 Body: ASTM B584, Grade C84400 cast bronze
 - .2 Cap: ASTM B584, Grade C84400 cast bronze

- .3 Disc: FPM
- .4 Disc holder: ASTM B584, Grade C84400 cast bronze
- .5 Spring: Phosphor bronze
- .2 Vertical lift valves in grooved end piping systems may be substituted with vertical lift check valves from Victaulic, or similar grooved end piping system ancillaries manufacturer, provided it can be demonstrated that all pressure, temperature, and other performance metrics can be maintained for the useful life expectancy of the piping system.

2.10 NON-SLAM WAFER TYPE CHECK VALVES

- .1 Dual disc, non-slam, silent wafer type check valves, size 2" (50mm) to 54" (1350mm), equal to Mueller Steam Specialty, as follows:
 - .1 Standards: ASTM, ANSI, and API as applicable.
 - .2 **ASME Class 125**, model 71, as follows:
 - .1 Valve sizes 2" (50mm) to 12" (300mm) suitable for:
 - .1 **200 psi service** from -20°F to 150°F
 - .2 150psi at 353°F
 - .2 Valve sizes 14" (350mm) to 24" (600mm) suitable for:
 - .1 **150 psi service** from -20°F to 150°F
 - .2 105 psi service at 325°F
 - .3 Valve sizes 30" (750mm) to 54" (1350mm) suitable for:
 - .1 **150 psi service** from -20°F to 150°F
 - .2 100psi service at 225°F
 - .4 Body: ASTM A126, grade B, **grey cast iron**;
 - .5 Disc: ANSI 316 stainless steel;
 - .6 Shaft/ spring: 316 stainless steel
 - .7 Seat: Buna-N.

2.11 STRAINERS – Y (WYE) PATTERN

- .1 Size ½" (12mm) to 2" (50mm), **Class 125, cast copper silicon alloy body**, Y (wye) pattern strainer, equal to Watts Series LF777 (threaded ends), or LFS777 (soldered ends), as follows:
 - .1 Standards:
 - .1 NSF 372 for potable water applications
 - .2 Pressure and Temperature:
 - .1 ¼" (6mm) to 3" (75mm):
 - .1 **400 psi WOG** at 210°F
 - .2 125 psi WSP to 353°F
 - .2 4" (100mm):
 - .1 **300 psi WOG** at 210°F
 - .2 125 psi WSP to 353°F
 - .3 Materials:
 - .1 Body: cast copper silicon alloy
 - .2 Solid retainer cap: cast copper silicon alloy
 - .3 Cap seal: EPDM O-ring for sizes ¼" (6mm) to 3" (75mm); Garlock gasket for size 4" (100mm)

- .4 Gasket: EPDM
- .5 Screen: #20 stainless steel mesh for sizes ½" (12mm) to 2 ½" (65mm); 3/64" (1.2mm) 304 stainless steel perforated screen for size 3" (75mm); 1/8" (3mm) 304 stainless steel perforated screen for size 4" (100mm)
- .2 Size 2 ½" (65mm) to 12" (300mm), **cast iron body**, Y (wee) pattern strainer, equal to Watts Series 77F-DI-125 flanged ends, as follows:
 - .1 Standards:
 - .1 ASME Class 125
 - .2 NSF 372 for potable water applications
 - .2 Pressure and Temperature:
 - .1 **200 psi WOG** at 210°F
 - .2 125 psi WSP to 353°F
 - .3 Materials:
 - .1 Body: ASTM A-126 Class B cast iron
 - .2 Cover: ASTM A-126 Class B cast iron with drain/ blowoff connection and ASTM A6 closure plug
 - .3 Cover bolt: ASTM A6
 - .4 Cover bolt nut: ASTM A6
 - .5 Set screw: ASTM B16
 - .6 Plate: ASTM A6
 - .7 Cotter pin: ASTM A112
 - .8 Washer: ASTM A6
 - .9 Cover gasket: Graphite
 - .10 Screen: 304 stainless steel with 1/16" perforations for sizes 2" (50mm) to 5" (125mm); 304 stainless steel with 1/8" perforations for sizes 6" (150mm) to 8" (200mm); 304 stainless steel with 3/16" perforations for sizes 10" (250mm) to 12" (300mm)
- .3 Y (wee) pattern strainers in grooved end piping systems may be substituted with Y (wee) pattern strainers from Victaulic, or similar grooved end piping system ancillaries manufacturer, provided it can be demonstrated that all pressure, temperature, and other performance metrics can be maintained for the useful life expectancy of the piping system.

2.12 AUTOMATIC AIR VENT

- .1 Standard float vent with brass or cast iron body and ½" (12mm) connection and rated at 150 psig (1035 kPa) working pressure.
- .2 Float shall be solid material suitable for 240°F (115°C) working temperature.
- .3 Acceptable Manufacturers:
 - .1 Amtrol: No 720;
 - .2 Maid-O-Mist: No. 75;
 - .3 Braukman: EA122;
 - .4 Taco: 418;
 - .5 Spirax Sarco - Fig. 13W
 - .6 Grinnell - Fig. 1401
 - .7 ITT Bell & Gossett - Model 107

- .8 Or equivalent.

2.13 AIR SEPARATOR-BOILER MOUNTED

- .1 Dip tube type;
- .2 150 psig (1035 kPa) working pressure);
- .3 Acceptable Manufacturers:
 - .1 Armstrong BMA
 - .2 ITT Bell & Gossett - Airtrol boiler fitting
 - .3 Or equivalent

2.14 AIR SEPARATOR (IN-LINE)

- .1 Scoop separation type;
- .2 150 psig (1035 kPa) working pressure);
- .3 Acceptable Manufacturers:
 - .1 Taco - 430 Series
 - .2 ITT Bell & Gossett - IAS
 - .3 Amtrol - 400 Series
 - .4 Armstrong – PMA
 - .5 Or equivalent

2.15 CENTRIFUGAL AIR SEPARATOR

- .1 Where shown on drawings and/ or equipment schedules provide external constructed in accordance with Section VIII, Division I of the ASME Boiler and Pressure Vessel Code, stamped for design pressure and temperature.
- .2 Air separators with connections up to 3" (75mm) be complete with cast iron bodies with NPT connections and shall be designed and constructed for 160 psig @ 350°F. (1100 Pa @ 177°C.)
- .3 Air separators with connections of 4" (100mm) to 12" (300mm) shall be fabricated steel with flanged connections designed and constructed for 165 psig @ 375°F. (1140 Pa @ 191 C.).
- .4 Provide a bottom connection for blowdown cleaning.
- .5 Acceptable manufacturers:
 - .1 Taco - Air separator
 - .2 ITT Bell & Gossett - Rolairtrol
 - .3 Amtrol -Tangential air separator
 - .4 Armstrong – VA
 - .5 Or Acceptable Equivalent

2.16 BLADDER TYPE EXPANSION TANKS

- .1 Construction:
 - .1 Provide Horizontal or Vertical, cylindrical steel pressurized bladder type expansion tanks, for each closed circulation system.
 - .2 Each tank shall have an EPDM elastomer diaphragm suitable for a 50% solution of inhibited propylene glycol and 240°F (115°C) operating temperature.
 - .3 suitable for the system working pressure: 125 psig (860 kPa) with ASME Section VIII stamp for unfired Pressure Vessels, CSA B-51, and Provincial regulations
 - .4 welded construction conforming to ASTM A516 pressure vessel carbon steel plate with dished ends,

- .5 finish: primed on outside,
- .6 Provide saddles for horizontal installation or base mount for vertical installation;
- .7 Capacity: As indicated on the Documents.
- .8 Air pre-charged to initial fill pressure of system.
- .2 Nozzles and couplings:
 - .1 NPS 1" (25mm) expansion line fitting at/near bottom.
- .3 Accessories:
 - .1 Schraeder tank valve for compressed air located above bladder;
 - .2 air precharged to 84 kPa (12 psi), or initial fill pressure of system noted in the Documents.
- .4 Acceptable Manufacturers:
 - .1 Amtrol Extrol
 - .2 Taco CBX
 - .3 ITT Bell & Gossett
 - .4 Conbraco
 - .5 S.A. Armstrong,
 - .6 Or Acceptable Equivalent

2.17 HYDRONIC SYSTEM PRESSURE SAFETY RELIEF VALVE

- .1 Valve: to ASME Section IV.
- .2 Body Construction: brass.
- .3 Adjustable Pressure Setting: 8 to 25 psig (55 to 172 kPa).
- .4 Maximum Operating Differential Pressure From Open To Close:
 - .1 3 psig (20 kPa).
- .5 Acceptable Manufacturers:
 - .1 Bell & Gossett;
 - .2 Taco;
 - .3 Watts;
 - .4 Or approved equivalent

2.18 WATER MAKE-UP PRESSURE REDUCING VALVE

- .1 Iron body water pressure regulator with:
 - .1 Low inlet pressure check valve;
 - .2 fast fill /purge lever;
 - .3 Removable stainless steel strainer, and;
 - .4 Iron body diaphragm operated relief valve
- .2 Adjustable Low Pressure: 0.8 to 25 psig (55 to 172 kPa).
- .3 Acceptable Manufacturers:
 - .1 Bell & Gossett;
 - .2 Taco;
 - .3 Watts - No.1450F series
 - .4 A.W. Cash Valve - Type CBL
 - .5 Or approved equivalent

2.19 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

- .1 Adjustable Pressure Setting: 30 psig (206 kPa) relief, 8 to 25 psig (55 to 172 kPa) reducing.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.
- .4 Acceptable Manufactures:
 - .1 Bell & Gossett;
 - .2 Taco;
 - .3 Watts;
 - .4 Or approved equivalent.

2.20 GLYCOL MAKE-UP UNIT AND MIXING TANK

- .1 Construction:
 - .1 210 litre (55 gallon) open cylindrical tank
 - .2 material: polypropylene, structurally formed tank or with channel reinforced bottom and support stand,
 - .3 enclosed, vented tank, or hinged gasketed cover with counterweight balanced hold-open mechanism.
- .2 Fittings and accessories:
 - .1 overflow, inlet and suction connections,
 - .2 pump mounting arrangement.
 - .3 suction and discharge piping with isolation valves and check valves.
- .3 Glycol transfer pump;
 - .1 single close-coupled iron fitted centrifugal feed pump with mechanical seal, mounted to mixing tank, and pre-piped to suction strainer,
 - .2 rated for 0.63 l/s at 210 kPa (10 gpm at 30 psi).
 - .3 low water level cut-out switch,
 - .4 high water level alarm,
 - .5 system low pressure pump start switch,
 - .6 remote annunciation contacts for low liquid level, high liquid level.
- .4 Acceptable Manufactures:
 - .1 Bell & Gossett - GMU
 - .2 Armstrong - GLA UHP1
 - .3 Or approved equivalent

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Comply with Manufacturer's requirements for the installation of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Locate equipment as shown on the drawings to provide connection arrangement and accessibility for servicing.
- .3 Provide clearances on all sides of equipment as required by the Manufacturer's Installation Instructions.
- .4 Install items of equipment with due regard to Architectural treatment, and ensure all items are level and finished in keeping with good workmanship.

- .5 Provide chemical treatment connections on heating and cooling circuits in locations as directed by chemical treatment supplier. Following completion of pipe leakage testing, provide for continuous flushing and cleaning of new piping systems prior to opening connections to new systems. Provide letter from Chemical Treatment vendor that systems have been cleaned prior to opening new systems to existing systems.
- .6 Provide branch take-offs from mains of heating and cooling pipes with shut off valves.
- .7 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.
- .8 Install and connect remote components such as thermostats, humidistats, control panels, level controllers, and other similar ancillary devices that are supplied with the equipment. Install in locations as shown on the drawings.
- .9 All independent hydronic circulating systems shall be provided with a properly sized safety pressure relief valve.

3.02 HVAC HYDRONIC PIPING SYSTEMS

- .1 Use valves and strainers of the same size as pipe in which it is installed, unless otherwise indicated.
- .2 Install eccentric reducing fittings so as not to trap air.
- .3 Provide long radius elbows unless noted otherwise.
- .4 Provide flanges or unions at connections to all equipment.
- .5 Provide screwed or flanged joints only in accessible locations. Provide access doors as required.
- .6 Do not use field fabricated fittings.
- .7 The first hanger on branch take off piping from a riser shall be spring hung to reduce stress on riser and branch.
- .8 Connect branch pipe runouts to top of main distribution pipe.
- .9 Provide line size (minimum 2" [50 mm]) threaded piping connections at the base/ end of piping supply and return connection to equipment. Piping arrangement will allow for threaded flexible hose connections between supply and return piping ends that will allow for continuous flushing and cleaning of piping systems while equipment remains isolated.

3.03 GATE VALVES

- .1 Provide line size gate valves for shut-off applications as follows:
 - .1 Supply and return piping connections to each piece of equipment;
 - .2 Drain connections;
 - .3 All piping risers as follows:
 - .1 at the base when supplied from, or returned to below, or;
 - .2 at the top when supplied from, or returned to above.
 - .4 Branch connections from mains (branch connections serve two or more pieces of equipment);
 - .5 Where otherwise required by the Contract Documents.

3.04 GLOBE VALVES

- .1 Provide globe valves on the discharge of each pump downstream of a check valve for shut-off and, balancing, throttling or controlling flow.
- .2 Globe valves may be provided in lieu of flow balancing valves for balancing, throttling or controlling flow.

- .3 When used for balancing, throttling or controlling flow, globe valves shall have established Cv values suitable for use by Testing Adjusting and Balancing (TAB) Trades, and be complete with valved pressure gauge tapings at globe valve inlet and discharge locations.
- .4 Provide globe valves in the appropriate pressure class, for modulating control applications in either two or three way configuration. Refer to Division 25 Specifications for Control Valve requirements.

3.05 BALL AND BUTTERFLY VALVES

- .1 Line size ball valves or butterfly valves in the appropriate pressure and temperature class may be substituted for gate valves for shutoff applications.
- .2 Provide minimum ¼" (6mm) full port ball valves in the pressure class required by the application for isolation of instrumentation components such as pressure gauges, thermometers, and other similar types of devices.
- .3 Provide high performance butterfly valves (BHP), for modulating control applications in either two or three way configuration, and where electric actuators are used. Refer to Division 25 Specifications for Control Valve requirements.

3.06 FLOW BALANCING VALVES

- .1 Provide flow balancing valves for balancing, throttling or controlling flow as follows:
 - .1 on the common return pipe from each:
 - .1 air handling unit coil;
 - .2 heat recovery coil;
 - .3 terminal device (fan coil unit, unit heater, duct mounted reheat coil, perimeter heating element and similar);
 - .4 heat exchanger;
 - .5 hot water heating boiler;
 - .6 chiller evaporator and condenser;
 - .2 on each return piping riser;
 - .3 where otherwise required by the Contract Documents.

3.07 PIPELINE CHECK VALVES

- .1 Provide a check valve in the discharge piping of every pump, where required by the Documents, and wherever else required for proper operation and maintenance of systems.
 - .1 Provide a vertical lift check valve, or non-slam check valve in the discharge piping of every pump.
 - .2 Vertical lift check valves, or non-slam check valves for installation in the discharge of vertical inline circulating pumps may be supplied as a pump accessory from the pump manufacturer in lieu of independent check valves specified in this Section.
- .2 Check valve shall be mounted a minimum of six (6) times the nominal pipe diameter from the outlet of all pumps, elbows or other flow transition ancillaries in the piping system.
- .3 Check valves mounted in vertical piping shall be suitable for the application, and with flow in the upward direction.

3.08 PIPELINE STRAINERS

- .1 Provide line size strainers in the following locations:
 - .1 On inlet side of water meters
 - .2 at the suction side of each pump;
 - .3 immediately upstream of each pressure reducing valve;
 - .4 immediately upstream of each entering side of a plate and frame heat exchanger.

- .5 immediately upstream of each control valve (except at terminal device coils with piping connections NPS ¾" (20mm) or less, radiant heating elements, or radiant heating panels);
- .6 where shown on the Drawings and the Details.
- .2 Install strainers in horizontal or down flow (Y (wye) pattern only) piping with clearance for removal of basket.
- .3 Supply strainers with extra construction screens and remove after systems have been thoroughly cleaned.
- .4 Equip each strainer 2" (50 mm) and smaller in size with plugged blow off tappings.
- .5 Equip each strainer 2 ½" (75mm) and larger in size with blow off tapping connection complete with shut off valve and blow off piping with same pressure and temperature rating of strainer. Terminate blow off piping in downward vertical position. Size blow off piping and valve the same size as the blow off tapping.
- .6 Ensure that each strainer can be isolated from piping systems with isolating valves on each side of strainer, and which are not more than 10 ft (3 metres) upstream or downstream from strainer.
- .7 Clean strainer baskets after piping system flushing and cleaning is complete, and before water quantity balancing commences.

3.09 PIPELINE AIR VENTS

- .1 Provide air vents at high points, and in sections of piping subject to air binding, in both supply and return mains, at equipment connections, and wherever else required.
- .2 Equip each air vent with a ball type shut-off valve installed between unit and piping.
- .3 Pipe vent outlets to discharge to drain, over janitors sinks, over floor drains in mechanical rooms and other similar visible locations.
- .4 Provide manual air vents, screwdriver or key type at each unit heater, cabinet unit heater, convactor, wallfin section and fan coil unit.

3.10 PIPELINE DRAIN VALVES

- .1 Provide a drain valve in accordance with Section 20 01 50 "Basic Materials and Methods"
- .2 Additionally, provide a drain valve at the base of each piping riser, in drain connections to equipment, in low points of horizontal piping and wherever else required by the Contract Documents.

3.11 BLADDER TYPE EXPANSION TANKS

- .1 General:
 - .1 Provide expansion tanks where required.
 - .2 Secure each vertical tank stand to a concrete housekeeping pad by means of machine bolts. Support horizontal tanks on steel saddles secured to the structure by means of hanger rods.
 - .3 Extend a drain line from each tank piping and terminate each drain line with a drain valve.
- .2 Water system expansion tank:
 - .1 Install equalizer line from air separator in piping system to bottom of tank.
 - .2 Provide domestic cold water line with globe valve, strainer, and line size backflow preventer with isolating valves connected to equalizer line.
 - .3 Provide water make-up assembly on domestic water line on tank side of backflow preventer, complete with:
 - .1 water safety relief valve, located in piping near bottom of tank with relief pressures set to maintain 105 kPa (15 psi) at highest point in system with pumps off.

- .2 relief valve of same model and size as relief valve used on heating convertor, minimum NPT $\frac{3}{4}$ " (20mm), if tank is connected to steam generated hot water system,
 - .3 relief connection on backflow preventer, on make-up assembly, piped to nearest open drain,
 - .4 pressure gauge to show pressure in tank,
 - .5 compressed air to each tank or group of tanks with globe valve and check valve, terminating 1200 mm (4 ft) above finished floor near tanks with 6 m (20 ft) length of hose and hose end fitting compatible with Schraeder connection on tank.
- .3 Glycol system expansion tank
- .1 Provide:
 - .1 equalizer line from air separator in piping system to bottom of tank,
 - .2 glycol make-up line from glycol fill system, and valved drain line from bottom of tank piped to glycol mixing tank,
 - .3 domestic cold water line with globe valve, strainer, and line size backflow preventer with isolating valves connecting to glycol mixing tank,
 - .4 Manual air vent valve near top of tank and code rated water safety relief valve, located in piping near bottom of tank with relief pressures set to maintain 70 kPa (10 psi) at highest point in system with system circulating pumps off.
 - .5 relief valve of same model and size as relief valve used on heating convertor, minimum NPT $\frac{3}{4}$ " (20mm), if tank is connected to steam generated hot water system,
 - .6 relief connection on backflow preventer piped to nearest open drain,
 - .7 relief valve and valved drain line from bottom of tank piped to glycol mixing tank
 - .8 pressure gauge to show pressure in tank,
 - .9 compressed air to each tank or group of tanks with globe valve and check valve, terminating 1200 mm (4 ft) above finished floor near tanks with 6 m (20 ft) length of hose and hose end fitting compatible with Schraeder connection on tank.
 - .10 controls for make-up pump and alarm system connected and tested.

3.12 HYDRONIC SYSTEM PRESSURE SAFETY RELIEF VALVE

- .1 Provide factory set hydronic system pressure relief valves on hot water boilers, heating convertors, expansion tanks and other pressure vessels and where ever else required by Code.
- .2 Install in accordance with relevant Codes.
- .3 Pipe the discharge of each relief valve to drain unless otherwise specified.

3.13 HYDRONIC SYSTEM PRESSURE REDUCING VALVES

- .1 Install pressure reducing valve stations with shut-off valve on either side of assembly and 115 mm (4½ in) pressure gauges on upstream and downstream sides of station.

3.14 PIPELINE EXPANSION COMPENSATION

- .1 Provide expansion compensators (including expansion loops) in accordance with Section 20 01 50 "Basic Materials and Methods"

3.15 PIPE LEAKAGE TESTING

- .1 Meet testing requirements of all Authorities Having Jurisdiction (AHJs). Obtain certification and certify tests not required by AHJs. Perform not less than the following tests:
 - .1 Complete pipe leakage in accordance with the Mechanical Contractors Association of America (MCAA) "Guide to Pressure Testing Safety".

- .2 Complete pipe leakage testing in accordance with the requirements of ASTM E 1003 "Standard for Practice for Hydrostatic Leak Testing" and/ or ASTM A1047 / A1047M-05 "Standard Test Method for Pneumatic Leak Testing of Tubing", as follows:
 - .1 Hydrostatic Pipe Leakage Testing:
 - .1 Pressure testing for piping subject to ASME B31.1 and/ or ASME B31.9 shall be tested at a minimum of 1.5 times the design pressure, but shall not exceed the maximum test pressure for any vessel, pump, valve, or other component in the system under test.
 - .2 Test without pressure drop for a period of not less than 10 minutes at the maximum test pressure, then reduce to the design pressure, or 100 psig, whichever is greater, and hold for a period that allows for a complete visual inspection of the piping systems under test, however, for a period not less than four (4) hours. Hydrostatic leakage testing shall be repeated until no leaks are found.
 - .2 Pneumatic Pipe Leakage Testing:
 - .1 A preliminary pneumatic test not to exceed 25 psig may be applied, prior to other methods of leak testing, as a means of locating major leaks for piping subject to ASME B31.1 and/ or ASME B31.9.
 - .2 For piping subject to ASME B31.1 and/ or ASME B31.9, a pneumatic pressure test may only be completed in lieu of a hydrostatic pressure test with the approval of the Consultant, and will typically be only limited to independent hydronic circuit(s) with a vertical height less than 30 ft. (10 m).
 - .3 The pneumatic test pressure shall be not less than 1.2 nor more than 1.5 times the design pressure of the piping system, but shall not exceed the maximum test pressure for any vessel, pump, valve, or other component in the system under test.
 - .4 Test without pressure drop for a period of not less than ten (10) minutes at the maximum test pressure, then reduce to the design pressure, and hold for a period that allows for a complete visual inspection of the piping systems under test, however, for a period not less than four (4) hours. Pneumatic leakage testing shall be repeated until no leaks are found.
 - .5 Examination for leakage shall be conducted using soap bubble or equivalent detection methods, shall be made of all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.
- .2 Perform tests before piping is covered or concealed.
- .3 Eliminate leaks or remove and refit defective parts. Do not caulk threaded or welded joints.
- .4 Remove all components which will not withstand test pressure following any remedial work after testing.
- .5 After pressure testing is completed, adjust and put all parts of the system into proper working order. Adjust all valves to achieve specified heating capacities. Leave the complete job ready for regular operation, all to the satisfaction of the Consultant.
- .6 After the testing period, drain the system, and before water treatment is introduced into the system, clean out all dirt pockets and strainers.
- .7 Provide lubricating oils, packing, and other accessories, for proper operation of the system.
- .8 The final test and acceptance shall not be made until the work is fully completed.

3.16 WATER BALANCING

- .1 Refer to Section 20 05 95.

- .2 Provide flow measurement ports as shown on detail drawings and piping schematics in locations as directed by the Testing Adjusting and Balancing ("TAB") Trades. Provide additional balancing valves where recommended by the TAB Trades.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with requirements of Section 20 05 70 Motors, Motor Starters, Motor Control Centres, and Wiring
- .5 Comply with requirements of Section 20 08 10 Mechanical Commissioning

1.02 SCOPE OF WORK OF THIS SECTION

- .1 Provision of HVAC system water piping systems, pumping systems, heat exchangers and all related ancillaries.

1.03 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the installation of pressure piping and pumping systems for hydronic heating and cooling applications.
- .2 All combustible piping to be ULC labelled and listed for flame spread rating of less than 25 and smoke classification of less than 50.

1.04 SUBMITTALS

- .1 Submit shop drawings for the following Products:
 - .1 HVAC Pumps;
 - .2 HVAC Pump Accessories

1.05 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 HVAC SYSTEM PUMPS AND CIRCULATORS GENERAL REQUIREMENTS

- .1 Comply with Manufacturer's requirements for the installation of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.
- .3 Provide HVAC pumps and circulators of type and size as indicated on the Equipment Schedules.
- .4 The following General Requirements apply to all HVAC Pumps and Circulators:
 - .1 Equipped with mechanical seals, non-overloading motor (not including motor service factor) in accordance with Section 20 05 70 over entire performance curve and bronze fitted except where noted.
 - .2 Provide split coupling for pumps with motor sizes equal to or greater than 7½ HP.
 - .3 The pump bearings shall be maintenance free permanently lubricated and sealed bearings with an L-10 life in excess of 100,000 hours, and L-50 life at 500,000 hours. Bearing frame shall be equipped with seals to protect bearings from moisture and airborne contaminants.

- .4 All pumps to be complete with suction and discharge flanged connections, tapings for gauges, drain and flush line connections.
- .5 Provide pump Suction Diffuser as follows:
 - .1 Standard Class 125 flange rated for 175 PSIG (1210 kPa) pressure and 250°F (120°C) temperature;
 - .2 Where noted, provide Class 250 flange rated for 300 PSIG (2070 kPa) pressure and 250°F (120°C) temperature;
 - .3 Ductile Iron Body;
 - .4 Ductile Iron Cover;
 - .5 Integral Ductile Iron Straightening Vanes;
 - .6 Stainless Steel (304) Permanent Strainer;
 - .7 Bronze (16 Mesh) Disposable Start Up Strainer;
 - .8 EPDM Cover O-Ring;
 - .9 Steel Grooved Adapter;
 - .10 Metering Port
 - .11 Blow Down port
 - .12 Magnetic Insert
- .6 Provide pump Multi-purpose Discharge Valve as follows:
 - .1 Standard Class 125 flange rated for 175 PSIG (1210 kPa) pressure and 250°F (120°C) temperature;
 - .2 Where noted, provide Class 250 flange rated for 300 PSIG (2070 kPa) pressure and 250°F (120°C) temperature;
 - .3 Five (5) functions as follows:
 - .1 shut off valve
 - .2 Globe style flow control valve with memory indicator, pointer and scale
 - .3 Non-slam check valve
 - .4 Flow metering valve complete with metering ports;
 - .4 Straight pattern valve shall be capable of field conversion to a right angle pattern valve;
 - .5 Ductile iron body;
 - .6 Stainless Steel (302) spring;
 - .7 Bronze gland;
 - .8 Teflon Impregnated Aramid Fiber (asbestos free) stem packing;
 - .9 Bronze/Stainless Steel (416) stem;
 - .10 EPDM seat
 - .11 Stainless Steel (304) seat disc;
 - .12 EPDM Body O-Ring;
 - .13 Steel grooved adapter.
- .7 Provide pump assembly supply and return piping connections double sphere neoprene flex connector with control units equal to Vibro-Acoustics type NNDCU.

2.02 BASE MOUNTED FLEX COUPLED PUMPS

- .1 Pumps shall be FloFab, ITT Bell & Gossett, S.A. Armstrong, TACO, Wilo Pumps, or approved equivalent meeting all Specification requirements. Alternative pumps may be considered by the Consultant provided a cost savings to the Owner can be demonstrated.
- .2 The pumps shall be single stage end suction rear pull out design. The bearings and seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the Schedules.
- .3 Pump casing shall be constructed of ASTM A48 class 30 cast iron. The pump casing/volute shall be rated for 250 psi working pressure.
- .4 The pump flanges shall be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges.
- .5 The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover shall be drilled and tapped to accommodate a seal flush line connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.
- .6 All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided with that pump to allow servicing.
- .7 Pump volute shall be foot mounted; overhung cantilevered design will not be accepted.
- .8 The pump shall be center line discharge for both positive air venting and load distribution.
- .9 The pump casing inlet shall have an integrally cast anti-rotational vane.
- .10 The pump impeller shall be ASTM B584-836/875 bronze and hydraulically balanced.
- .11 The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key.
- .12 The pump shaft shall be a dry shaft design to prevent the circulating fluid from contacting the shaft and shall be constructed of ASTM A582 Type 416T or ASTM A582 Type 410T stainless steel with field replaceable bronze SAE 660 shaft sleeve.
- .13 The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250°F. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity.
- .14 Open system pumping applications (condenser water pumps and similar) and closed system pumping applications (chilled water, heating water and similar) shall be furnished with a seal flush line and a Cuno / Kynar / Purocell #900 replaceable cartridge filter or separator with shut-off isolation valve installed in the seal flushing line. The filter shall have the ability to remove particles down to five microns in size.
- .15 All pumps to be provided with a fully welded, rigid structural steel base. The base shall include closed ends and top openings to allow for grouting. The base shall include an integral drain pan fabricated from steel with a minimum thickness of 0.1875" and shall contain an integral ¾" drain connection.
- .16 The pump shall be flexibly coupled to a NEMA standard T frame motor in accordance with Section 20 05 70. The coupler shall be suitable for across the line starting as well as variable speed conditions associated with variable frequency drives. The coupling shall be equal to a Woods Dura-Flex coupler.
- .17 The coupling and shafts shall be covered by a metal guard.
- .18 Pump shall be aligned upon receipt at job, during installation, and after system fill by Mechanical Contractor.

2.03 VERTICAL IN-LINE PUMPS

- .1 Pumps shall be FloFab, ITT Bell & Gossett, S.A. Armstrong, TACO, Wilo Pumps, or approved equivalent closed coupled for pumps with motors 5 HP and smaller, or split coupled for pumps with

- motors larger than 5 HP, meeting all Specification requirements. Alternative pumps may be considered by the Consultant provided a cost savings to the Owner can be demonstrated.
- .2 The pumps shall be single stage end suction rear pull out design. The seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.
 - .3 Pump casing shall be constructed of ASTM A48 class 30 cast iron.
 - .4 The pump casing/volute shall be rated for 250 psi working pressure.
 - .5 The pump flanges shall be matched to suit the working pressure of the piping components, with either ANSI Class 125 flanges or ANSI class 250 flanges.
 - .6 The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line.
 - .7 The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.
 - .8 All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided with that pump to allow for servicing.
 - .9 The pump shall have a factory installed vent/flush line to ensure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge.
 - .10 The pump impeller shall be ASTM B584-836/875 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key.
 - .11 The pump shall be manufactured with ASTM A582 Type 416T or ASTM A582 Type 410T stainless steel shaft.
 - .12 The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250°F. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity.
 - .13 Model KS split coupled pumps shall be coupled via a high tensile aluminum split style coupling. The design shall permit easy replacement of the mechanical shaft seal without removal of the motor. The motor mount must be designed to accept several different motor frame standards; CZ and HP.

2.04 SEISMIC IN-LINE PUMP STANDS

- .1 For each vertical in-line pump assembly provide a Vibro-Acoustics, model SIPS-NP, or equal, seismic pump stand to ensure rigid support and restraint for vertical inline pump and motor assembly as follows:
 - .1 withstand at least 1 g of lateral seismic force for complete pump and motor assembly;
 - .2 complete with Neo+ isolation pads;
 - .3 tested per ANSI/ASHRAE 171;
 - .4 ANSI Class 125 and Class 250 bolt patterns to suit pump pressure rating;
- .2 Provide low-profile model where spring isolators are required.

2.05 IN-LINE CIRCULATORS

- .1 Pumps shall be FloFab, ITT Bell & Gossett, S.A. Armstrong, TACO, Wilo Pumps, or approved equivalent meeting all Specification requirements. Alternative pumps may be considered by the Consultant provided a cost savings to the Owner can be demonstrated.
- .2 The pumps shall be single stage horizontal in-line design. The seal shall be serviceable without disturbing the piping connections.
- .3 The capacities and characteristics shall be as called for in the Equipment Schedules.
- .4 Pump shall be constructed of ASTM A48 class 30 cast iron.

- .5 The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections.
- .6 All casings shall be flanged connections.
- .7 The impeller shall be ASTM C87500 or C89833 bronze and hydraulically balanced.
- .8 The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted with a holding taper and left handed 431 series stainless steel bolt.
- .9 The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft.
- .10 The pump shaft shall be AISI 1045 carbon steel with field replaceable copper nickel 90-10 shaft sleeve.
- .11 The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250°F.
- .12 The pump shall be coupled to a NEMA 56C face motor in accordance with Section 20 05 70 with threaded on shaft extension.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Comply with Manufacturer's requirements for the installation of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Locate equipment as shown on the drawings to provide connection arrangement and accessibility for servicing.
- .3 Provide clearances on all sides of equipment as required by the Manufacturer's Installation Instructions.
- .4 Install items of equipment with due regard to Architectural treatment, and ensure all items are level and finished in keeping with good workmanship.
- .5 Provide chemical treatment connections on heating and cooling circuits as directed by chemical treatment supplier.
- .6 Provide branch take-offs from mains of heating and cooling pipes with shut off valves.
- .7 Install and connect remote components such as thermostats, humidistats, control panels, level controllers, etc., that are supplied with the equipment. Install in locations as shown on the drawings.

3.02 HVAC PUMPS

- .1 Install HVAC pumps as shown on detail drawings.
- .2 Pump shall be aligned upon receipt at job, during installation, and after system fill by the Mechanical Contractor.
- .3 Mount all vertical in line pumps over 5 HP at floor level as shown on the detail drawings.
- .4 Provide all pumps with Suction Diffusers and Multipurpose Discharge Valves in accordance with the specifications. Where Suction Diffusers and Multipurpose Discharge Valves are unavailable due to size or space restrictions provide the following:
 - .1 Pump Suction: line size shut-off valve, line size inlet strainer;
 - .2 Pump Discharge: line size check valve, line size Flow Balancing Valve.
- .5 Provide 12mm (1/2") drain lines with ball valves from Cuno filters to nearest floor drain.

3.03 TESTING

- .1 Meet testing requirements of all Authorities Having Jurisdiction (AHJs). Obtain certification and certify tests not required by AHJs. Perform not less than the following tests.
- .2 Prove hydronic piping tight under a hydrostatic test of 150% of design working pressure but not less than 700kPa (100 psi). Test without pressure drop for a period of not less than 4 hours.

- .3 Perform tests before piping is covered or concealed.
- .4 Remove all components which will not withstand test pressure and replace after tests.
- .5 Eliminate leaks or remove and refit defective parts. Do not caulk threaded or welded joints.
- .6 After work is completed, adjust and put all parts of the system into proper working order. Adjust all valves to achieve specified heating capacities. Leave the complete job ready for regular operation, all to the satisfaction of the Consultant.
- .7 After the testing period, drain the system, and before water treatment is introduced into the system, clean out all dirt pockets and strainers.
- .8 Provide lubricating oils, packing, and other accessories, for proper operation of the system.
- .9 The final test and acceptance shall not be made until the work is finally completed.

3.04 EQUIPMENT START UP

- .1 Follow manufacturer's instructions and have manufacturer's representative present to certify the installation.
- .2 Check each item of equipment to ensure proper piping connections, electrical connections, pump rotation and similar, to verify proper operation.

3.05 WATER BALANCING

- .1 Refer to Section 20 05 95.
- .2 Provide flow measurement ports as shown on detail drawings and piping schematics in locations as directed by the Testing Adjusting and Balancing ("TAB") Trades. Provide additional balancing valves where recommended by the TAB Trades.

END OF SECTION

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PART 1 - GENERAL

1.01 RELATED WORK

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements and all Documents referenced therein.
- .3 Comply with requirements of Section 20 01 50 Mechanical Basic Materials and Methods.
- .4 In accordance with the Montreal Protocol on substances that deplete the Ozone layer, all new refrigerating, cooling and air conditioning equipment shall not contain any CFC nor HCFC based refrigerants nor mixtures of such refrigerants.

1.02 REFERENCE STANDARDS

- .1 Perform refrigeration system work in accordance with the Authorities Having Jurisdiction ("AHJs"), the latest version of Technical Standards & Safety Authority (TSSA) ("Refrigeration Code"), CSA B52 and ANSI B31.5.

1.03 PERMITS AND QUALIFICATIONS

- .1 Ensure permit is obtained before anyone commences to install or alter refrigeration system.
- .2 Persons installing or making alternations or repairs to refrigeration system shall be holder of valid Refrigeration Contractors license and persons repairing equipment with ODS/CFC's shall have completed Environment Canada approved training program.

1.04 WARRANTY

- .1 Warrant piping system loss of refrigerant for 5 years.

1.05 SHOP DRAWINGS

- .1 Provide Shop Drawings in accordance with Section 20 01 10.
- .2 Refrigeration trade shall prepare electrical control schematic for each type of system (product refrigeration only) and submit shop Drawings for review.

1.06 ELECTRICAL WIRING

- .1 Refrigeration trade shall carry out and be responsible for refrigeration control wiring unless otherwise noted, including line voltage wiring from disconnect switch to units.
- .2 Refrigeration trade shall provide electric heat trace cable on drain lines in cold rooms with temperatures below 35°F (1.7°C).
- .3 Power wiring to units shall be by Electrical Trades.

PART 2 - PRODUCTS

2.01 REFRIGERANT TUBING

- .1 Provide processed tubing for refrigeration installation, deoxidized, dehydrated and sealed.
- .2 Hard copper tube, Type "L", to ASTM B88M.
- .3 Annealed copper tube to ASTM B280, with minimum wall thickness as per CSA B52.

2.02 FITTINGS

- .1 Service: Design pressure 300 psi (2,070 kPa) and temperature 250°F (120°C).
- .2 Brazed: Wrought copper to ANSI B16.22 or cast bronze to MIL-F-1183E.
- .3 Flanged: Bronze or brass, Class 150 Class 300 to ANSI B16.24.
- .4 Flare: Bronze or brass, for refrigeration, to ANSI B16.26.
- .5 Long radius type for elbows and return bends.

2.03 JOINTS

- .1 Brazing materials shall be SIL-FOS-15 phosphor-copper-silver alloy for copper piping jointed by copper fittings and silver solder for brass fittings.
- .2 Flexible Connections: 9.5mm or less shall be made using coiled soft copper tubing. For larger sizes, use seamless flexible bronze hose with bronze wire braid covering. Use factory sealed neoprene jacket unit where freezing may occur.

2.04 VALVES

- .1 Shut-Off Valves:
 - .1 Line size, selected for low pressure drop.
 - .2 Acceptable Products:
 - .1 Sizes 1/4" (6 mm) to 5/8" (16 mm) Diameter: Henry Standard, Mueller Linemaster Special.
 - .2 Sizes 7/8" (22 mm) Diameter and Larger: Henry Wing Cap (back seating, Mueller Globemaster).
 - .3 All sizes may be Henry or Mueller ball valves.
 - .3 To be provided at each point of connection to all refrigeration equipment.
- .2 Solenoid Valves:
 - .1 With field replaceable coil, serviceable without removing valve from line.
 - .2 Coil voltage to suit field requirements.
 - .3 Provide upstream of thermostatic expansion valves.
 - .4 Acceptable Products: Alco 240 RA series.
- .3 Expansion Valves:
 - .1 Thermostatic type with external equalizer, adjustable superheat setting, capacity and bulb charge to suit operating conditions.
- .4 Water Regulating Valves:
 - .1 Pressure activated 2-way straight-through type.
 - .2 For 3-way regulators, install balancing valve in by-pass, adjusted to maintain constant system flow rate irrespective of valve position.
- .5 Charging and Purging Valves:
 - .1 Valves to be same size as line size into which they are connected or 1/2" (12 mm) whichever is larger.
 - .2 Valve complete with removable seal cap chained to valve body.
 - .3 Acceptable Products: Henry Standard type, Mueller Linemaster Special.

2.05 SIGHT GLASS

- .1 Provide sight glass in liquid line following filter drier.
- .2 Sight glass shall be combination moisture-liquid indicator and with protective removable cap.
- .3 Sight glass to be fitted in-line.
- .4 Acceptable Products: Henry Dri-Vue, Mueller Vuemaster, Sporlan See All.

2.06 ACCESS FITTINGS

- .1 Provide Schrader access fittings in each suction connection from evaporator, located adjacent to superheat sensing element of expansion valve.
- .2 Fittings to be used for checking superheat of suction gas.
- .3 Access fitting shall be soldered into tee and shall be complete with quick-seal cap.

2.07 FILTER DRIERS

- .1 Provide filter drier in liquid line from condenser. Shut-off valves shall be installed on each side of drier and sight glass.
- .2 Filter drier shall be selected to have pressure drop no more than 0 psi (0 kPa) when passing 150% of system flow rate.
- .3 Removable core with flare connections.
- .4 Desiccant drier material shall be replaceable.
- .5 Acceptable Products: Alco Extra-Klean, Catch-All, Henry Dri-Cor, Mueller Drymaster II, Sporlan.

2.08 REFRIGERANT DRIERS

- .1 Driers shall be in-line or angle type with copper or brass shell.
- .2 Desiccant drier material shall be replaceable.

2.09 STRAINERS

- .1 Refrigerant strainers shall be angle replaceable cartridge type with brass shell.
- .2 Cartridge material and screen size shall be suitable for refrigerant and piping material utilized in system.

2.10 PRESSURE GAUGES – REFRIGERATION

- .1 Acceptable Manufacturers:
 - .1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.
- .2 Minimum Requirements:
 - .1 Panel surface mounting type, flanged type.
 - .2 Flush panel mounting type, flush mount case style.
 - .3 Seamless phosphor bronze Bourdon tube type, with minimum 2-1/2" (65 mm) diameter dial, unless otherwise indicated.
 - .4 Cast aluminum, black steel or stainless steel case, with stainless steel or chrome-plated face ring.
 - .5 Accuracy $\pm 2\%$ of scale range.
 - .6 Scales to be calibrated in both pressure and corresponding temperature of refrigerant.
 - .7 Scale Range:

<u>Operating Pressure</u>	<u>Scale Range</u>
15" Hg (50 kPa) – 100 psi (690 kPa)	29.5" Hg (100 kPa) – 150 psi (1,034 kPa)
100 psi (690 kPa) – 400 psi (2,760 kPa)	0 – 500 psi (3,450 kPa)

- .8 Gauges complete with recalibrator and restrictor.
- .9 Install a needle valve (carp) ahead of each gauge.

2.11 EVAPORATOR DRAINS

- .1 Each evaporator shall be fitted with copper drain line, size as indicated.
- .2 Drain line shall be complete with running trap.

2.12 FLEXIBLE CONNECTIONS

- .1 Braided tin-bronze corrugated flexible connections.
- .2 Design pressure 300 psi (2,070 kPa).

- .3 Acceptable Products: Anaconda.

2.13 REFRIGERANT TUBE SUPPORTS

- .1 Middle Attachments (Rod):
- .1 Carbon steel black (electro-galvanized for mechanical rooms) continuous threaded rod – Grinnell Fig. 146 Myatt Fig. 434.
- .2 Pipe Hangers:
- .1 Uninsulated pipe, up to 1-1/4" (32 mm) – Grinnell 97C.
- .2 Insulated pipe, up to 25mm – Grinnell fig. 269 or Myatt Fig. 120.
- .3 Insulated pipe, 32mm – Grinnell Figs. 65 or 260 or Myatt Figs. 122 or 124.
- .4 Maximum horizontal pipe hanger spacing:

Pipe Size	Maximum Spacing	Rod Diameter
Up to 20mm	5'-0" (1.5 m)	3/8" (9.5 mm)
25mm and 32mm	6'-0" (1.8 m)	3/8" (9.5 mm)

- .5 On insulated piping, where insulation is specified to have continuous sealed vapour barrier, (cold services) install oversized clevis hangers and insulation protection shields (Grinnell Fig. 167 or equivalent) with metal thickness and lengths as recommended by Grinnell.
- .6 Hangers for copper pipe shall be copper plated or plastic dipped unless pipe hangers bear on piping insulation (cold services).
- .7 Cold Services – refrigerant suction lines.
- .3 Wall Supports:
- .1 Horizontal Pipe Adjacent to Wall: Angle iron wall brackets with specified hangers.
- .2 Vertical Pipe Adjacent to Wall: Exposed pipe wall support for lateral movement restraint – Grinnell Figs. 262 or 263.

PART 3 - EXECUTION

3.01 GENERAL

- .1 Install and test in accordance with Technical Standards & Safety Authority (TSSA) and CSA B52.

3.02 INSTALLATION

- .1 Refrigerant Tubing:
- .1 Fittings shall be "Sil-Fos" brazed or silver soldered as specified. Solder will not be permitted. Special precautions shall be taken to prevent overheating of copper tube. No joint shall be made without pressurized nitrogen flow through joint.
- .2 Tubing shall be cut square and have burrs removed.
- .3 Piping shall be kept meticulously clean. Cleaned piping in process of erection, whether installed or awaiting installation shall be capped or plugged.
- .4 Piping shall be installed in vertical and horizontal close to walls and ceilings, with specified pitch. Provide offsets to account for expansion.
- .5 Piping connections to equipment and terminal apparatus shall be supported independently and arranged to give easy access for maintenance.
- .6 Provide rubber grommets where refrigerant piping passes through metal surface.

- .7 Grade horizontal pipe carrying gases 1:240 down in direction of flow.
- .8 Locate double risers in hot gas or suction piping as indicated.
- .9 Locate trap every 15'-0" (4.5 m) of vertical rise in any suction riser 30'-0" (9 m) or more in length.
- .10 Install piping to prevent condensate or oil from flowing back into compressor or evaporator.
- .11 Provide isolation valves at the terminal equipment: VRF fan coils, refrigerant coils, or Branch controllers (VRF Systems).
- .2 Strainers:
 - .1 Provide full size strainer ahead of each automatic valve. Where multiple expansion valves with integral strainers are used, install single main liquid line strainer.
 - .2 On steel piping systems provide adequate strainer in suction line to remove scale and rust inherent to steel pipe.
 - .3 Provide shut-off valve on each side of strainer to facilitate maintenance.
- .3 Refrigerant Driers:
 - .1 Provide full flow permanent refrigerant drier in low temperature systems and systems utilizing hermetic compressors.
 - .2 Mount drier vertically in liquid line adjacent to receiver with three valve bypass assembly to permit isolation of drier for servicing.
- .4 Filter Driers:
 - .1 Filter driers may be used in systems instead of separate strainers and driers.
 - .2 Install with three valve bypass assembly to permit isolation for servicing.
- .5 Solenoid Valves:
 - .1 Provide solenoid valves in liquid line of system operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.
 - .2 Provide solenoid valves with manually operated stems.
- .6 Expansion Valves:
 - .1 Size expansion valves to avoid penalty of being undersized at full load and of being excessively oversized at partial load.
 - .2 Evaluate refrigerant pressure drop through system to determine available pressure drop across valve.
 - .3 Select valves for maximum load at design operating pressure and minimum 126°F (52.2°C) of superheat.
 - .4 Locate remote expansion valve sensing bulb immediately after evaporator outlet and suction line.
- .7 Charging Valves:
 - .1 Provide refrigerant charging connections in liquid line between receiver shut-off valve and expansion valves.
- .8 Flexible Connectors:
 - .1 Install suction and hot piping connections to compressors with three directional changes for minimum of six pipe diameters before reaching point of support.
 - .2 Flexible connectors shall only be utilized at or near compressor where it is not physically possible to absorb vibration within piping configuration.

3.03 ELECTRICAL

- .1 In cold storage rooms, use one conduit to bring wiring into compartment, just below ceiling insulation. Seal inside of conduit at point where it penetrates wall.

3.04 REFRIGERANT TESTS

- .1 Each refrigerant system shall be tested as follows before operation with dry nitrogen gas to pressure not less than 1.5 times system working pressure. During test, each joint shall be tested for leaks with solution of soap and water. Compressors with refrigerant holding charge shall remain isolated from system
- .2 System shall then be evacuated to not less than 250 microns (33.25 Pa) absolute and left for 24 hours, during which pressure shall not have increased more than 250 microns (33.25 Pa). System shall then be pressurized to 0 psi (0 kPa) with refrigerant to be used and shall be evacuated to 500 microns (66.5 Pa) absolute and then immediately fully charged with refrigerant to be used in system and each joint checked with electronic testing device. Tests shall be performed before insulation is applied. Refrigerant charge shall be applied immediately after acceptance of tests. If any tube or other component failure results in the loss of part of refrigerant charge, another charge shall be applied.
- .3 Damaged or defective components shall be replaced with new (not reconditioned) components. Cracked or defective tube shall be replaced. If defect occurs in insulate tube, insulation shall be stripped to locate leak. Amount of insulation stripped shall be replaced with new to be finished as specified.

3.05 START-UP AND ADJUSTMENT

- .1 Provide necessary instruments, gauges and testing equipment required. Adjust controls, to obtain design requirements and Manufacturer's ratings.
- .2 Test and record cooling apparatus entering and leaving air temperatures, dry bulb and wet bulb.
- .3 Test and record voltage and running amperes and compare to motor nameplate data, and starter heater rating against design requirements.
- .4 Ensure that refrigerant temperatures are accurate to within 1°F (-17.2°C) of design requirements.
- .5 In cooperation with Controls Contractor's Representative, set and adjust automatic control system to achieve required sequence of operations.
- .6 Bring equipment into operation, trial run and make up loss of oil and refrigerant.
- .7 Test reports to be submitted for review and inclusion in Maintenance Manuals.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 SCOPE OF WORK

- .1 Provide for cleaning and degreasing of systems that use glycol or water as heat transfer medium.
- .2 Provide for cleaning and disinfection of domestic hot and cold systems.
- .3 Provide temporary strainers, connections and by-pass lines as required.
- .4 Provide equipment to add chemicals to systems as specified herein.
- .5 Provide equipment to operate and control system as specified herein. Provide appropriate protection so capped off unused piping does not corrode.
- .6 Provide corrosion coupons for closed and open loop circulation systems as specified herein, to include testing and analysis at least twice in the first year during the warranty period.
- .7 Piping systems to be chemically treated include the following systems:
 - .1 Chilled water system(s).
 - .2 Hot water heating system(s).
 - .3 Heat pump water system(s).
 - .4 Glycol system(s).
- .8 Provide complete start-up and commissioning, including the amounts of chemicals and filter media change-outs sufficient to calibrate the system and provide supplies for the first year of warranty.

1.03 QUALITY ASSURANCE

- .1 Water treatment chemicals and treatment process shall be supplied and performed by the Mechanical Trades. Work shall be supervised by Water Treatment Specialist who, upon completion, shall certify process is satisfactory and submit report outlining cleaning operation and treatment process. Mechanical Trades shall provide name and supplier of chemical treatment specialist as part of post-tender submittals and progress claim breakdown.

1.04 REFERENCE STANDARDS

- .1 Provide HVAC water treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of Authorities having Jurisdiction (AHJs), except where specified otherwise.

1.05 SUBMITTALS

- .1 Submit shop drawings including proposed chemicals, quantities, procedures and equipment to be supplied. Provide written operating instructions and system schematics including Material Safety Data Sheet (MSDS) data, and safe disposal instructions. Provide samples of testing record sheets with recommended water treatment testing schedule for the proposed treatment.
- .2 Provide written report containing log and procedure of system cleaning, giving times, dates, problems encountered and condition of water.
- .3 Submit written report containing test results and list of chemicals added every fourteen (14) days from time of commissioning to acceptance.
- .4 Notify Consultant forty-eight (48) hours prior to chemical cleaning so work may be verified and reviewed.

1.06 WATER TREATMENT SERVICE

- .1 Water Treatment Specialist shall provide supervision of installations, set-up and adjustments and shall submit written report on system operations.
- .2 Chemicals, feed systems and test equipment shall be provided by Water Treatment Specialist.
- .3 Treatment chemicals shall not contain hydrazine.
- .4 Treatment chemicals shall be non-foaming.
- .5 Water Treatment Specialist shall instruct maintenance personnel before substantial completion. Written instructions of treatment, dosages, control charts and test procedures shall be included in maintenance manuals.
- .6 Water Treatment Specialist shall provide monthly visits to check chemical treatment, take water samples and recommend any changes to treatment, and provide written report for period of one year after Substantial Performance. Provide sufficient chemicals to treat system from time of commissioning to acceptance of building. Provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months normal operation or minimum 5,000 hours of operation for system volume.
- .7 Provide test kit suitable for chemical treatments used. Test kit shall be made available for on-site tests. Hand kit over to Building Operator at project completion; obtain receipt.

PART 2 - PRODUCTS

2.01 CHEMICALS

- .1 Closed system pre-operational cleaner for systems **without** aluminum metallurgy:
 - .1 Concentrated blend of cleaners and surfactants to remove oil, grease, dirt and other construction debris from closed system piping to be used in cleaning and flushing as per procedure from Water Treatment Specialist (Equal to Chem-Aqua 61502).
- .2 Closed system chemical treatment (Hot Water, Chilled Water) for systems **without** aluminum metallurgy:
 - .1 Use Borated molybdate or nitrite or all organic based corrosion inhibitor. (Equal to Chem-Aqua 52885 or Chem-Aqua 51999 or Chem-Aqua 54205).
- .3 Glycol System:
 - .1 Charge hot water and/or heat recovery system(s) and chilled water system(s) with a 40% solution (by volume) in water of inhibited propylene glycol and suitable for system with aluminum if required.

2.02 EQUIPMENT

- .1 Closed Systems (hot water heating, chilled water, heat pump and closed circuit condenser water):
 - .1 Bypass Pot Feeder: Closed water systems shall have by-pass chemical pot feeder with 2 gal (7.6 L) capacity, constructed of heavy-duty cast-iron or welded steel (suitable for 300 psi working pressure), with quick opening cap and complete with NPS ¾ connections. Install isolating valves on inlet, outlet and drain.
 - .2 Automatic Chemical Injection system (optional): Board mounted NanoTron microprocessor controller, contact water meter and chemical dose pump to inject chemical into closed system piping automatically when required.
 - .3 Side Stream Filters: Closed systems shall have side stream filters. 304 stainless steel housing to accept 20 micron filter cartridges- single or multiple cartridges. Filter must be selected for handling minimum flow rate of 3% of system recirculation flow rate. Include 10 filter replacement cartridges for each side stream filter unit.
 - .4 Sight Flow Indicator: provide and install suitably sized sight flow indicator after the side-stream filter matching the pipe size.
 - .5 Provide contact water meter of size matching dia. of pipe of incoming make-up water complete with electronic output for analogue flow monitoring by building automation system.

- .6 Two (2) station Corrosion Coupon and Holder Assembly with Dole Valve:
 - .1 Mild steel and/or Copper and/or Aluminum corrosion coupons.
 - .2 Holder, NPS ¾" (20mm) or NPS 1" (25mm) connection.
 - .3 Provide malleable or cast-iron cross, NPS ¾" (20mm) or NPS 1" (25mm) connection.
- .2 Cooling Towers (Open systems):
 - .1 Board mounted- Packaged conductivity controller with 240 x 128 Graphic LED display, 0-10,000 microS, selectable feeders (pulse, %, post blow down, limit and 28 day), on-off switch, NEMA 4X enclosure. Mounted on a 24" x 18" x 3/8" (600 mm x 450 mm x 10 mm) thick wall, rigid PVC panel, mounting holes at each corner; conductivity probe; and flow switch mounting tee; with three (3) magnetic impulse solenoid pumps with a rated capacity to pump the required amount of chemical against system pressure, complete with manual stroke length adjustment, stroke frequency adjustment, manual stroke frequency override, suction tubing with foot valve, and discharge tubing with injection fitting.
 - .2 For using solid chemical products use HandiFeed Ultra-S Dissolving Feeders- 3 units; Provide one mixing unit per solid chemical product used
 - .3 Make-up Water Meter: Cumulative totalizer register, electrical contacting head water meter, sized to suit cooling tower make-up line size, adjustable output, pre-set to make contact at gallons selected by Water Treatment Specialist.
 - .4 Solenoid Bleed Valve: ¾" size 115/1/60, brass body, , normally closed operation, zero operating pressure differential, threaded connections, size by Water Treatment Specialist, to meet minimum requirements of NEMA-4, DIN43650A cable plug.
 - .5 Two (2) station Corrosion Coupon and Holder Assembly with Dole Valve:
 - .1 Mild steel and/or Copper and/or Aluminum corrosion coupons.
 - .2 Holder, NPS ¾" (20mm) or NPS 1" (25mm) connection.
 - .3 Provide malleable or cast-iron cross, NPS ¾" (20mm) or NPS 1" (25mm) connection.
 - .6 Filter: Filtration system shall be sized for 5% side stream flow and cooling tower sump to be fitted with Sweeper Jet System if required.
- .3 Steam System:
 - .1 Automatic Blow down and chemical feed Controller Package: Packaged conductivity controller with 240 x 128 Graphic LED display, 0-10,000 µS, selectable feeders (pulse, %, post blow down, limit and 28 day), on-off switch, NEMA 4X enclosure. Mounted on a 24" x 18" x 3/8" (600 mm x 450 mm x 10 mm) thick wall, rigid PVC panel, mounting holes at each corner; standard boiler electrodes with MNPT stainless steel bushing and FNPT cross designed for mounting in the surface blow-down line; with one (1) or more based on chemical products being used, magnetic impulse solenoid pumps with a rated capacity to pump the required amount of chemical against system pressure, complete with manual stroke length adjustment, stroke frequency adjustment, manual stroke frequency override, and discharge tubing with SS injection system.
 - .2 Blow down valve AVP 60-30-F: Steam Rated valve; 110 volts, single phase, 60 Hz
 - .3 For using Solid chemical products use HandiFeed Ultra-S Dissolving Feeders- Provide one mixing unit per solid chemical product used
 - .4 Sample cooler for drawing water samples
- .4 Glycol System:
 - .1 Bypass Pot Feeder: Closed glycol systems shall have by-pass chemical pot feeder with 2 gal (7.6 L) capacity, constructed of heavy-duty cast-iron or welded steel (suitable for 200

- psi (1,380 kPa) working pressure), with quick opening cap and complete with NPS ¾ connections. Install isolating valves on inlet, outlet and drain.
- .2 Side Stream Filters: Closed systems shall have side stream filters. 304 stainless steel housing to accept 20 micron filter cartridges- single or multiple cartridges. Filter must be selected for handling minimum flow rate of 3% of system recirculation flow rate. Include 10 filter replacement cartridges for each side stream filter unit.
 - .3 Sight Flow Indicator: provide and install suitably sized sight flow indicator after the side-stream filter matching the pipe size.
 - .4 Two (2 station Corrosion Coupon and Holder Assembly with Dole Valve:
 - .1 Mild steel and/or Copper and/or Aluminum corrosion coupons.
 - .2 Holder, NPS ¾" (20mm) or NPS 1" (25mm) connection.
 - .3 Provide malleable or cast-iron cross, NPS ¾" (20mm) or NPS 1" (25mm) connection.
 - .5 Automatic feed system with manual override (CA-GF-1A1A1M or acceptable equal), comprising the following:
 - .1 Pump: 1.5 US gpm (7.5 L/min) at 100 psi (690 kPa), Motor, 1725 rpm, 1/3 HP, 115/1/60 VAC.
 - .2 Tank: 55 US gal polyethylene tank with hinged poly cover on a steel stand
 - .3 Pressure Switch: Glycol addition shall be controlled by adjustable pressure switch with high and low set-points. When pressure in loop reaches low set-point, pump shall start and feed glycol until high set-point pressure is achieved and pump stops.
 - .4 Control Panel: NEMA 4X enclosure, 115/1/60 VAC and shall consist of the following:
 - .1 Power supply cord with molded plug.
 - .2 H-O-A switch for pump motor.
 - .3 Pump "ON" indication.
 - .4 "LOW" tank level indication with audible alarm.
 - .5 Push button to silence.
 - .6 Contacts for remote connection.
 - .5 Accessories:
 - .1 Float switch for low level cut off of pump.
 - .2 Pressure switch.
 - .3 Relief valve piped back to tank.
 - .6 Provide pressure gauge located in discharge piping.
 - .7 Provide chart showing specific gravity of specified solution by volume, at specified temperature.

PART 3 - EXECUTION

3.01 GENERAL EXECUTION REQUIREMENTS

- .1 Comply with the Water Treatment Specialist requirements for the provision of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of Chemical Treatment supplied by the Water Treatment Specialist. Include all additional labour necessary as part of the project commissioning requirements.
- .3 Mechanical Trades shall be responsible for initial flush and final fill of all glycol solution systems.

3.02 PRE-OPERATIONAL CLEANING & PASSIVATION PROCEDURE

- .1 Follow the procedure as recommended by the Water Treatment Specialist.

3.03 WATER TREATMENT PROGRAM START-UP

- .1 Contact the Water Treatment Specialist to begin water treatment program immediately after flushing confirmation.

END OF SECTION

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PART 3 - EXECUTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provision of air distribution equipment and related ancillaries.
- .2 Louvers are to be supplied and installed by Trades other than Mechanical Division Trades.

1.03 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the construction and installation of air distribution equipment and related ancillaries.
- .2 Submittals: Submit shop drawings for the following Products:

1.04 REFERENCE STANDARDS

- .1 SMACNA HVAC Duct Construction Standards Metal and Flexible - Second Edition
- .2 NFPA 96 Ventilation Control and Fire Protection of Commercial Cooking Operations
- .3 NFPA 90A Installation of Air Conditioning and Ventilating Systems
- .4 NFPA 90B Installation of Warm Air Conditioning and Air Conditioning Systems
- .5 ASTM A621 & A621M - 1998 Specification for Forming Steel (FS), sheet and Strip, Carbon, Hot Rolled.
- .6 ASTM A653M Specification for Steel Sheet, Zinc Coated Galvanized or Zinc Alloy Coated (Galvannealed) by the Hot Dip Process
- .7 ASTM A924M General Requirements for Sheet Steel, Metallic Coated by the Hot Dip Process
- .8 Duct dimensions shown on Drawings are net, inside insulation and acoustic duct lining.

1.05 VOLATILE ORGANIC COMPOUND ("VOC") REQUIREMENTS

- .1 All adhesives, sealants, paints and coatings used on or inside of building weatherproofing layer shall have a VOC content that is less than the content limits defined in LEED® Product Requirements.

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 LOW PRESSURE DUCTWORK UP TO 4 in.wg. (1000 Pa)

- .1 Applies to ductwork serving systems with external static pressures up to 4 in.wg. (1000 Pa).
- .2 Low Pressure Ductwork Classification:
 - .1 Ductwork material shall be constructed in accordance with SMACNA ratings for the following pressure classifications. Pressure classifications shall be in accordance with the Low Pressure Classifications Table as follows:

TABLE – Low Pressure Classification			
Ductwork	Operating Pressure	Seal Classification	Remarks
Ductwork Exposed to the Outdoors	All	A	
Air Ductwork	3 to 4 in.wg. (750 - 1000 Pa)	A	
Supply Air Ductwork Upstream of VAV Boxes	Up to 3 in.wg. (750 Pa)	B	
Supply Air Ductwork Downstream of VAV Boxes	Up to 1 in.wg. (250 Pa)	C	
Exhaust and Return Air Ductwork	Up to +/- 1 in.wg. (+/- 250 Pa)	C	
Exhaust and Outside Air Intake Plenums	Up to +/- 1 in.wg. (+/- 250 Pa)	B	
All Other Ductwork Not Listed Above	Up to 0.5 in.wg. (125 Pa)	D	

.3 Sealing Classification:

- .1 Sealing classifications shall be in accordance with the Sealing Classifications Table as follows:

TABLE – Low Pressure Sealing Classification			
Seal Class	Sealing Requirements	Applicable Static Pressure Construction Class	Allowable Leakage Rate
A	All traverse joints, longitudinal seams and duct wall penetrations.	4 in.wg. (1000 Pa) -4 in.wg. (-1000 Pa)	3% of total system design at system operating pressure 4 in.wg. (1000 Pa)
B	All transverse joints and longitudinal seams	Up to 3 in.wg. (750 Pa) -3 in.wg. (-750 Pa) and less	3% of total system design at 3 in.wg. (750 Pa)
C	All transverse joints only	Up to 2 in.wg. (500 Pa) -2 in.wg. (500 Pa) and less	1.5% of total system design at 2 in.wg. (500 Pa)
D	Not sealed	Up to 1" w.g. (250 Pa) -1 in.wg. (-250 Pa) and less	5% of total system design at 1 in.wg. (250 Pa)

.4 Low Pressure Fittings:

- .1 Fabrication shall be to SMACNA Standards.
- .2 Radiused elbows shall be to standard radius.
- .3 Square elbows shall be used over 16" (400 mm) with double thickness vanes. Square elbows shall not be used unless specifically shown on drawings.
- .4 Main Supply Duct Branches: Provide branch duct balancing damper where deemed to be required by TAB Trades for balancing.
- .5 Transitions:
 - .1 Diverging: 1:7 maximum included angle.
 - .2 Converging: 1:4 maximum included angle.
- .6 Offsets: Radiused elbows as indicated.
- .7 Obstruction Deflectors: Maintain full cross-sectional area. Maximum included angles as for transitions.

.5 Galvanized Steel:

- .1 G-60 coated galvanized of lock-forming grade conforming to ASTM A653 and A924 Standards.
- .2 Minimum yield strength for steel sheet and reinforcements shall be 30,000 psi (207 kPa).
- .3 The sheet metal gauge and requirement for reinforcement shall be in accordance with Tables 1-3-1/2 in.wg. static pressure to Table 1-7 4 in.wg. static pressure of SMACNA.
- .4 Fabrication shall be to SMACNA Standards.
- .5 Joints: To SMACNA.
- .6 Joint reinforcement shall be in accordance with Tables 1-10 to 1-13 of the SMACNA Standard.

.6 Hangers and Supports:

- .1 Strap hangers shall be of same material as the duct material but shall be to the next sheet metal thickness heavier than the duct.
- .2 Hanger configuration shall be to SMACNA. Maximum size duct supported by strap hanger shall be 19" (500 mm).
- .3 Hangers: Galvanized steel angle with galvanized steel rods shall be in accordance with SMACNA.
- .4 Upper Hanger Attachments:
 - .1 Concrete: after concrete pour:
 - .1 expanded concrete anchors shall be made of steel;
 - .2 powder actuated fasteners shall not be utilized;
 - .3 holes for expanding fasteners shall be drilled either by a carbide bit or by the teeth on the fastener itself. Expansion shield shall be "set" by driving it into the hole and expanding it with a conical plug.
 - .2 Steel Joist: manufactured joist clamp or steel plate washer:
 - .1 clamp or washer shall be mounted to top chord of steel truss only.
 - .2 Acceptable Manufacturer: Joist Clamps: Grinnell: Fig. 61 or 86, Hunt or approved equal.
 - .3 Steel Beams: Manufactured beam clamps:
 - .1 Acceptable Manufacturer (as listed or equal): Grinnell: Fig. 60, Hunt or equal.
- .5 Round Ductwork: duct shall be supported as follows:
 - .1 duct dimensions 24" (600 mm) single hangers are acceptable;
 - .2 duct dimensions over 24" (600 mm) hanger rods shall be provided on both sides of the duct;
 - .3 minimum hanger sizes shall be in accordance with Table 4-2 of SMACNA.
 - .4 Where reviewed and accepted by seismic engineer, proprietary gripple hanger systems can be used.
- .6 Loading on trapeze bars shall be in accordance with Table 4-3 of SMACNA.
- .7 Duct hangers in MRI's shall be non-ferrous.
- .7 Round Ductwork:
 - .1 All round ductwork shall be of Spiro lockseam construction with rigidity equivalent to SMACNA Standard - Gauge Spiral Duct.
 - .2 Fittings:
 - .1 Elbows shall be standard gore construction.
 - .3 All couplings shall be slipped joint construction with minimum 2" (50 mm) insertion length. Duct sealer shall be applied on male end connectors before insertion and afterwards to cover the entire joint and sheet metal screws. Sheet metal screws shall be installed at a maximum 12" (300 mm) spacing, with a minimum of three (3) screws per joint. In large diameters, flanging gasketed joints are acceptable, in lieu of slip joints.
 - .4 All couplings shall be slipped joint construction with minimum 2" (50 mm) insertion length. Duct sealer shall be applied on male end connectors before insertion and afterwards to cover the entire joint and sheet metal screws. Sheet metal screws shall be installed at a maximum 12" (300 mm) spacing, with a minimum of three (3) screws per joint. In large diameters, flanging gasketed joints are acceptable, in lieu of slip joints.
- .8 Aluminum Duct for Static Pressures 3 in.wg and Less

- .1 To SMACNA: Aluminum type 3003-H-14.
- .2 Thickness: to SMACNA Section 1.12.
- .3 Fabrication: to SMACNA or as indicated.
- .4 Joints: to SMACNA.
- .5 Provide cadmium plated hangers and nuts for support of pool and change room ductwork.
- .6 Provide for the following systems:
 - .1 locker room exhaust
 - .2 as shown on drawings
- .9 Stainless Steel
 - .1 To ASTM A480m-09, Type 304.
 - .2 Thickness: SMACNA Standards.
 - .3 Duct: rectangular ductwork shall be welded pipe to SMACNA Standards for the pressure classification required. Round ductwork shall be of Spiro lockseam construction with an intermediate standard rib to provide rigidity equivalent to SMACNA Standard – Gauge Spiral Duct.
 - .4 Fittings: continuous weld.
 - .5 Joints: Vanstone gasketed flanges with bolts connections or welded joints.
 - .6 Fabrication: The ductwork shall be factory fabricated to SMACNA standards.
 - .7 All stainless steel shall be passivated prior to delivery to site.
 - .8 Provide for the following systems:
 - .1 as shown on drawings
 - .9 Provide stainless steel 20 mm ($\frac{3}{4}$ ") threaded pipe nipples and caps welded into the ductwork at all low points and at the base of each riser.

2.02 MEDIUM & HIGH PRESSURE DUCTWORK BETWEEN 4 in.wg. (1000 Pa) UP TO 10 in.wg. (2500 Pa)

- .1 Applies to ductwork serving systems with external static pressures between 4 in.wg. (1000 Pa) up to 10 in.wg. (2500 Pa) positive or negative.
- .2 Medium and High Pressure Ductwork:
 - .1 Thickness: To SMACNA; continuously welded. Vanstone joints are acceptable.
 - .2 Construction:
 - .1 All ductwork shall be of high pressure construction. Joints shall be sealed airtight.
 - .2 Circular and Oval: Factory fabricated spiral wound with matching fittings and specials to SMACNA.
 - .3 Provide stiffeners and reinforcements as required by the duct design.
 - .4 All flanges and stiffeners shall be compatible with material to match that of the attached ductwork.
 - .5 Minimum galvanized steel ductwork gauge and support locations shall be in accordance with SMACNA.
 - .6 Minimum stainless steel ductwork gauge and support locations shall be in accordance with SMACNA.
 - .3 Elbows:
 - .1 Centre line radius of 1.5 x diameter non-vaned to SMACNA and ASTM.
 - .4 Flanges:

- .1 All flanges to be of same material as duct sections they are connecting.
- .5 Instrument test ports shall be provided and will match ductwork materials in which they are installed.
- .3 Sealing Classification:
- .4 Sealing classifications shall be in accordance with the Sealing Classifications Table as follows:

TABLE – Medium and High Pressure Ductwork Sealing Classification					
Service	Operating Pressure	Particulate Density	Joining Method	Operating Temperature	Duct Class
Supply ductwork between air handling unit and terminal VAV boxes	up to 6 in.wg. (1500 Pa)	n/a		up to 85°F (up to 29.5°C)	2

- .5 Elbows:
 - .1 Elbows: radius with centreline radius of 1.5 x diameter non-vanned. Elbows to conform to requirements outlined in SMACNA.
- .6 Joints:
 - .1 The joining method shall be in accordance with requirements outlined in the Pressure Classification Table noted above.
 - .2 Joints - Flanged Systems:
 - .1 Transverse Joints: Vanstone or TDC/ TDF flange connections with associated gasket.
 - .2 Joints shall be provided with flange, non-extruding gasket and 8 mm (5/16") diameter bolts at a maximum spacing of 8" (200mm) intervals.
 - .3 Joints - Welded Systems:
 - .1 Provide penetration welds at all joints and seams. All welds shall conform to the following Standards:
 - .1 SMACNA - Managers' Guide to Welding;
 - .2 AWS D9.1.
 - .4 Regulating (Balancing) Dampers:
 - .1 Provide regulating dampers in locations as shown on the plans.
 - .2 Dampers shall be constructed in accordance with SMACNA (RIDCS).
 - .5 Hangers and Supports:
 - .1 Steel Joist: Manufactured joist clamp or steel plate washer.
 - .2 Steel Beams: Manufactured beam clamps.
- .7 Galvanized Steel
 - .1 G-60 coated galvanized conforming to ASTM A653 and A924 Standards. Minimum yield strength for steel sheet and reinforcements shall be 30,000 psi (207 kPa).

2.03 FLEXIBLE DUCTWORK

- .1 General Requirements:
 - .1 Factory fabricated.
 - .2 Pressure drop coefficients listed below are based on sheet metal duct pressure drop coefficient of 1.00.

- .3 Fire retardant type insulation materials, coverings and adhesives with maximum flame spread rating of 25 and maximum smoke developed rating of 50 when tested in accordance with CAN/ULC-S102 and NFPA 255-2006. Materials tested in accordance with ASTM C411-05 shall not flame, smoulder, glow or smoke at temperature to which exposed in service. Flexible duct system shall meet OBC requirements for smoke and flame spread for return air plenums.
- .2 Acoustic Flexible Ductwork
 - .1 Flexible ducting shall be equal to True Flex Acoustic – Model TFAPB-M by Peppertree Air Solutions Inc. and suitable for use in healthcare facilities.
 - .2 The core shall consist of a continuous spirally wound strip of perforated aluminum (with an open area of 20–25%); sheathed by a black polyethylene fiber retention jacket; wrapped in Owens Corning GREENGUARD Gold Certified fiberglass insulation (Certified R-Value of 8.0); and sleeved with a metalized polyester vapor barrier.
 - .3 Acoustic flexible ducting shall be ULC-S110 Listed as Class 1 Air Duct Connector with a Flame Spread Rating of not over 25 without evidence of continued progressive combustion and a Smoke Developed Rating of not over 50.

2.04 FLEXIBLE DUCT CONNECTIONS

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material: Fire resistant, self-extinguishing, neoprene coated glass fabric, temperature rated at -40°F to plus 194°F (- 40°C to plus 90°C), density of 0.266 lb/ft² (1.3 kg/m²).

2.05 SEALANT AND TAPE

- .1 Sealant: fibre reinforced, flame resistant (flame spread 5, smoke developed 0) high velocity duct sealing compound. Temperature range of minus -22°F to 200°F (30°C to plus 93°C). Sealant to meet ULS102. System to be rated up to 16 in.wg. without the need for fibreglass mesh tape.
- .2 Where system pressures are in excess of 16in.wg. utilize a fibreglass mesh scrim to reinforce the system. Where a gap exists which is larger than 1/4" provide fiberglass mesh scrim over the gap prior to applying the sealant.
- .3 Acceptable Manufacturer (as listed or equal): Phoenix #33-526, 3M or equal.

2.06 ACOUSTIC DUCT LINING

- .1 Provide {25 mm} [1"] thick acoustic duct liner where shown on drawings and as follows:
 - .1 Rectangular Duct Liner insulation equal to Johns Manville Linacoustic RC-IG meeting ASTM C 1071 with air surface coated with acrylic coating treated with EPA registered anti-microbial agent proven to resist microbial growth as determined by ASTM G 21 and G 22.
 - .1 Noise Reduction Coefficient: .70 or higher based on "Type A mounting" and tested in accordance to ASTM C 423.
 - .2 Adhesive: meeting ASTM C 916.
 - .3 Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
 - .2 Round Duct Liner: rigid preformed round liner equal to Johns Manville Spiracoustic Plus with air surface coated with acrylic coating treated with EPA registered anti-microbial agent proven to resist microbial growth as determined by ASTM G 21 and G 22.
 - .1 Noise Reduction Coefficient of .70 as per ASTM C 423. (Type A mounting)
 - .3 Acoustic ducting lining shall be ULC-S102 Listed with a Flame Spread Rating of not over 25 without evidence of continued progressive combustion and a Smoke Developed Rating of not over 50.

PART 3 - EXECUTION

3.01 GENERAL DUCTWORK INSTALLATION REQUIREMENTS

- .1 Install ducts in accordance with SMACNA Standards and as indicated, and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.
- .3 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 4" (100 mm) beyond insulated duct.
- .4 Support risers in accordance with SMACNA Standards or as indicated.
- .5 Provide a drain at the low point of all exhaust and outside air plenums. Slope plenum back to louvre. Pipe drain to funnel floor drain.
- .6 Return air plenums that are formed by exterior walls, and roof slabs shall be sealed air-tight to prevent untreated outdoor air from being drawn into the return air stream.

3.02 LOW PRESSURE DUCTWORK INSTALLATION REQUIREMENTS

Provide low pressure ductwork in accordance with the following:

Fan System Designation	Fan Shop Drawings	Duct Construction
VAV Box Discharge	3.5 in.wg.	2 in.wg.
Supply air ductwork	3.25 in.wg.	2 in.wg.
Return air ductwork	3.25 in.wg.	2 in.wg.

- .1 Install ducts in accordance with SMACNA Standards and as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 4" (100 mm) beyond insulated duct.
- .3 Support risers in accordance with SMACNA Standards or as indicated.
- .4 Suspended plenums shall have the bottoms sloped back towards the louvre; flash over top of the bottom channel of the louvre to allow for any moisture accumulation to drain outside.

3.03 MEDIUM AND HIGH PRESSURE DUCTWORK INSTALLATION REQUIREMENTS

- .1 Provide Medium and High Pressure ductwork as follows:

Fan System Designation	Fan Shop Drawings	Duct Construction
Air Handling Unit Supply Air Discharge	3.5 in.wg.	6 in.wg.

- .2 Install ducts in accordance with SMACNA or as indicated.
- .3 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate band hangers 4" (100 mm) beyond insulated duct.
- .4 Support risers in accordance with SMACNA or as indicated.
- .5 Contractor to submit layout sheet metal shop drawings outlining all elbows, fittings, construction, clean-outs, etc. for approval prior to manufacturing and installation.
- .6 Support ductwork and Owner supplied accessories from structure.

3.04 FLEXIBLE DUCT INSTALLATION

- .1 Install where indicated and in accordance with preferred method of SMACNA and the following:
 - .1 Connections:
 - .1 Duct Sizes 300 mm (12") and Under:
 - .1 Provide a minimum of three (3) #8 sheet metal screws equally spaced to hold the flexible duct.
 - .2 Duct sizes above 300 mm (12"):
 - .1 Provide a minimum of five (5) #8 sheet metal screws equally spaced to hold the flexible duct.
 - .3 Screws shall be located at least 1/2" (12 mm) from the end of the duct.
 - .4 The collar to which the flexible duct is attached shall be a minimum 2" (50 mm) in length.
 - .2 Supports:
 - .1 Support shall be in accordance with SMACNA.
 - .3 Length – Class 1 Ductwork
 - .1 Minimum length of flexible duct: 1500 mm (5 ft.).
 - .2 Maximum length of flexible duct: 3600 mm (12 ft.).
 - .3 Maximum length of flexible duct connecting to light fixture troffers or ceiling diffusers shall be 72" (1800 mm).
- .2 Flexible ductwork shall be installed fully extended with bend radius greater than the duct diameter to avoid kinking.

3.05 WATERTIGHT DUCTWORK

- .1 Provide watertight ducts for:
 - .1 locker room exhaust
 - .2 as shown on drawings
- .2 Form bottom of horizontal duct without longitudinal seams Conform to ASTM Standard B32.
- .3 Seal all other joints with duct sealer.

3.06 DUCT HANGERS

- .1 Provide Duct Hangers in accordance with SMACNA.
- .2 Where ductwork is to be fire wrapped, increase size of hangers to suit the listing of fire wrap product.

3.07 DUCT LEAKAGE TESTING

- .1 Test air duct distribution systems to ensure they conform to the leakage requirements as specified above.
- .2 If ductwork fails leakage test, reseal ductwork and retest.
- .3 Conduct tests in accordance with AABC.
- .4 Acceptable Procedure:
 - .1 Provide an appropriate level of filtration on the intake to the test apparatus prior to starting the test procedure.
 - .2 Connect flexible tubing from the test apparatus to the duct section under test. Select the appropriate orifice plate and start test apparatus at minimum speed. Slowly increase the speed of the blower until the desired static pressure is achieved.
 - .3 Maintain attained system static pressure for a period of 15 minutes. From appropriate manometer gauge on test apparatus read the pressure differential. From the chart supplied

- with the test apparatus read leakage flow rate for a given pressure differential and orifice size. If the test results meet the allowable flow rate complete test report and obtain signatures as required.
- .4 Compare actual leakage with allowable rate. If the test result exceeds the allowable rate undertake appropriate remedial action and repeat the test until satisfactory outcome is achieved.
 - .5 Duct leakage shall not exceed that allowed for ductwork classification when calculated as follows:
 - .1 $Q = Q_1 \times L_1 \times F / L_2$
 - .2 Where:
 - .1 'Q' is allowable leakage in test section in cfm.
 - .2 'Q1' air quantity in cfm of total system.
 - .3 'L1' is Test section length in ft.
 - .4 'L2' is Total system length in ft.
 - .5 'F' is System allowable leakage expressed as a decimal for class of ductwork.
 - .6 When duct leakage tests are being performed on factory cleaned ductwork a HEPA filter shall be installed on the air intake for the pressure testing blower to prevent contamination of the ductwork.
 - .7 Notify the Consultant a minimum of forty-eight (48) hours prior to conducting leakage tests.
 - .8 Ductwork leak testing shall be witnessed by the Commissioning Authority or the Owner's Project Manager.

3.08 FLEXIBLE CONNECTIONS

- .1 Install in following locations where equipment is not internally isolated:
 - .1 Inlets to supply air units.
 - .2 Outlets from supply air units.
 - .3 Inlets and outlets of exhaust and return air fans.
 - .4 As indicated on the Drawings and in the Specifications.
- .2 Length of connection: 3-6" (75-150 mm) pending equipment size and operating pressure.
- .3 Minimum distance between metal parts when system in operation: 2" (50 mm).
- .4 Install in accordance with recommendations of SMACNA.

3.09 SEALANTS AND TAPES

- .1 Apply sealant in accordance with SMACNA and to manufacturer's recommendations. The application temperature for the sealer must be between 35°F (1.7°C) and 111°F (44°C).
- .2 Bed tape in sealant and recoat with minimum of one (1) coat of sealant to manufacturer's recommendations.

3.10 ACOUSTIC DUCT LINING INSTALLATION

- .1 Provide acoustic duct lining where indicated on the drawings.
- .2 Seal all leading and trailing edges and repair all rips or tears of acoustic duct liner with a suitable sealing compound similar to Johns-Manville Superseal.
- .3 Provide a tapered sheet metal nose piece to hold the leading edge of acoustic duct liner and direct the air over the edge.

3.11 DUCT CLEANING

- .1 Prior to shipping ductwork from the factory, the Sheet Metal Contractor shall ensure that all ductwork is clean. Ductwork shall be shipped to the site in closed trucks/trailers.
- .2 During installation, it shall ensure that no debris or foreign objects stay inside ductwork.

- .3 Prior to operation or test and balance, clean systems and equipment including but not limited to ductwork (supply/return/exhaust), air handling equipment, plenums, terminal units, fans, dampers, grilles/registers/diffusers to ensure they are free from debris and dust.
- .4 Cleaning shall be performed in accordance with National Duct Cleaners Association (NADCA) standards, and by agent specializing in this field of work, and a member in good standing with NADCA.
- .5 Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.
- .6 Cleaned according to the following procedures:
 - .1 The space shall be cleaned without debris and construction dust before duct cleaning. Once duct cleaning is complete for the area, there shall not be any more dust generating activities in the area.
 - .2 Ducts shall be cleaned before TAB work.
 - .3 Isolate sections of duct with friction-fitted blocks of closed-cell polyurethane foam, install HEPA vacuums at one end, and insert the full contact brushes at the other. Energize brushes so that they travel toward vacuum units, changing brush sizes as necessary to ensure a constant interference fit within the duct or component.
 - .4 Clean all fittings, components and other features within the system on the same section basis so that dirt from a section being cleaned will never pass through a section that has already been cleaned.
 - .5 Pass brushes through sections or components as many times as necessary to achieve the degree of cleanliness required.
 - .6 Where brushing and vacuuming is not appropriate or sufficient to clean a component of the system, dismantle and remove the component to the outside where it is to be pressure washed with water or chemical to the required state of cleanliness. Clean the component in place only if there is no hazard to the surroundings.
 - .7 Coils, walls, humidifiers, elements and heat exchange surfaces are to be brushed, vacuumed and, where necessary, low volume pressure washed in-place. Fan blades and housings should be wiped or vacuumed. Make all provisions and supply all materials necessary to accomplish this.
- .7 Cleaning of components:
 - .1 All components of the system are to be thoroughly cleaned, including fan units, turning vanes, filter racks, control components including sensing bulbs, branch take-off points, fire dampers, balancing dampers, splitter dampers and any other internal duct or system features, especially corners and pockets where dirt or dust may accumulate.
 - .2 After ducts are cleaned, ceiling diffusers and grilles shall be dusted by another section.
- .8 Equipment requirements:
 - .1 Self-propelling Full Contact Brushes:
 - .1 Employ brushes specially made and shaped to fit the individual ducts or components in which they are used. Ensure continuous full contact and powerful

- scrubbing action of the interior surfaces of the ducts or component in which they are installed.
- .2 Brush bristles to be of nylon, polypropylene or other non-metallic material.
- .3 Brushes to be robotic or self-propelled, in either case having an integrally-mounted propulsion motor or drive. Motors or drives must be powerful enough to continue to propel the brush even when the brush bristles have been severely distorted.
- .4 Brushes to have the capability to clean ventilation duct of 80 sq. mm. to 500 sq. mm.
- .2 Robotic Brush
 - .1 A remote controlled, self-propelled robotic brush is to be used in all areas where the self-propelled brush is not suitable or cannot reach.
 - .2 The robot-manipulated brush is to be of the same material as all other brushes, and have either a rotating or reciprocating scrubbing action. The brush shall maintain contact with the interior surfaces of the duct.
- .3 Robotic Acoustic Lining Cleaner
 - .1 Clean acoustic lining only by a specially-designed, self-propelled and remote controlled robotic assembly that has been demonstrated not to damage the lining. The unit shall be fitted with a compressed air supply which will then blow the freed dirt and dust toward the vacuums at the end of the respective section. The operation of this assembly shall be constantly video monitored and adjusted to ensure that no damage is caused to the acoustic lining.
 - .2 The robot vehicle shall be provided with a video camera device mounted to monitor cleaning process and record to video tape at all time. Where video camera is not part of the robot vehicle, contractor must provide a video record on the condition of the ventilation duct and components before and after cleaning as proof of cleaning has been completed as per the contract.
- .4 Vacuum
 - .1 Vacuum unit shall consist of fan, HEPA filter section, hose, and vacuum head. All vacuum units shall be equipped with integral HEPA filters. Filters must be maintained in top condition.
 - .2 Vacuum cleaning units shall be used only to supplement direct contact brushing.
 - .3 Vacuum units shall be powerful enough and multiple units shall be used, to entrain all removed dirt and particulate matter in the airstream until captured by the vacuum units.
 - .4 No cleaning operations shall take place until vacuum unit are in place and operating
- .9 Post Cleaning
 - .1 Carry out inspection with a third party certifier and/or engineer and provide a certificate with an engineer's stamp stating that the ductwork conforms to cleanliness stated in:
 - .1 NADCA; provide surface compassion test (method 2 in NADA ACR 2006). If test result is inconclusive, proceed with vacuum testing (method 3 in NADCA ACR 2006).

3.12 AIR BALANCING

- .1 Refer to Section 20 05 95.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .2 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.03 WORK PERFORMED BY THIS SECTION

- .1 Provision of air distribution equipment and related ancillaries.
- .2 Louvers are to be supplied and installed by Trades other than Mechanical Division Trades.

1.04 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the construction and installation of air distribution equipment and related ancillaries.
- .2 Submittals: Submit shop drawings for the following Products:

1.05 REFERENCE STANDARDS

- .1 SMACNA HVAC Duct Construction Standards Metal and Flexible - Second Edition
- .2 NFPA 96 – 2008 Ventilation Control and Fire Protection of Commercial Cooking Operations
- .3 NFPA 90A-2009 Installation of Air Conditioning and Ventilating Systems
- .4 NFPA 90B-2009 Installation of Warm Air Conditioning and Air Conditioning Systems
- .5 ASTM A621 & A621M - 1998 Specification for Forming Steel (FS), sheet and Strip, Carbon, Hot Rolled.
- .6 ASTM A653M – 09 Specification for Steel Sheet, Zinc Coated Galvanized or Zinc Alloy Coated (Galvannealed) by the Hot Dip Process
- .7 ASTM A924M – 09 General Requirements for Sheet Steel, Metallic Coated by the Hot Dip Process
- .8 Duct dimensions shown on Drawings are net, inside insulation and acoustic duct lining.

1.06 VOLATILE ORGANIC COMPOUND ("VOC") REQUIREMENTS

- .1 All adhesives, sealants, paints and coatings used on or inside of building weatherproofing layer shall have a VOC content that is less than the content limits defined in LEED® Product Requirements.

1.07 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 DUCT ACCESS DOORS

- .1 General.
 - .1 The access doors shall be of ultra-low leakage, premium quality design. Flat oval design optimizes access area and simplifies installation.
 - .2 The access doors shall be complete with insulated double flanged door with pre-punched holes on inner flange for surface mounting.

- .3 Provide camlock for positive seal and easy opening.
- .2 Construction
 - .1 Die-formed 24 gauge galvanized flanged frame for extra strength.
 - .2 Die-formed 24 gauge galvanized door panel for extra strength.
 - .3 1" (25mm) insulation with 24 gauge galvanized backing plate.
 - .4 3/16" (5mm) dia pre-punched attachment holes on inner flange for surface mounting.
 - .5 Plated steel camlock fasteners.
 - .6 Positive bulb door seal.
 - .7 Oval or flat oval shaped opening adaptable to all ducts 5" (125mm) and over.
 - .8 Tested in accordance to DW142 Class C – maximum leakage at 8 in.wg. (2kPa):
 - .1 12"x 6" (300 x 150 mm): 0.06 cfm (1.8 l/min)
 - .2 18"x12" (450 x 300 mm): 0.13 cfm (3.8 l/min)
 - .3 25"x 17" (625 x 425 mm): 0.28 cfm (8.1 l/min)
- .3 Acceptable Manufacturers:
 - .1 Nailor;
 - .2 Or approved equivalent.

2.02 INSTRUMENT TEST PORTS

- .1 0.063" (1.6 mm) thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug.
- .3 1" (25 mm) minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.
- .5 Acceptable Manufacturers:
 - .1 Duro Dyne IP1 or IP2 for insulated ducts;
 - .2 Duro Dyne IP4 for non-insulated ducts.

2.03 ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Equal to Flexmaster Canada Ltd. galvanized steel, flared, flanged or notched "Spin-On" round duct take-off collars with locking dampers in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.04 AIR TURNING VANES

- .1 For square duct elbows - multiple-radius turning vanes, interconnected with bars, adequately reinforced to suit the pressure and velocity of the system, and constructed of the same material as the duct they are associated with, and in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 For short branch ducts at grille and diffuser connections - air extractor type, each equipped with a matching bottom operated 90 degree opposed blade volume control damper, constructed of the same material as the duct it is associated with, and in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.05 SPLITTER DAMPERS

- .1 Minimum #20 gauge damper blade constructed of same material as duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware equal to DynAir Inc. #Q-50 "DYN-A-QUAD S-S" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

2.06 SINGLE BLADE BALANCING DAMPERS

- .1 Of same material as duct. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 12" (300 mm).
- .3 Locking device.
- .4 Inside and outside end bearings for special fume exhaust ducts.

2.07 MULTI-BLADED BALANCING DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration to recommendations of SMACNA.
- .3 Bearings: pin in bronze bushings.
- .4 Linkage: shaft extension with locking quadrant.
- .5 Channel frame complete with angle stop.
- .6 Inside and outside end bearings.

2.08 MULTI-LEAF AUTOMATIC CONTROL DAMPERS

- .1 Automatic Control Dampers are specified in Section 25 30 10 shall be supplied by the BAS Trades for installation in the Air Distribution system. Coordinate all requirements with BAS Trades.

2.09 AIR FLOW STATIONS

- .1 Air flow stations are specified in Section 25 30 10 shall be supplied by the BAS Trades for installation in the Air Distribution system. Coordinate all requirements with BAS Trades.

2.10 BACKDRAFT DAMPERS

- .1 Backdraft dampers shall meet the following minimum construction standards:
 - .1 Frame shall be 0.125" (3.2 mm) wall thickness 6063T5 extruded aluminum.
 - .2 Frame shall have galvanized steel braces at all corners.
 - .3 Blades shall be 0.070" (1.8 mm) wall thickness 6063T5 extruded aluminum.
 - .4 Blades shall begin to open at approximately 0.12 in. wg. and be fully open at approximately 0.20 in.wg. static pressure.
 - .5 Blade edge seals shall be extruded vinyl mechanically locked into blade edge; adhesive type seals are unacceptable.
 - .6 Bearings shall be corrosion resistant long life synthetic for quiet operation.
 - .7 Linkage shall be ½" (13mm) tie bar with stainless steel pivot pins; linkage shall have the capability of being manually locked in the closed position for independent fan isolation from the remained of fans in the array.
 - .8 Damper shall be designed for 3500 fpm maximum spot air velocity.

2.11 CASING AND PLENUM ACCESS DOORS

- .1 Gasketed access doors, factory insulated type in insulated casings or plenums, each constructed of galvanized steel (unless otherwise specified) in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible, to suit the pressure classification of the casing or plenum.
- .2 Where access doors occur in casings and/or plenums constructed of materials other than galvanized steel, the doors shall be as above but constructed of material to match the casing and plenum material.

2.12 SILENCERS

- .1 Provide silencers to maintain the maximum Noise Criteria (NC) levels as stated in the following Table:

Area	Maximum NC Level
------	------------------

Open office/reception areas	35
Private offices	30
Conference, interview & meeting rooms	30
Circulation and lobbies	40
Washrooms, service and storage areas	40

- .2 Silencers certified to ASTM E477 "Standard Method of Testing Duct Liner Materials and Prefabricated Silencers For Acoustical and Airflow Performance" completely prefabricated and as follows:

.1 Materials:

- .1 No-medial type rectangular type silencers shall be constructed with a 22 gauge (0.78 mm) galvanized steel outer casing and 26 gauge (0.47 mm) galvanized perforated steel;
- .2 Film lined rectangular type silencers shall be constructed with a 22 gauge (0.78 mm) galvanized steel outer casing and 26 gauge (0.47 mm) galvanized perforated steel.
- .3 No-media and film lined elbow silencers shall be constructed with an 18 gauge (1.24 mm) galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" (1200 mm) shall have at least two half splitters and one full splitter.
- .4 Circular silencers shall be constructed with a galvanized steel casing as noted below and 22 gauge (0.78 mm) galvanized perforated steel. All casing and seams and joints shall be lock formed and sealed or stitch welded and sealed.

CASING DIAMETER	CASING GAUGE
Less than 30" (750 mm)	20
30" (750 mm) to 54" (1350 mm)	18
Over 54" (1350 mm)	16

.2 Acoustic Media:

- .1 Media for film lined silencers shall be media containing 100% natural cotton fibers treated with an EPA registered, non-toxic borate solution, "flash dried" to provide resistance to mold, mildew and fungi. Media shall comply with UL181 and NFPA 90A. Media shall be packed with a minimum of 15% compression during silencer assembly. Media shall not cause or accelerate corrosion of aluminum or steel.

.3 Acoustic Media Protection:

- .1 Film lined silencers shall be as above with acoustic media completely wrapped with Tedlar film to prevent shedding, erosion and impregnation of glass fibre. The wrapped acoustic media shall be separated from the perforated metal by a factory installed 1/2" (12 mm) thick acoustically transparent spacer. The spacer shall be

flame retardant and erosion resistant. A mesh, screen or corrugated liner will not be acceptable as a substitute for the specified spacer.

.4 High Transmission Loss ("HTL") Ductwork

- .1 Silencers shall have a High Transmission Loss ("HTL") walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. Provide breakout noise calculations as part of the silencer shop drawing submissions for each air handling and fan system with HTL silencers. Breakout noise shall be based on the sound power levels of the specified equipment.

- .3 Manufacturer shall certify on shop drawings that silencer performance is per ASTM E477.

2.13 DYNAMIC FIRE DAMPERS

.1 Application:

- .1 HVAC System operates under fire alarm, smoke control, or smoke evacuation modes.

.2 Construction:

- .1 Provide Dynamic rated fire dampers, meeting or exceeding the following criteria:

- .1 Fire dampers shall all the requirements of UL and NFPA 80, 90A and 101 for fire dampers in dynamic HVAC systems, as well as National Building Code of Canada (NBC) requirements.

- .2 Manufactured, tested and labeled in accordance with UL 555 and CAN/ULC-S112 Standard for Dynamic Fire Dampers, including Dynamic Closure Test (formerly the Operation Test). Dampers shall be classified for dynamic closure against an airflow velocity of 2000 fpm (10.16 m/s) at 4" w.g. (1 kPa) static pressure differential across closed damper.

- .2 Each fire damper shall bear a UL 1½ hours or 3 hours fire resistance rating label in addition to label verifying the airflow and closure pressure ratings as established by the Dynamic Closure Test.

- .3 Each fire damper shall also be marked with the words "For use in dynamic systems"; Dampers marked "For use in static systems only" are not acceptable.

- .4 Each fire damper shall be complete with a 165°F (74°C) UL Listed fusible link.

- .5 Fire dampers shall each include a steel sleeve of appropriate length/gauge and retaining angles, supplied by damper manufacturer to ensure proper installation in accordance with damper manufacturer's instructions.

- .6 Contractor shall provide an access door at each fire damper, of appropriate size to allow for inspection, testing and fusible link replacement.

- .7 Fusible link dampers shall be Type B or Type C (as required) with curtain blade out of air stream. Type A dampers (with the curtain blade in the air stream) may be installed only where size or location are such that Type B and Type C cannot be installed. Consultant shall review application of Type A use prior to installation.

- .8 Fusible link dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.

.3 Acceptable Manufacturers:

- .1 Nailor Industries D0100 series for 1½ hr rated, and D0500 series for 3 hr rated.
.2 EH Price, Brisk, Ruskin;
.3 Or acceptable equivalent

2.14 MULTI-BLADE FIRE DAMPERS

- .1 Application:
 - .1 Provide Multi-Blade Dynamic Fire Dampers as shown on plans and/or schedules,
 - .2 Each fire damper shall also be marked with the words "For use in dynamic systems". Dampers marked "For use in static systems only" are not acceptable.
- .2 Construction:
 - .1 Fire dampers shall meet the requirements of NFPA 80, 90A and 101 and shall be manufactured, tested and labeled in accordance with UL 555.
 - .2 Each damper shall bear a UL fire resistance rating label of 1½ hours or 3 hours, in accordance with the fire rating of the assembly being penetrated, and in addition, a label verifying the airflow and closure pressure ratings of 2000 fpm (10 m/s) at 4 in.wg. (1 kPa) static pressure differential, as established by the Dynamic Closure Test.
 - .3 Frame shall be constructed of 16 ga. (1.6) galvanized steel hat channel with mitered corners reinforced with die-formed corner gussets for strength.
 - .4 Blades shall be 14 ga. (2.0) equivalent galvanized steel formed double skin, airfoil design, on 5 1/2" (140) centers.
 - .5 Dampers shall be of opposed blade configuration with an inter-locking blade design. Blade seals are not acceptable.
 - .6 Blade axles shall be plated steel, double bolted at each end of blade to provide positive locking connection. Hex, square friction-fit or press-fit axles are not acceptable.
 - .7 Bearings shall be self-lubricating oilite bronze type. Blade linkage shall be zero-maintenance, concealed in frame, out of airstream. Each fire damper shall be complete with a 165°F (74°C) UL Listed fusible link that will cause the damper to close and lock in closed position by means of an over center/knee lock linkage for assured closure.
 - .8 Fire dampers shall each include a steel sleeve of appropriate length/gauge as field verified by contractor, with retaining angles supplied by damper manufacturer to ensure proper installation in accordance with damper manufacturer's instructions.
 - .9 Each damper shall be supplied with an internal manual quadrant(s) for setting and locking of blades in desired position. Contractor shall provide and install an access door at each fire damper, of appropriate size to allow for inspection, testing and fusible link replacement.
- .3 Acceptable Manufacturers:
 - .1 Nailor Industries.
 - .2 EH Price, Brisk, Ventex/Lloyd Industries, Ruskin;
 - .3 Or acceptable equivalent

2.15 LOW LEAKAGE MOTORIZED SMOKE DAMPERS

- .1 Application:
 - .1 Provide Class I low leakage motorized smoke dampers as shown on plans and/or schedules.
 - .2 Dampers shall be suitable for use in dynamic or static smoke control systems.
 - .3 Dampers shall be fail safe opposed blade configuration with an interlocking blade design that provides complete smoke seal under elevated temperature conditions when in closed position.
- .2 Construction:
 - .1 Dampers shall meet the requirements of NFPA 90A, 92, 101 and 105 and shall be classified as a Class I Leakage Rated (Smoke) Damper under UL 555S at an elevated temperature of 250°F (121°C) and each damper shall bear a ULC label verifying same.
 - .2 Dampers must comply with the requirements of AMCA 511 Certified Ratings Program and be qualified to bear the AMCA Seal.

- .3 Dampers shall have been operation tested by ULC to a minimum velocity/pressure rating of 2000 fpm @ 4 in.wg.
- .4 Frame shall be constructed of 16 ga. (1.6mm) galvanized steel hat channel with mitered corners reinforced with die-formed corner gussets for strength.
- .5 Blades shall be type 6063-T5 extruded aluminum airfoil design on maximum 6" (152) centers with integral structural reinforcing tube running full length of each blade
- .6 Blade axles shall be ½" (13mm) dia. plated steel, double bolted at each end of blade to provide positive locking connection; hex, square friction-fit or press-fit axles are not acceptable.
- .7 Bearings shall be self-lubricating bronze type.
- .8 Blade linkage shall be zero-maintenance, concealed in frame, out of airstream.
- .9 Jamb seals shall be compression type stainless steel.
- .10 Blade seals shall be silicone, mechanically locked in extruded blade slots.
- .11 Externally mounted electrical actuators shall be installed by the damper manufacturer in the factory; review with Consultant any smoke damper actuator proposed to be internally mounted prior to installation. Actuators shall incorporate an OEM internal spring-return mechanism. Damper and actuator assembly shall be factory cycled a minimum of three (3) times to ensure correct operation.
- .12 Submitted pressure drop data to be based on tests in accordance with AMCA Standard 500-D and shall demonstrate a maximum pressure drop of 0.02 in.wg. @ 849 fpm (5 Pa @ 4.3 m/s) across a 36" x 36" (914mm x 914mm) damper.
- .13 Damper shall come complete with a position indicator switch where damper is required to be reopened or closed from a remote location for smoke management and control; damper open end switches shall be adjustable in the field.
- .14 Provide manual test switch to demonstrate proper damper operation as part of regular on-going system maintenance and verification.
- .3 Acceptable Manufacturers:
 - .1 Nailor Industries
 - .2 EH Price
 - .3 Ruskin
 - .4 Or acceptable equivalent

2.16 COMBINATION FIRE/SMOKE DAMPERS

- .1 Application:
 - .1 Provide Combination Fire/Smoke Dampers as shown on plans and/or schedules.
- .2 Construction:
 - .1 Combination Fire Smoke Dampers shall meet the requirements of NFPA 80, 90A, 92 101 and 105.
 - .2 Combination Fire Smoke Dampers shall be classified by Underwriter's Laboratories and labeled as a 1½ hour Fire Damper under UL 555, and as a Class I Smoke Damper under UL 555S at an elevated temperature of 250°F (121°C). Each Combination Fire Smoke Damper shall bear a ULC label verifying same for use in dynamic or static Smoke Control Systems.
 - .3 Dampers must comply with the requirements of AMCA 511 Certified Ratings Program and be qualified to bear the AMCA Seal.
 - .4 Frame shall be constructed of 16 ga. (1.6mm) galvanized steel hat channel with mitered corners reinforced with die-formed corner gussets for strength.

- .5 Blades shall be 14 ga. (2.0mm) equivalent galvanized steel formed double skin, airfoil design.
- .6 Dampers shall be of opposed blade configuration with an interlocking blade design that provides complete flame and smoke seal under fire conditions at an elevated temperature of 2000°F (1093°C) when in closed position.
- .7 Blade axles shall be plated steel, double bolted at each end of blade to provide positive locking connection.
- .8 Bearings shall be self-lubricating bronze type.
- .9 Blade linkage shall be zero-maintenance, concealed in frame, out of airstream.
- .10 Jamb seals shall be compression-type stainless steel.
- .11 Dampers shall have been tested for dynamic closure by UL to a minimum velocity/pressure rating of 2000 fpm @ 4in.wg.
- .12 Dampers shall be supplied with factory installed sleeves of minimum 16" (406mm) length and shall be field verified by contractor, dependent on wall thickness. Factory sleeves shall be caulked to UL requirements and shall be 20 ga. (1.0mm) through 84" (2134mm) wide, and 18 ga (1.2mm) above 84" (2134mm) wide.
- .13 Appropriate electric (115 V/1ph/60Hz) actuator shall be installed by the damper manufacturer in the factory and shall have been tested and classified under UL 555S. Actuators shall incorporate an OEM internal spring return mechanism.
- .14 Each damper shall be equipped with a UL Classified heat responsive device that will cause the damper to close in a controlled manner and lock in a closed position by means of an over center/knee lock linkage, when the duct temperature reaches the maximum degradation temperature of the damper/actuator assembly as required by UL 555S. Closure devices that cause instantaneous closure are not acceptable.
- .15 Submitted pressure drop data to be based on tests in accordance with AMCA Standard 500-D and shall demonstrate a maximum pressure drop of 0.02 in.wg. @ 849 fpm (5 Pa @ 4.3 m/s) across a 36" x 36" (914 x 914) damper.
- .16 Damper shall come complete with a position indicating switch where damper is required to be reopened or closed from a remote location for smoke management and control; damper open end switches shall be adjustable in the field.
- .17 Provide manual test switch to demonstrate proper damper operation as part of regular on-going system maintenance and verification.
- .3 Acceptable Manufacturers:
 - .1 Nailor Industries.
 - .2 EH Price
 - .3 Ruskin
 - .4 Or acceptable equivalent

2.17 WIRE MESH (BIRDScreen)

- .1 Heavy-gauge galvanized steel or aluminum mesh, 12 mm x 12 mm (½" x ½") secured in a rigid galvanized steel or aluminum framework, sized as indicated on drawings, and constructed so as to be removable.

2.18 LOUVRES

- .1 Fixed Blade Horizontal Louvers, 6" (150mm) Deep:
 - .1 Nailor model 1606KD extruded aluminum stationary blade drainable louvers as follows:
 - .1 Frame: 6" (152mm) deep, Type 6063-T6 extruded aluminum, .080" (2.03mm) nominal wall thickness. Integral caulking slot provided;

- .2 Blades: Type 6063-T6 extruded aluminum, .080" (2.03) nominal wall thickness, with reinforcing bosses; K style.
- .3 Blade Angel: Fixed at 37 degrees;
- .4 Blade Spacing: Approx. 6" (152mm) on centers;
- .5 Free Area: 50%
- .6 Performance: 0.14 in.wg. APD at 1017 ft/min velocity through free area.
- .7 Blade Support Brackets: Concealed type, factory installed on rear of louver on maximum 60" (1524mm) centers; reinforced with 1 1/2" x 2" (38mm x 51mm) angle; adds approximately 2" (51mm) to overall louver depth;
- .8 Mullions: Concealed type allowing continuous line appearance up to 120" (3048mm) wide; larger assemblies require separate visible frames with downspouts;
- .9 Birdscreen: 3/4" x .051" (19mm x 1.3mm) expanded, flattened aluminum bird screen in removable frame, inside (rear) mount; adds approximately 3/8" (10mm) to louver depth.
- .10 Finish: Custom high performance powder coat finish to suit architectural requirements.

- .2 Other acceptable manufacturers: Ruskin, Greenheck, Ventex, Construction Specialties.

2.19 LOUVRE BLANK-OFF PANELS

- .1 Insulated, framed, sandwich construction panels consisting of two staggered layers of (2") 50 mm thick low temperature phenolic board insulation between minimum #20 gauge galvanized sheet steel with exterior face of panels finished to match finish of exterior wall louvres.

PART 3 - EXECUTION

3.01 GENERAL AIR DUCT ACCESSORIES INSTALLATION REQUIREMENTS

- .1 Install ducts in accordance with SMACNA Standards and as indicated, and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.
- .3 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 4" (100 mm) beyond insulated duct.
- .4 Support risers in accordance with SMACNA Standards or as indicated.
- .5 Provide a drain at the low point of all exhaust and outside air plenums. Slope plenum back to louver. Pipe drain to funnel floor drain.
- .6 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.

3.02 DUCT ACCESS DOORS

- .1 Size:
 - .1 25" x 17" (650 x 425 mm) for person size entry.
 - .2 21" x 14" or 18" x 10" (525 x 350 mm or 450 x 250 mm) for servicing entry depending on required space.
 - .3 18" x 10" or 12" x 6" (450 x 250 mm or 300 x 150 mm) for viewing depending on site condition.

- .4 As indicated on the Drawings and in the Specifications.
- .2 Location:
 - .1 At fire and smoke dampers.
 - .2 At control dampers if linkage is located internally.
 - .3 Upstream of all reheat coils.
 - .4 At devices requiring maintenance.
 - .5 At locations required by Code.
 - .6 As indicated on the Drawings and in the Specifications.

3.03 INSTRUMENT TEST PORTS

- .1 General:
 - .1 For traverse readings, install in accordance with recommendations of SMACNA.
 - .2 Provide adjacent to all control sensors installed by Control Contractors to allow for confirmation and validation of the readings provided by these sensors. This includes but is not limited to temperature sensors, relative humidity sensors, pressure sensors, and flow stations.
 - .3 Install in accordance with manufacturer's instructions.

3.04 INSTALLATION OF ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

3.05 INSTALLATION OF TURNING VANES

- .1 Provide turning vanes in ductwork elbows where shown on drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified.

3.06 INSTALLATION OF SPLITTER DAMPERS

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on the drawings.
- .2 Install splitter dampers so they do not vibrate and rattle and so damper operation mechanisms are in an easily accessible and operable location.
- .3 Ensure operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

3.07 MANUAL BALANCING DAMPERS

- .1 Provide balancing dampers as follows:
 - .1 at each branch duct connection from a main trunk duct (branch ducts serve more than one terminal device, diffuser, grille, or register);
 - .2 at each duct run-out to an individual terminal device, diffuser, grille, or register;
 - .3 where indicated in the Documents.
- .2 Install balancing dampers in accordance with recommendations of SMACNA.
- .3 Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers do not move or rattle.
- .4 Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .5 Where a duct for which a balancing damper is required has dimensions larger than dimensions of maximum size volume damper available, provide multiple dampers bolted together in a properly

sized assembly, or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.

- .6 Confirm exact damper locations with TAB Trades performing air balancing testing work and install dampers to suit. Include for providing an additional eight [8] manual balancing dampers at no additional cost.

3.08 AUTOMATIC CONTROL DAMPERS

- .1 Sheet Metal Trades shall install Automatic Control Dampers supplied by BAS Trades.
- .2 Install in the exhaust air ducts from all air handling units and return fans where the exhaust duct connects to the exhaust air plenum unless otherwise noted on the drawings.
- .3 Outside air and return air dampers shall be factory mounted within the air handling units unless otherwise noted on the drawings.
- .4 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .5 Seal multiple damper modules with UL listed non-transparent silicon sealant.
- .6 Upon system start-up, ensure that dampers operate properly. Refer to BAS Specification Sections for additional requirements.

3.09 AIR FLOW STATIONS

- .1 Sheet Metal Trades shall install Air Flow Stations supplied by BAS Trades.

3.10 INSTALLATION OF FIRE DAMPERS, SMOKE DAMPERS AND COMBINATION FIRE AND SMOKE DAMPERS

- .1 General:
 - .1 Install dampers as per manufacturer's ULC listing.
 - .2 Where a fire damper, smoke damper or combination fire smoke damper exceeds maximum size limitations then a hybrid or Multi-blade dampers must be installed.
 - .3 Maintain integrity of fire wall and/or fire separation.
 - .4 For fire dampers, smoke dampers and combination fire/smoke dampers provide an access door adjacent to the damper to allow for inspection of the damper. Refer to Section 23 33 10 for access door requirements.
 - .5 After completion and prior to concealment, obtain approvals from the Authorities having Jurisdiction (AHJs) of complete installation.
 - .6 Provide fire stop flaps on any grilles penetrating fire-rated ceilings.
 - .7 The Mechanical Contractor shall review the Architectural Drawings. Any discrepancies between fire damper locations and the fire rated walls shall be brought to the attention of the Consultant.
- .2 Fire Dampers and Combination Smoke/Fire Dampers:
 - .1 Install fire dampers in accordance with NFPA 90A, UL555 and suppliers instructions, complete with retaining angles on both sides of wall or floor and fastened to damper collars.
 - .2 Minimum size of the opening for the fire damper shall be larger than the fire damper by 1/8" (3 mm) for each 12" (300 mm) of width or height of the damper to allow for expansion. The maximum allowable size of the opening shall be 1/2" (12 mm) larger in either dimension than the allowable minimum size.
 - .1 **Example, a sleeve dimension of 36" x 48" (900 x 1200 mm) shall have an opening of 36-3/8" x 48-1/2" (912 x 1212 mm) The maximum opening size shall be 36-7/8" x 49" (924 x 1224 mm).**
 - .3 The damper shall be connected to the sleeve by one (1) of the following methods:

- .1 Where the sleeve is the same metal gauge as the duct, the duct shall be connected to the sleeve utilizing one (1) of the approved slip joints.
- .2 Where the sleeve is 16-gauge up to 36" x 24" (900 x 600 mm) and 14-gauge for sizes exceeding 36" x 24" (900 x 600 mm) the duct may be connected with a rigid or fixed joint.
- .4 The damper shall be centred horizontally in the opening and all of the clearance in the vertical plane shall be at the top.
- .5 Dampers shall not be cast-in-place. Retaining angles and damper shall not be fastened directly to the wall or floor.
- .6 The damper shall be installed in the plane of the fire separation.
- .3 Smoke Dampers:
 - .1 Smoke dampers shall be installed in accordance with NFPA 92A, UL555S and the supplier's installation listing.
 - .2 All joints between the damper and the sleeve or duct and between dampers in multiple sections shall be sealed with silicone sealant on one (1) side only.
 - .3 Damper shall be installed a maximum of 24" (600 mm) from the smoke barrier.

3.11 INSTALLATION OF WIRE MESH (BIRDSCREEN)

- .1 Provide framed, removable wire mesh panels over openings in ducts and/or walls where shown and/or specified on drawings. Rigidly secure in place but ensure panels are removable.
- .2 Provide wire mesh panels for open-end return air ducts in ceiling spaces whether shown on drawings or not.

3.12 INSTALLATION OF LOUVRES

- .1 Provide louvres for wall openings.
- .2 Install louvre assemblies and secure in place in accordance with manufacturer's instructions and details.
- .3 Confirm exact louvre sizes and finish prior to ordering.
- .4 Provide vertical blade louvers for commercial kitchen exhaust applications subject to NFPA 96 requirements.
- .5 Hurricane rated louvers and sill flashing to be installed in accordance with the manufacturer's recommended procedures to ensure complete water integrity performance of louver system.

3.13 INSTALLATION OF LOUVRE BLANK-OFF PANELS

- .1 Provide blank-off panels for inactive portions of exterior wall louvres.
- .2 Secure panels in place with non-ferrous hardware so they cannot move or rattle, yet are easily removable.
- .3 Confirm exact finish of panels prior to fabrication.

3.14 AIR BALANCING

- .1 Refer to Section 20 05 95.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .2 Comply with requirements of Section 20 10 50 Basic Materials and Methods.
- .3 Comply with requirements of Section 20 05 70 Motors, Motor Starters, Motor Control Centres, Variable Frequency Drives and Wiring
- .4 Refer to Section 25 30 10 BAS Instrumentation and Devices for Automatic Damper requirements.

1.03 SCOPE OF WORK

- .1 Provide fans and accessories for the Mechanical Work as specified herein.

1.04 RELATED WORK SPECIFIED ELSEWHERE

- .1 Power wiring for all electric motors will be by Mechanical Trades unless indicated otherwise.
- .2 Electromagnetic starters with required number of ancillary contactors will be provided by Mechanical Trades unless supplied as an integral part of equipment.
- .3 Testing, Adjusting and Balancing ("TAB") Work Specified in Section 20 05 95 Testing Adjusting and Balancing.

1.05 REFERENCES

- .1 Anti-Friction Bearing Manufacturers Association (AFBMA) 9 – Load Ratings and Fatigue Life for Ball Bearings
- .2 Anti-Friction Bearing Manufacturers Association (AFBMA) 11 – Load Ratings and Fatigue Life for Roller Bearings
- .3 Air Movement and Control Association International (AMCA) Standard 204 - Balance Quality and Vibration Levels for Fans
- .4 Air Movement and Control Association International (AMCA) Standard 205 - Energy Efficiency Classification for Fans
- .5 Air Movement and Control Association International (AMCA) Standard 210 - ASHRAE 51 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
- .6 Air Movement and Control Association International (AMCA) Publication 211 - Certified Ratings Program - Product Rating Manual for Fan Air Performance
- .7 Air Movement and Control Association International (AMCA) Standard 300 - Reverberant Room Method for Sound Testing of Fans
- .8 AMCA Publication 311 - Certified Ratings Program - Product Rating Manual For Fan Sound Performance
- .9 National Electrical Manufacturers Association (NEMA) MG 1 – Motors and Generators
- .10 National Fire Protection Association NFPA 70 - National Electric Code
- .11 Underwriters Laboratories Inc. UL 705 - Standard for Power Ventilators
- .12 Underwriters Laboratories Inc. UL/cUL 762 - Standard for Power Roof Ventilators for Restaurant Exhaust Appliances

1.06 SUBMITTALS

- .1 Submit shop drawings as follows:
 - .1 Fans and accessories;

- .1 Provide fan curves for all fans;
- .2 Provide fan sound power levels (radiated and discharge) for all fans 200 l/s (400 CFM) capacity and greater.
- .2 AMCA A (Airstream) SRC includes all airstream parts constructed of a spark-resistant alloy. AMCA B (Wheel) SRC includes the fan wheel constructed of a spark resistant alloy and a buffer plate around the housing shaft-hole opening. AMCA C (Buffer) SRC includes a spark resistant alloy buffer affixed to the housing interior adjacent to the wheel back-place, a spark resistant alloy inlet cone, and a buffer plate around the housing shaft-hole opening.

PART 2 - PRODUCTS

2.01 GENERAL REQUIRMENTS

- .1 Provide Spark Resistant Construction where indicated on the Drawings and/or Equipment Schedules as follows:
 - .1 Class A: AMCA A (Airstream) SRC includes all airstream parts constructed of a spark-resistant alloy.
 - .2 Class B: AMCA B (Wheel) SRC includes the fan wheel constructed of a spark resistant alloy and a buffer plate around the housing shaft-hole opening.
 - .3 Class C: AMCA C (Buffer) SRC includes a spark resistant alloy buffer affixed to the housing interior adjacent to the wheel back-place, a spark resistant alloy inlet cone, and a buffer plate around the housing shaft-hole opening.

2.02 SQUARE INLINE CENTRIFUGAL FANS

- .1 Square Inline Centrifugal Fans: Belt-driven, square, inline fan suitable for duct installations handling clean ventilation air.
 - .1 Acceptable Manufacturers: Twin City, Greenheck, Cook, Northern Blower, or approved equal.
 - .2 Permanently attach nameplate displaying serial number and unit information.
- .2 Housing: Heavy-gauge galvanized steel with continuously gasketed contact surfaces and interior insulation.
 - .1 Provide inlet venturi matched to fan wheel.
 - .2 Provide removable side panels for maintenance.
 - .3 Construct fan to allow complete removal of motor, drives, and fan wheel when side panel is removed.
 - .4 Provide universal mounting brackets to allow for horizontal or vertical fan orientation.
 - .5 Provide one inch thick fiberglass neoprene coated insulation liner in fan housing. Do not expose fiberglass to airstream.
- .3 Fan Shaft:
 - .1 Turn, grind, and polish stainless steel shaft.
 - .2 Key shaft to wheel hub.
 - .3 Size shaft for first critical speed minimum 1.25 times maximum speed for each fan class.
- .4 Bearings: Manufacturer's standard, heavy duty, field-lubricated pillow block ball type, based on fan size and mounting orientation.
 - .1 Minimum L-10 life in excess of 100,000 hours; L-50 life at 500,000 hours at the maximum cataloged operating speed, in accordance with AFBMA.
 - .2 Provide belt and bearing enclosure to shield from airstream.
- .5 Fan Wheels: Aluminum hub and non-overloading wheel with backward-inclined blades, statically and dynamically balanced.

- .6 Belt Drive:
 - .1 Drive Components: V-Belt drive, rated for minimum 150 percent of motor nameplate horsepower, with machined, cast-iron pulleys, and heat resistant, oil resistant, static-free V-belts.
 - .2 Motor Pulley: Adjustable pitch.
- .7 Motors: Comply with NEMA MG-1 for designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 20 05 70.
 - .1 Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - .2 When required, provide premium efficiency motor, suitable for inverter duty, for motors controlled by Variable Frequency Drive (VFD).
 - .3 Provide unfused disconnect switch, NEMA 3R (NEMA 4X for outdoor installations) shipped loose for field mounting and wiring.
- .8 Finish: Galvanized mill finish internal parts, and uncoated external aluminum parts exposed to weather.
- .9 Accessories:
 - .1 Backdraft Damper: Motorized, parallel-blade type. Adjust backdraft damper to close when fan is not running; fabricate frame from galvanized steel.
 - .1 Backdraft damper actuator suitable for 24 VAC, single phase.
 - .2 Belt Guard: Provide formed galvanized steel guard to cover the complete drive assembly.
 - .3 Motor Cover: Provide formed galvanized steel guard to cover the motor and complete drive assembly.
 - .4 Stainless steel hardware.
 - .5 Extended lube lines.
 - .6 Provide isolation hangers selected for 1 in. (25.4 mm) deflection.
 - .7 Side Discharge Kits: Provide replacement side panels to add 1-way, 2-way, or 3-way discharge.

2.03 TUBULAR INLINE CENTRIFUGAL FANS

- .1 Belt-driven backward inclined centrifugal fans, configured for horizontal or vertical flow of relatively clean air for Heating, Ventilating, and Air-Conditioning (HVAC) applications.
 - .1 Acceptable Manufacturers: Twin City, Greenheck, Cook, Northern Blower, or approved equal.
 - .2 Permanently attach nameplate displaying serial number and unit information.
- .2 Fan Capacities, Characteristics, and Configuration: Refer to Drawing schedule.
- .3 Fan Wheel: Fabricate backward inclined wheel from aluminum wheels 27 in. diameter and smaller, and steel for wheels 30 in diameter and larger. Include matched inlet venturi.
 - .1 Statically and dynamically balance wheel when fabricated, and again after fan unit has been assembled.
- .4 Fan Shaft: Turned, ground, and polished steel. Select shaft diameter so that First Critical Speed is minimum 1.25 times maximum operating speed. Finish with petroleum based rust protectant.
- .5 Bearings: Manufacturer's standard, self-aligning, field-lubricated pillow block ball bearings, based on fan size and mounting orientation, with polyethylene grease lines extended to outside fan housing.
 - .1 Minimum L-10 life in excess of 100,000 hours; L-50 life at 500,000 hours at the maximum cataloged operating speed, in accordance with AFBMA.

- .6 Housing: Formed [steel] [aluminum] with continuously welded seams and prepunched inlet and outlet flanges for duct connections. Include mounting feet or hanger connections to suit installation requirements.
- .7 Belt Drives:
 - .1 Drive Components: V-belt drive, rated for minimum 150 percent of motor nameplate horsepower, with machined, cast-iron pulleys, and heat resistant, oil resistant, conductive, static-free V-belts. Provide belt guard or motor cover to shield drives.
 - .1 Motor 20 HP and Smaller: Adjustable pitch.
 - .2 Motor Larger than 25 HP: Fixed pitch.
 - .3 Provide belt shield tubes to isolate drive components from airstream. Continuously weld tubes where they penetrate inner cylinder and outer housing.
 - .4 Belt Guard: Steel, totally encloses motor sheaves and V-belt drive assembly.
 - .5 Outdoor Weather Cover: Provide OSHA compliant steel weather cover to shield motor and belt-drive from weather. Fabricate with rainproof ventilation slots.
- .8 Motors: Comply with NEMA MG-1 for designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 20 05 70.
 - .1 Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - .2 When required, provide premium efficiency motor, suitable for inverter duty, for motors controlled by Variable Frequency Drive (VFD).
 - .3 Provide unfused disconnect switch, NEMA 3R (NEMA 4X for outdoor installations), shipped loose for field mounting and wiring.
 - .4 Provide electrical metal tubing (EMT) conduit into motor compartment, with watertight fitting at curb cap penetration.
 - .5 Motor Mounting Platform: Heavy-duty motor mounting platform allows adjustment of drive belt tension.
- .9 Vibration Isolation:
 - .1 Provide spring vibration isolators in accordance with fan manufacturer's requirements; spring isolators selected for 1 in. (25.4 mm) deflection.
- .10 Finishes:
 - .1 After fabrication, clean and chemically pretreat steel parts by phosphatization. Apply two coats gray enamel.
- .11 Accessories:
 - .1 Mounting Brackets: Provide factory welded mounting brackets to mount fan unit in horizontal or vertical position.
 - .2 Belt Guard: Steel, totally enclosed and non-sealed.
 - .3 Inlet Vane Dampers: Provide pre-rotational inlet vane dampers nested in fan inlet.
 - .1 Provide inlet damper actuator suitable for 24VAC, single phase.
 - .4 Access Door:
 - .1 Provide inspection and maintenance of the internal section V-belt drive area units.
 - .2 Doors are gasketed, single-skinned, and hinged to the housing exterior.
 - .5 Shaft seal, including non-asbestos rubbing ring and metal cover plate, to limit airstream infiltration.
 - .6 Provide anti-static shaft grounding blocks to protect motor bearings by draining stray currents to ground.

- .7 Bolt-on companion flanges that match fan flanges for making connections to ductwork.

2.04 BACKWARD INCLINED SINGLE WIDTH SINGLE INLET (SWSI) CENTRIFUGAL FANS

- .1 Description: Belt Driven, Backward Inclined Centrifugal Fans: Single-width, single-inlet fan.
 - .1 Acceptable Manufacturers: Twin City, Greenheck, Cook, Northern Blower, or approved equal.
 - .2 Permanently attach nameplate displaying serial number and unit information.
- .2 Fan Capacities, Characteristics, and Configuration: Refer to Drawing schedule.
- .3 Fan Wheel: Fabricated wheel with flat, single thickness blades, continuously welded to conical rim and backplate. Hub to be keyed to shaft. Partial welds are not acceptable.
 - .1 Materials of Construction: Manufacturer's standard, based on wheel size and pressure class.
 - .2 Statically and dynamically balance wheel.
 - .3 Minimum Balance Quality Grade: G6.3, in accordance with AMCA Standard 204.
- .4 Fan Shaft: Turned, ground, and polished stainless steel shaft, with shaft keyed to wheel hub, sized for first critical speed minimum 1.25 times maximum speed for each fan class.
 - .1 Include OSHA compliant shaft and bearing guard.
- .5 Bearings: Heavy-duty, grease lubricated, spherical roller or anti-friction ball, self-aligning, pillow block type, based on fan size and mounting orientation, with grease lines extended to outside fan housing.
 - .1 Minimum L-10 life in excess of 100,000 hours; L-50 life at 500,000 hours at the maximum cataloged operating speed, in accordance with AFBMA.
- .6 Housing: Continuously welded steel, reinforced with rigid bracing. Includes aerodynamically spun inlet cone.
 - .1 Access Door - Bolted flush with interior, 6 inches (152 mm)
 - .2 Drain: 3/4 inch NPT with plug.
 - .3 Provide housing with pre-punched flanges for making connections to ductwork.
- .7 Supports: Steel angle, intermittently welded with sealant filled between welds.
- .8 Direct Drive:
 - .1 Where Direct Drive is noted on equipment schedules mount fan wheel directly on motor shaft.
 - .2 Provide coupling with service factor of 1.5 x motor HP between motor and fan shaft.
 - .3 Include OSHA compliant coupling guard.
- .9 Belt Drive:
 - .1 Where Belt Drive is noted on equipment schedules, provide V-belt drive, rated for minimum 150 percent of motor nameplate horsepower, with machined, cast-iron pulleys, and heat resistant, oil resistant, V-belts. Locate belts and drives outside fan housing.
 - .1 Motor 10 HP and Smaller: Adjustable pitch.
 - .2 Motor 15 HP and Larger: Fixed pitch.
 - .3 Belt Guard: Steel, ventilated, OSHA compliant.
- .10 Motors: Comply with NEMA MG-1 for designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified Section 20 05 70.
 - .1 Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - .2 Motor Speed: Based upon performance requirements and application.

- .3 Provide unfused disconnect switch, NEMA 3R (NEMA 4X for outdoor installations), shipped loose for field mounting and wiring.
- .4 When controlled with a Variable Frequency Drive (VFD), provide premium efficiency motors suitable for inverter duty use.
- .11 Motor Mounting Platform: Heavy-duty motor mounting platform that allows adjustment of drive belt tension.
- .12 Isolation Type Base:
 - .1 Provide spring isolators with 1 in. (25.4 mm) deflection.
- .13 Accessories:
 - .1 Weather Cover: for exterior mounted fans provide steel weather cover with painted finish to shield motor and belt-drive from weather. Fabricate with ventilation slots.
 - .2 Spark Resistant Construction: where noted on the equipment schedules, mount bearings outside flow airstream.
 - .1 AMCA Type B: Provide aluminum fan wheel impeller and aluminum rub ring where shaft penetrates fan housing. Maximum operating temperature: 250 deg. F (121 deg. C).
 - .3 Piezometer Ring: Provide piezometer ring type differential pressure device with connections for field-installed flow measuring instrumentation.
 - .1 Pressure Transducer without Display: Provide piezometer ring and transducer to convert differential pressure readings to 4 - 20 mA DC signal proportional to flow for input to Building Automation ("BAS") system.
 - .4 Extended Lube Lines: Provide lubrication lines with grease fittings from the fan bearings terminating on the drive side of the fan for ease of lubrication.
 - .5 Standard Coating: All carbon steel components shall be cleaned and chemically treated by a phosphatizing process. Fan shall then be coated with blue enamel.

2.05 ROOF MOUNTED CENTRIFUGAL MUSHROOM VENTILATORS

- .1 Belt-Driven, Centrifugal Roof Ventilators: Centrifugal fan units, configured for vertical flow of relatively clean supply or exhaust air for general ventilation applications.
 - .1 Acceptable Manufacturers: Twin City, Greenheck, Cook, Northern Blower, or approved equal.
 - .2 Permanently attach nameplate displaying serial number and unit information.
- .2 Fan Capacities, Characteristics, and Configuration: Refer to Drawing schedule.
- .3 Motor Mount Assemblies: Provide motor mount assemblies fabricated of heavy gage galvanized steel.
- .4 Wheel: Centrifugal, backward inclined type, containing matching inlet venturi.
 - .1 Statically and dynamically balance wheel.
- .5 Fan Shaft: Turned, ground, and polished steel shaft, with shaft keyed to wheel hub, sized for first critical speed minimum 1.25 times maximum speed for each fan class.
- .6 Bearings: Manufacturer's standard, heavy duty, field-lubricated pillow block ball type, based on fan size and mounting orientation.
 - .1 Minimum L-10 life in excess of 100,000 hours; L-50 life at 500,000 hours at the maximum cataloged operating speed, in accordance with AFBMA.
- .7 Housing: Bolt on type. Heavy gauge spun aluminum construction of shroud, top cover, and motor bands. Roll edge beads.
 - .1 Fabricate units with deep formed inlet venturi to prevent snow and rain entry into building.
 - .2 Provide galvanized steel wire bird screen at fan outlet.

- .8 Curb Cap: One-piece, weather-tight construction, pre-punched mounting holes for correct attachment to roof curb. Fabricate from aluminum and include flange to mate with fan unit inlet flange.
- .9 Belt Drive:
 - .1 Drive Components: V-belt drive, rated for minimum 150 percent of motor nameplate horsepower, with machined, cast-iron pulleys, and heat resistant, oil resistant, static-free V-belts.
 - .1 Motor Pulley: Adjustable pitch.
 - .2 Motor and Drive Assembly: Resiliently mounted on rubber isolators.
 - .1 Provide mechanism that allows for precise belt tensioning by one person.
- .10 Motors: refer to Section 20 05 70
 - .1 Provide NEMA 3R (NEMA 4X for outdoor installations), unfused disconnect switch supplied loose for field mounting.
- .11 Finish: Galvanized mill finish internal parts, and galvanized steel parts exposed to weather.
- .12 Accessories:
 - .1 Roof Curb: 18 inches (457 mm) high, unvented, with 1-1/2 inch (38 mm) thick insulation.
 - .2 Curb Cap: One-piece, weather-tight construction, pre-punched mounting holes for correct attachment to roof curb. Fabricate aluminum and include flange to mate with fan unit inlet flange.
 - .3 Insulated automatic damper meeting requirements of 25 05 30.
 - .4 Aluminum wire insect screen.

2.06 PROPELLOR WALL FANS

- .1 Propeller Wall Fans: Belt Driven, heavy duty propeller wall fans for general-purpose ventilation
 - .1 Acceptable Manufacturers: Twin City, Greenheck, Cook, Northern Blower, or approved equal.
 - .2 Permanently attach nameplate displaying serial number and unit information.
- .2 Fan Capacities and Characteristics: Refer to Drawing schedule.
- .3 Propeller: Fixed pitch cast aluminum blades and hub. Secure wheel to fan shaft with taper lock bushing.
 - .1 Machine propeller to proper diameter.
 - .2 Statically and dynamically balance propeller.
- .4 Fan Shaft:
 - .1 Hot-rolled steel.
 - .2 Grind, polish and ring gauge shaft.
 - .3 Key shaft to wheel hub.
 - .4 Size shaft for first critical speed minimum 1.42 times maximum fan speed.
- .5 Bearings shall be heavy-duty, grease lubricated, anti-friction ball or roller type, self-aligning, mounted in pillow blocks.
 - .1 Minimum L-10 life in excess of 100,000 hours; L-50 life at 500,000 hours at the maximum cataloged operating speed, in accordance with AFBMA 9.
- .6 Belt Drive:
 - .1 Drive Components: V-belt drive, rated for minimum 150 percent of motor nameplate horsepower, with machined, cast-iron pulleys, and heat resistant, oil resistant, static-free V-belts.

- .1 Motor Pulley: Adjustable pitch for motors up to 15 HP.
- .2 Motor Pulley: Fixed pitch for motors 20 HP and larger.
- .7 Motors: refer to Section 20 05 70
 - .1 Provide NEMA 3R (NEMA 4X for outdoor installations), unfused disconnect switch, shipped loose for field mounting and wiring.
- .8 Frame: Formed tube steel supports welded to steel panel with formed inlet venturi and pre-punched holes for mounting anchors. Motor mounting plate bolted to frame tubes.
- .9 Finishes:
 - .1 After fabrication, deburr, clean and chemically pretreat metal parts by phosphatization.
 - .2 Apply two coats of air dry enamel.
- .10 Accessories:
 - .1 Motorized Damper, Center-pivoted steel type. Suitable for 3000 feet/minute (15.2 meter/second) air velocity.
 - .2 24V Damper actuator;
 - .3 Wall Box: Painted steel, sized to match dimensions of fan panel, with mounting flange and pre-punched mounting holes. Suitable for attachment of inlet screen, backdraft damper, weather hood, outlet screen, and disconnect switch.
 - .4 Wire Guards: Provide hinged welded or woven type wire to enclose fan and motor size of unit.

PART 3 - EXECUTION

3.01 INSTALLATION OF FANS

- .1 Fans shall be installed in strict accordance with Manufacturer's installation instructions and all requirements of the Authorities Having Jurisdiction.
- .2 Mount fans with vibration isolation, floor mounted springs or spring hangers as applicable, with minimum 1" (25mm) deflection. Ensure assembly is vibration free during fan performance testing.
- .3 For suspended fan applications provide steel support brackets from floor or overhead with vibration isolators at centreline supports on fan; do not place isolators on floor or at overhead attachment point. Install snubbers parallel with fan horizontal longitudinal axis.
- .4 Leave sufficient access for servicing fan components. Install belt guards and accessories as required.
- .5 Install all fan accessories in accordance with fan manufacturer's requirements.
- .6 Where remote fan air flow volume digital display is specified, locate the display where noted on the drawings and/or directed by the Consultant. Coordinate sensor BAS integration with Control Trades.
- .7 Where fan knock down is specified the Contractor shall identify limiting dimensions to move fan components to position on site and provide for the reassembly where noted on the Drawings. Reassembly and resulting fan performance shall be verified by fan manufacturer.

END OF SECTION

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PART 2 - PRODUCTS

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provision of terminal air grilles and diffusers, and related ancillaries.

1.03 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the construction and installation of air distribution equipment and related ancillaries.
- .2 Submittals: Submit shop drawings for the following Products:
 - .1 All products specified

1.04 REFERENCE STANDARDS

- .1 SMACNA HVAC Duct Construction Standards Metal and Flexible - Second Edition

1.05 VOLATILE ORGANIC COMPOUND ("VOC") REQUIREMENTS

- .1 All adhesives, sealants, paints and coatings used on or inside of building weatherproofing layer shall have a VOC content that is less than the content limits defined in LEED® Product Requirements.

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 GENERAL

- .1 Provide standard product to meet capacity, throw, noise level, and throat and outlet velocity as indicated on the Drawings and the Equipment Schedules.
- .2 Where grilles, registers and diffusers penetrate fire walls and fire partitions, provide approved steel sleeve secured to structure in accordance with NFPA 90A and required fire damper.
- .3 Frames:
 - .1 Steel: primed cold rolled steel with exposed welded joints and mitred corners.
 - .2 Aluminum: extruded satin finish with mechanical fasteners and mitred corners.
 - .3 Provide plaster frames as plaster stops where set into plaster or gypsum board.
 - .4 Provide concealed fasteners and balancing operators in all finished areas.
 - .5 Final finish to be selected by Architect from standard manufacturer finishes at shop drawing stage.
 - .6 Style, frame, and installation details as indicated on the schedule.
 - .7 Sizes and capacities: as indicated on the Drawings and in the Equipment Schedules.
- .4 Wherever possible, grilles and diffusers shall be the product of one (1) manufacturer. Acceptable Manufacturers (unless noted otherwise):

- .1 Nailor;
- .2 EH Price;
- .3 Metalaire;
- .4 Tuttle and Bailey;
- .5 Or approved equivalent.

2.02 SUPPLY GRILLES AND REGISTERS

- .1 1¼" (32 mm) border double deflection with airfoil shape horizontal face and vertical rear bars and gaskets.

2.03 RETURN AND EXHAUST GRILLES AND REGISTERS

- .1 1¼" (32 mm) border, single deflection, air foil shape, horizontal bar type 35° max turn up, when shown on the schedule opposed blade damper with concealed operator and rubber sealing strips.
- .2 Egg crate to be ½"x½"x1" deep (12x12x25mm deep), type as per schedule.
- .3 Perforated Grilles shall consist of a perforated core with 3/16" (5) holes on 1/4" (6) centres staggered 60 degrees and an extruded aluminum border. Finish in accordance with the schedule.

2.04 DIFFUSERS

- .1 Diffusers shall consist of a precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct.
- .2 Refer to schedule for finish.
- .3 As indicated on the schedule, circular, square or perforated type, having adjustable fixed pattern.
- .4 Equip supply diffusers having a basic 4-way or all round air pattern for operation in one (1), two (2) or three (3) way pattern where so directed on the drawings
- .5 For plaque or cone diffusers an inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance. The inner plaque or cone assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck.

2.05 LINEAR GRILLES

- .1 Bar core linear grilles with frame as indicated, plaster frame, sealing strip and accessories as indicated.
- .2 All corners shall be mitred.
- .3 Floor grilles to be capable of supporting 200 lb (90 kg) point load weight between supports with negligible deflection.
- .4 Do not supply OBD in return air linear grilles.
- .5 Extruded aluminium linear slot diffuser with adjustable vane controls and accessories as indicated.
- .6 Provide end cap for continuous linear diffuser terminating at walls and partitions.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Comply with Manufacturer's requirements for the installation of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.
- .3 Unless otherwise specified, install grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

- .4 Exactly locate grilles and diffusers to conform to the final architectural reflected ceiling plans and detailed wall elevations, and to conform to the final lighting arrangement, ceiling layout, ornamental and other wall treatment.
- .5 For linear bar grilles and linear slot diffusers site measure for exact fit.
- .6 Install and adjust air registers to provide noiseless and draftless distribution.
- .7 Supply plaster frames for installation by Drywall Trades for grilles and diffusers installed in plaster or drywall finishes. Fit frames tightly to prevent leakage and smudging.
- .8 Primary air balance to be completed at duct dampers with final adjustment only at diffusers and grilles.

3.02 SPECIAL INSTALLATION REQUIREMENTS

- .1 Grilles, registers and diffusers penetrating fire walls and fire partitions shall have steel sleeves secured to structure in accordance with ULC or cUL listing and NFPA 90A.
- .2 For security grilles and diffusers, and other grilles and diffusers exceeding 5 kg (12 lbs) weight, mechanically fasten grille/diffuser to ceiling or wall structure, independent of ductwork connection or support.

3.03 AIR BALANCING

- .1 Refer to Section 20 05 95.

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- 3.06 AIR BALANCING**

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provision of air distribution equipment and related ancillaries.
- .2 Louvers are to be supplied and installed by Trades other than Mechanical Division Trades.

1.03 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the construction and installation of air distribution equipment and related ancillaries.
- .2 Submittals: Submit shop drawings for the following Products:
 - .1 Variable/ Constant Air Volume ("VAV/ CAV") control boxes;
 - .2 Fan Powered Box ("FPB") Terminal Control Units
 - .3 Bypass Terminal ("BPT") Units
 - .4 Duct Monitoring Stations ("DMS");

1.04 REFERENCE STANDARDS

- .1 SMACNA HVAC Duct Construction Standards Metal and Flexible - Second Edition
- .2 NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems
- .3 NFPA 90B - Installation of Warm Air Conditioning and Air Conditioning Systems
- .4 ASTM A621 & A621M Specification for Forming Steel (FS), sheet and Strip, Carbon, Hot Rolled.
- .5 ASTM A653M Specification for Steel Sheet, Zinc Coated Galvanized or Zinc Alloy Coated (Galvannealed) by the Hot Dip Process
- .6 ASTM A924M General Requirements for Sheet Steel, Metallic Coated by the Hot Dip Process

1.05 VOLATILE ORGANIC COMPOUND ("VOC") REQUIREMENTS

- .1 All adhesives, sealants, paints and coatings used on or inside of building weatherproofing layer shall have a VOC content that is less than the content limits defined in LEED® Product Requirements.

1.06 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 VARIABLE AIR VOLUME/ CONSTANT AIR VOLUME ("VAV/ CAV") BOXES:

- .1 Single duct, pressure independent variable/constant air volume control assemblies, complete with discharge attenuator and electronic digital controls.
- .2 Units: Pressure independent volume regulator type; designed and constructed for hospital and critical care applications.

- .3 Low pressure systems of single duct type with constant or variable volume control and housed within sound attenuating box.
- .4 Casing: 22 gauge (0.89 mm) minimum thickness galvanized steel insulated with minimum of 13/16" (21 mm) thick 4 lb/cu.ft. (64 kg/cu.m) thermal and acoustic steri-liner insulation which complies with UL-181 and NFPA 90A. Fibreglass shall be with a reinforced aluminum FSK facing meeting the requirements of NFPA 90A, UL-181 and ASTM C655. Casing leakage upstream of the damper shall not exceed 2% @ 3" w.g. (746 Pa); casing leakage downstream of the damper shall not exceed 1% @ 1" w.g. (250 Pa).
- .5 The primary air valve damper shall be opposed blade type 16-gauge metal, with peripheral gasket, pivoted in self-lubricating bearings. In full closed position, air leakage past the closed damper shall not exceed 2% of the nominal catalog rating at 3 in.wg. (750 Pa) inlet static pressure as rated by ASHRAE Standard 130.
- .6 The primary air valve damper and DDC motor operator shall vary primary air in response to a signal. Damper operation shall be demonstrated to be closed to minimum position before heating is activated. No overlap under any circumstances shall be allowed. Damper shall be located inside unit. Damper connection to operating shaft shall be a positive mechanical connection.
- .7 The air flow sensor shall be of cross or diamond configuration located at the inlet of the assembly. The sensor shall have twelve total pressure sensing ports and a centre averaging chamber designed to accurately average the flow across the inlet of the assembly. Sensor shall be certified to provide accuracy within 5% of actual air flow with a 90° sheet metal elbow directly at the inlet of the assembly. The air flow sensor shall amplify the sensed air flow signal.
- .8 At an inlet velocity of 2000 fpm pressure drop for cfm range of box shall not exceed 0.11 in.wg. (27 Pa.).
- .9 All sound data shall be compiled in an independent laboratory and in accordance with the latest version of AHRI Standard 880 and ANSI/ASHRAE Standard 130. Sound rating of assembly including box and attenuator or dissipative silencer under design operating conditions shall not exceed the following:
 - .1 Radiated: NC 35 unless noted otherwise on the Equipment Schedules.
 - .2 Discharge: NC 35 Based on room absorption of 10 db, and an inlet static pressure of 1.5" W.G. (375 Pa.) unless noted otherwise on the Equipment Schedules.
- .10 Sound Attenuation:
 - .1 The manufacturer shall supply sound attenuators to meet scheduled acoustical performance requirements of NC 30 unless noted otherwise. The unit shall be provided with discharge attenuators and/ or discharge silencers as required to meet acoustic requirements.
 - .2 Where one attenuator fails to provide the sound performance required, provide additional attenuators or lengths of duct lining. Where attenuators with outlets are used they shall be rated with the outlets and not as straight attenuators without outlets
 - .3 Attenuators:
 - .1 Provide minimum 36" (914mm) discharge attenuator(s) in accordance with the Equipment Schedules.
 - .2 Attenuator sections shall contain a unit casing constructed of 22 ga. (.86) coated steel perforated baffles encapsulate fiberglass acoustic media; provide mylar lining with acoustical spacer to isolate material from airstream.
 - .3 Inlet and discharge shall be rectangular and configured for slip and drive connections.
 - .4 Each attenuator section shall be internally lined with 3/4" (19mm) thick, 4 lb./cu. ft. (64 kg/m³) density Steri-Liner insulation with a reinforced aluminum FSK facing, placed inside the top and bottom sides of the attenuator.

- .11 Provide integral **hot water heating coil** sized in accordance with the schedule where indicated on the drawings. Hot water heating coils shall be as follows:
 - .1 Terminal unit hot water heating coils shall be mounted on the discharge of the unit with slip and drive connections; provide an access door or panel on the bottom of the attenuator section of the terminal unit for servicing and cleaning the unit.
 - .2 Hot water heating coils shall be constructed with copper tubes and aluminum plate fins. Coils shall have a maximum of 10 fins per inch. Supply and return connections shall be on the same end of the coil. Fins shall be bonded to the tubes by means of mechanical expansion of the tubes. Fins shall be at least .0045" (0.11mm) thick.
 - .3 Coils shall have galvanized steel casings on all sides no lighter than 22 ga. (1.00mm).
 - .4 Copper tubes shall be 1/2" (13) O.D. and shall be spaced approximately 1 1/4" (32mm) apart and shall have a minimum wall thickness of 0.016" (0.41mm). Hot water shall be equally distributed through all tubes by the use of header design.
 - .5 Select coils with water velocity in the tubes not to exceed five feet per second. The water pressure drop through the coil shall not exceed 10 ft.wg. Heating coil face velocities shall not exceed the maximum face velocity indicated in the Schedules.
 - .6 Coils shall be tested by air pressure under water. Coils shall be tested at 350 psi (2,413 kPa) air static pressure.
 - .7 Coil ratings, calculations and selection data shall be in accordance with the applicable AHRI Standards and shall be submitted with the Shop Drawings.
 - .8 Control valves, automatic air vents and drain vents, shall be supplied and field installed by the Mechanical Trades.
- .12 All digital controls including motor, transducer, controller, and similar control devices to be supplied by the BAS Trade Contractor for factory installation by box manufacturer. The cost of the Installation of the controls shall be carried by the box manufacturer.
- .13 Equipment Schedules: as indicated on the Drawings.
- .14 Acceptable Manufacturers:
 - .1 Nailor Industries
 - .2 E.H. Price,
 - .3 Metalaire,
 - .4 Titus,
 - .5 Tuttle and Bailey,
 - .6 Or approved equivalent.

2.02 SERIES FLOW FAN POWERED POWER BOX ("FPB") TERMINALS

- .1 Provide series flow, constant or variable volume per the intended application, fan powered box terminal units of the sizes and capacities as indicated on the drawings. Units shall be **low noise**, pressure independent with digital electronic controls.
- .2 The entire terminal unit shall be designed and built as a single unit.
- .3 The units shall be provided with a primary variable air volume damper that controls the air quantity in response to an electronic thermostat.
- .4 Unit casings shall be space frame construction utilizing 18 ga. (1.31mm) galvanized steel corner structural members and 20 ga. (1.00mm) galvanized steel panels.
- .5 Each unit shall be internally lined with 3/4" (19mm) thick, 4 lb. /cu.ft. (64 kg/cu.m) density fiberglass insulation with a reinforced aluminum FSK facing. Units shall meet NFPA 90A and UL 181 standards.

- .6 Unit casing shall have four access panels, one on each side of the unit and one on the bottom and top for easy access to motor and blower assembly and for maintenance and replacement of parts without disturbing duct connections.
- .7 The unit shall be rated to operate in left hand or right hand mode by turning the unit over.
- .8 Access panels shall be attached to casing with quick acting latches.
- .9 Casing leakage shall not exceed 2% of terminal rated airflow at 0.5 in.wg. (125 Pa) interior casing pressure. All high side casing joints shall be sealed with approved sealant and high side casing leakage shall not exceed 2% of terminal rated airflow at 3 in.wg. (750 Pa).
- .10 Units shall have round inlets for the primary air connections and shall have a 6" (152mm) deep inlet duct collar for field connection. The outlets shall be rectangular and suitable for flanged duct connections. Casing shall have mounting area for hanging by sheet metal straps from a concrete slab.
- .11 The damper shall be of rectangular, multiple inclined opposed blade construction and designed to operate on a 45° arc. Blades shall be minimum 16 ga. (1.61mm) galvanized steel, single thickness construction with heavy duty gasket glued to the blades. The blades shall be screwed through the damper shaft to ensure that no slippage occurs. Blade shafts shall pivot on corrosion free bearings. Damper leakage shall not exceed 2% of the terminal rated air volume in CFM at 3 in.wg. (750 Pa) inlet static pressure.
- .12 Entire terminal unit shall be factory assembled with electronic controls. All components including all controls except the room thermostat shall be factory installed and mounted with the unit.
- .13 Provide a digital electronic flow control device that will limit the maximum and minimum airflow to that on the Equipment Schedules.
- .14 Airflow limits shall be factory set.
- .15 Thermostat signal shall reset the flow control device to adjust primary airflow to match load requirements.
- .16 Control of the terminal unit shall be pressure independent.
- .17 The terminal unit shall be capable of operation as described herein with inlet static pressure of 0.05 in.wg. (12 Pa) at full cooling with no mixing of induced and primary air.
- .18 Mixing of the primary and secondary airstreams shall be such that no more than 2.5°F (1.4°C) variation shall exist in the discharge airstream for each 20°F (11.1°C) of difference between the primary and secondary airstreams.
- .19 Blower casings shall be constructed of heavy gauge coated steel. Blower wheel shall be forward curved centrifugal type, dynamically balanced and driven by Electronically Commutated Motor(s). Motor(s) shall be suitable for 120 or 208 or 240 or 277 volt single phase power.
- .20 Fan airflow volume shall be factory set.
- .21 Fan assembly shall be mounted so as to isolate the casing from the motor and blower vibration at no less than four points. Isolation shall be supplied at the motor and at the blower mounting points.
- .22 A gasketed backdraft damper shall be included on the fan discharge to reduce primary air leakage back into the plenum space.
- .23 An electronic motor speed controller sized and designed for the specific blower motor combination shall be provided to allow infinitely adjustable fan speed from the minimum voltage stop to the line voltage signal to the motor. A minimum voltage stop shall be employed to ensure that fan cannot run in stall mode.
- .24 Units shall incorporate a single point electrical connection. The entire assembly including the hot water coil shall be cETL listed for zero clearance and labeled, and shall meet all requirements of the latest Canadian Electrical Code, CSA Standard C22.1. All electrical components shall be mounted in a control box. The entire assembly shall be cETL listed and labeled.
- .25 Hot Water Heating Coil:

- .1 A hot water coil shall be factory mounted as an integral package with the fan powered terminal unit. Hot water coils shall be sized as shown on the drawings.
- .2 The unit shall have a single point electrical connection.
- .3 Water coil casing and panels shall be a minimum of 20 ga. (1.00mm) galvanized steel.
- .4 Access panels shall be supplied on the top and bottom of the unit for easy access to the coil for inspection and cleaning.
- .5 All copper, including the headers and return bends, shall be encased to eliminate heat loss during heating sequence and heat gain during cooling sequence.
- .6 Coils shall be 1, 2 or 3 row as required and heating capacities shall be as shown on the Equipment Schedules.
- .7 Coils shall have aluminum plate fins spaced 10 per inch and bonded to ½" (13mm) O.D. copper tubes.
- .8 Copper connections shall be sweat joints.
- .9 All coils shall be tested at a minimum of 300 psi (2.1 MPa) under water to produce a working pressure of 250 psi (1.7 MPa).
- .10 Controls and valves for the hot water coils shall be field mounted.
- .11 Heating coils shall be located on the discharge side of the fan.
- .26 All sound data shall be compiled in an independent laboratory and in accordance with the latest version of AHRI Standard 880. All units shall be AHRI certified and bear the AHRI certification label.
- .27 Unit maximum radiated sound power levels at 1.0" w.g. (250 Pa) inlet pressure and 0.25" w.g. (63 Pa) discharge static pressure shall not exceed the values in Tables below at the specified airflow. No credit or reduction shall in any way be considered for room, plenum, ceiling and/or similar item effects.

Maximum Radiated Sound Power Levels Full Cooling (Fan on and 100% primary air)								
Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
1	400	189	63	61	53	46	43	41
2	550	260	60	59	51	45	43	42
3	700	330	58	58	50	45	42	41
4	1200	566	67	62	56	52	49	47
5	1600	755	68	63	56	51	48	46
6	2100	991	71	66	60	56	52	49
7	2800	1321	70	64	58	53	49	47

Maximum Radiated Sound Power Levels Full Heating (Fan Only)								
Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
1	400	189	62	59	52	45	41	37
2	550	260	57	53	46	39	36	33
3	700	330	55	53	47	41	36	32
4	1200	566	63	58	52	48	45	44
5	1600	755	66	60	54	50	46	42
6	2100	991	70	65	59	55	51	47
7	2800	1321	69	65	56	53	50	46

- .28 Unit maximum discharge sound power levels at 1.0" w.g. (250 Pa) inlet pressure and 0.25" w.g. (63 Pa) discharge static pressure shall not exceed the values in the Table below at the specified airflow. No credit or reduction shall in any way be considered for room, downstream duct, elbows and/or similar item effects.

Maximum Discharge Sound Power Levels Full Cooling (Fan on and 100% primary air)								
Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
1	400	189	71	68	63	59	55	52
2	550	260	70	66	61	57	53	50
3	700	330	70	65	62	58	54	50
4	1200	566	82	77	73	70	67	66
5	1600	755	80	76	71	70	68	67
6	2100	991	80	79	76	77	74	73
7	2800	1321	79	76	73	71	68	67

- .1 Plenum Return Filter:
- .1 The plenum return shall be supplied with filters.
 - .2 When tested in accordance with ASHRAE 52.2, the filter shall have a Minimum Efficiency Reporting Value of MERV 8.
- .2 Sound Attenuation:
- .1 The manufacturer shall supply sound attenuators to meet scheduled acoustical performance requirements of NC30 unless noted otherwise. The unit shall be provided with inlet attenuators, discharge attenuators and discharge silencers as required to meet acoustic requirements.

- .2 Where one attenuator fails to provide the sound performance required, provide additional attenuators or lengths of duct lining. Where attenuators with outlets are used they shall be rated with the outlets and not as straight attenuators without outlets
- .3 Attenuators:
 - .1 Provide minimum 60" (1500mm) inlet and/ or discharge attenuator(s) in accordance with the Equipment Schedules.
 - .2 Attenuator sections shall contain a unit casing constructed of 22 ga. (.86) galvanized steel.
 - .3 Inlet and discharge shall be rectangular and configured for slip and drive connections.
 - .4 Each attenuator section shall be internally lined with 3/4" (19mm) thick, 4 lb./cu. ft. (64 kg/m³) density fiberglass insulation with a reinforced aluminum FSK facing, placed inside the top and bottom sides of the silencer.
- .3 Controls:
 - .1 Terminal unit manufacturer to provide fan relay, power transformer and power disconnect switch.
 - .2 Provide digital controller to operate primary air damper operator between maximum or minimum air volume settings.
 - .3 Terminal units to be factory set to 30% minimum air flow position unless noted otherwise on drawings. Minimum air flow to be field adjustable.
- .4 Acceptable Manufacturers:
 - .1 Nailor Industries Inc. model 35SST "Stealth".
 - .2 Or acceptable equivalent

2.03 BYPASS TERMINAL ("BPT") UNITS

- .1 General Information
 - .1 Provide variable air volume bypass terminal units where shown on the drawings. Performance and capacities shall be as scheduled on the drawings.
- .2 Construction
 - .1 Each section shall be internally lined with 3/4" (19mm) thick, 4 lb. density fiberglass insulation with a reinforced aluminum FSK facing. Units shall meet NFPA 90A and UL 181 standards.
 - .2 Units shall incorporate a heavy duty steel cylindrical flow diverter valve.
 - .3 Units shall include integral inlet and bypass balancing dampers for field adjustment as standard components.
 - .4 Static pressure taps shall be provided to facilitate air balancing.
- .3 Controls
 - .1 Units shall be provided with a modulating electronic control package. The 24 volt reversible actuator shall be factory mounted direct to the damper shaft and shall include an adjustable minimum air volume end stop as a standard feature.
 - .2 The 24 volt modulating electronic thermostat for field mounting shall be supplied with a (°C) (°F) temperature scale. The thermostat shall be suitable for vertical wall mounting.
 - .3 The thermostat shall be microprocessor based and provide proportional plus integral control of airflow and reheat when specified.
 - .4 A 115 to 24 volt 20 VA transformer shall be provided, complete with all necessary hardware for field mounting.

- .5 A changeover thermistor shall be provided with control packages designed to control both heating and cooling supply air.
- .4 Attenuators:
 - .1 Provide minimum 60" (1500mm) attenuator at the discharge of every box.
 - .2 Attenuator sections shall contain a unit casing constructed of 22 ga. (.86) galvanized steel.
 - .3 Inlet and discharge shall be rectangular and configured for slip and drive connections.
 - .4 Each attenuator section shall be internally lined with 3/4" (19mm) thick, 4 lb./cu. ft. (64 kg/m³) density fiberglass insulation with a reinforced aluminum FSK facing, placed inside the top and bottom sides of the silencer.
- .5 Provide integral hot water reheat coil sized in accordance with the schedule where indicated on the drawings. Hot water heating coils shall be as follows:
 - .1 Terminal unit hot water heating coils shall be mounted on the discharge of the unit with slip and drive connections; provide an access door or panel on the bottom of the attenuator section of the terminal unit for servicing and cleaning the unit.
 - .2 Hot water heating coils shall be constructed with copper tubes and aluminum plate fins. Coils shall have a maximum of 10 fins per inch. Supply and return connections shall be on the same end of the coil. Fins shall be bonded to the tubes by means of mechanical expansion of the tubes. Fins shall be at least .0045" (0.11mm) thick.
 - .3 Coils shall have galvanized steel casings on all sides no lighter than 22 ga. (1.00mm).
 - .4 Copper tubes shall be 1/2" (13) O.D. and shall be spaced approximately 1 1/4" (32mm) apart and shall have a minimum wall thickness of 0.016" (0.41mm). Hot water shall be equally distributed through all tubes by the use of header design.
 - .5 Select coils with water velocity in the tubes not to exceed five feet per second. The water pressure drop through the coil shall not exceed 10 ft.wg. Heating coil face velocities shall not exceed the maximum face velocity indicated in the Schedules.
 - .6 Coils shall be tested by air pressure under water. Coils shall be tested at 350 psi (2,413 kPa) air static pressure.
 - .7 Coil ratings, calculations and selection data shall be in accordance with the applicable AHRI Standards and shall be submitted with the Shop Drawings.
 - .8 Control valves, automatic air vents and drain vents, shall be supplied and field installed by the Mechanical Trades.
- .6 Acceptable Manufacturers:
 - .1 Nailor Industries,
 - .2 E.H. Price,
 - .3 Metalaire,
 - .4 Titus,
 - .5 Tuttle and Bailey,
 - .6 Or approved equivalent.

2.04 DUCT MONITORING STATIONS ("DMS")

- .1 Provide Nailor model 36VRS, or equivalent, pressure independent variable air volume duct monitoring stations ("DMS") for duct retrofit applications in accordance with the Equipment Schedules where shown on the drawings.
- .2 Duct monitoring stations shall be designed, constructed and configured to retrofit and convert existing constant air volume systems into variable air volume systems.
- .3 Duct monitoring station construction shall be as follows:

- .1 16 ga. Galvanized steel damper with extruded PVC blade seals and metallic side jamb seals;
 - .2 Leakage less than 2% of nominal air flow at 3.0 in.wg. pressure when tested in accordance with ASHRAE Standard 130;
 - .3 Celcon® bearings;
 - .4 ½" (13mm) diameter plated steel drive shaft, double bolted to blade;
 - .5 Indicator mark on the end of the drive shaft to show the damper position;
 - .6 A 20 ga. (0.91mm) galvanized steel control enclosure to enclose all controls (BAS Control Trades to verify enclosure size requirements to accommodate vendor specific devices);
 - .7 Multi-point averaging flow sensor complete with aluminum gauge taps for field balancing;
 - .8 Gasket material around the perimeter of the duct monitoring station mounting plate to seal the assembly to the interior surface of the duct.
- .4 Duct monitoring stations shall be complete with the following options:
- .1 A factory minimum air flow setting of zero (shut-off);
 - .2 16" (408mm) long sleeve;
 - .3 24V control transformer;
 - .4 Toggle disconnect switch;
- .5 Dust tight enclosure seal.
- .6 Acceptable Manufacturers:
- .1 Nailor Industries,
 - .2 Or approved equivalent.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Comply with Manufacturer's requirements for the installation of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.
- .3 Support Air Terminal Control Units and connecting ductwork in accordance with SMACNA Standards or as indicated.
- .4 Provide an air vent at the high point of all hot water reheat coil piping.
- .5 Provide a drain at the low point of all hot water re-heat air piping.

3.02 INSTALLATION OF VARIABLE AIR VOLUME/ CONSTANT AIR VOLUME (CAV/VAV) BOXES

- .1 Secure each box in place from the structure by means of galvanized steel angles and hanger rods, independent of connecting ductwork.
- .2 Connect each box with ductwork as indicated. Provide straight inlet duct the same size as the box inlet and of a length equal to a minimum of four duct diameters. Co-ordinate final box adjustments and settings with personnel doing system testing and balancing work.

3.03 INSTALLATION OF FAN POWERED BOX ("FPB") TERMINALS

- .1 Secure each box in place from the structure by means of galvanized steel angles and hanger rods, independent of connecting ductwork.

- .2 Connect each box with ductwork as indicated. Provide straight inlet duct the same size as the box inlet and of a length equal to a minimum of four duct diameters. Co-ordinate final box adjustments and settings with personnel doing system testing and balancing work.

3.04 INSTALLATION OF BYPASS TERMINAL ("BPT") UNITS

- .1 Secure each box in place from the structure by means of galvanized steel angles and hanger rods, independent of connecting ductwork.
- .2 Connect each box with ductwork as indicated. Provide straight inlet duct the same size as the box inlet and of a length equal to a minimum of four duct diameters. Co-ordinate final box adjustments and settings with personnel doing system testing and balancing work.

3.05 DUCT MONITORING STATIONS ("DMS")

- .1 Install air monitoring stations ("DMS") in strict accordance with manufacturer's requirements and all requirements of the Authorities Having Jurisdiction.
- .2 Install duct monitoring stations generally where shown on the drawings to meet manufacturer's minimum upstream and downstream straight duct length requirements to ensure flow measurement accuracy and repeatability.
- .3 Confirm existing duct size in the field prior to ordering duct monitoring stations.

3.06 AIR BALANCING

- .1 Refer to Section 20 05 95.

END OF SECTION

CONTENTS

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PART 3 - EXECUTION

- 3.01 GENERAL INSTALLATION REQUIREMENTS**
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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.02 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.1, Gravimetric and Dust Spot for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter (ANSI Approved).

1.03 WORK PERFORMED BY THIS SECTION

- .1 Provision of air filters.
- .2 Provision of filter housings.
- .3 Provision of HEPA Filter Housings.
- .4 Activated Carbon Filters.

1.04 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the construction and installation of air filters.
- .2 Submittals shall include a letter of certification noting filter media rating meets or exceeds the specified and/or published values.
- .3 Submittals: Submit shop drawings for the following Products:
 - .1 Pre-Filers;
 - .2 Final Filters;
 - .3 Air filter housings;

PART 2 - PRODUCTS

2.01 GENERAL FILTER REQUIREMENTS

- .1 Allow minimum 18" (450mm) clear space upstream of filter frame to allow full utilization of filter area in contact with the air stream.
- .2 Filters: Suitable for air at 100% RH and air temperatures up to 350°F.
- .3 Filters shall bear burst strength of 10 in.wg. (2500 Pa).
- .4 Provide air filter section in each air handling unit to accept specified filters including frames for removal through the plenum section, upstream of the filters.
- .5 Provide frames reinforced to prevent deflection by the air stream with a 6 in.wg. (1500 Pa) pressure differential.
- .6 Provide blank-off plates and gaskets to prevent air bypass.
- .7 Acceptable filter manufacturers: American Air Filter ("AAF"), and Camfil. Alternative filters may be considered by the Consultant provided a cost savings to the Owner can be demonstrated.

2.02 PRE-FILTERS

- .1 Provide filter racks on each side of heating coil to accept pre-filters.
- .2 Pleated Panel Filters: 2" deep (50mm), MERV 8, UL 900 Class 2 and as follows:
 - .1 Each filter shall consist of an individual pleated media pack, enclosed in a clay coated board frame, with integral pleat stabilizers and support straps.

- .2 Filter media shall be a blend of 100% virgin synthetic fibres.
- .3 Filter media must be self-supporting in pleated form, with no metal or plastic material laminated to the media to provide pleat support.
- .4 The pleated media pack must be enclosed in a 1-piece, 28 pt. moisture resistant beverage carrier board frame.
- .5 Filter must have three pleat stabilizers bonded to the media on the air leaving side and three support straps adhered to the air entering side of the filter. The pleat stabilizers must be made of moisture resistant beverage carrier board, and bonded to the media to maintain the proper pleat spacing throughout the life of the filter. The support straps are to be made from moisture resistant beverage carrier board and must be adhered along the tips of each pleat.
- .3 Filters of the size and air flow capacity shall meet the rated performance specifications based on the ASHRAE 52.2-1999 test method. Pertinent tolerances specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 600mm x 600mm (24"x24") face dimension.
- .4 The filters shall be approved and listed by Underwriters' Laboratories, Inc. as Class 2 when tested according to UL 900 and CAN 4-5111.

2.03 HIGH EFFICIENCY CARTRIDGE TYPE FINAL FILTERS

- .1 Extended Surface V-Bank Cartridge Filters: 12" (305mm) deep, MERV 14 or MERV 13 per the equipment schedules, UL 900 Class 2 and as follows:
 - .1 Each filter shall consist of 8 pleated media packs assembled into 4 V-banks within a totally plastic frame.
 - .2 The filters shall be capable of operating at temperatures up to 176°F.
 - .3 The moulded end panels are to be made of high impact polystyrene plastic.
 - .4 The centre support members shall be made of ABS plastic; no metal components are to be used.
 - .5 The media shall be made of micro glass fibres with a water repellent binder. The media shall be a dual density construction, with coarser fibres on the air entering side and finer fibres on the air leaving side.
 - .6 The media shall be pleated using separators made of continuous beads of low profile thermoplastic material.
 - .7 Media packs shall be bonded to the structural support members at all points of contact to ensure rigidity and to eliminate potential air bypass.
- .2 Filters of the size, air flow capacity and nominal efficiency (MERV) shall meet the rated performance specifications based on the ASHRAE 52.2-1999 test method. Where applicable, performance tolerance specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 600mm x 600mm (24"x24") header dimension.
- .3 The filters shall be approved and listed by Underwriters' Laboratories, Inc. as Class 2 when tested according to UL 900 and CAN 4-5111.

2.04 AIR FILTER HOUSING

- .1 General
 - .1 Air Filter Housings shall be Camfil GlidePack, Uni Track 25 (25" deep), or approved equal.
 - .2 Filter housing shall be sized based on 12" (305mm) deep filters with nominal module sizes of 24"x24" (610mm x 610mm) up to a maximum of five (5) modules high by six (6) modules wide, and a maximum velocity of 500 fpm, unless noted otherwise in the documents.

- .3 Air Filter Housing shall be dual-stage air filter housing consisting of 16-gauge galvanized steel enclosure, extruded aluminum filter mounting track, dual-access doors, three static pressure taps, door and filter gaskets and seals. In-line housing depth shall not exceed 25".
- .2 Construction
 - .1 The housing shall be constructed from 16-gauge galvanized steel with standing flanges to facilitate attachment to other HVAC system components. Corner posts of Z-channel construction shall ensure housing stability and rigidity.
 - .2 The housing shall be weatherproof and suitable for rooftop/ outdoor installation without modification.
 - .3 The housing shall incorporate a nominal 1" (25.4mm) deep filter header track that will hold 12" (305mm) deep box filters, constructed of extruded aluminum and shall be an integral component of filter box housing.
 - .4 Dual access swing-open doors shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal against all individual stages of filtration. Each door shall be equipped with adjustable and replaceable positive sealing UV-resistant star-style knobs and replaceable door hinges.
 - .5 The housing shall include a pneumatic fitting to allow the installation of static pressure gauge to evaluate pressure drop across the installed air filter.
- .3 Performance
 - .1 Leakage at rated airflow, upstream to downstream of filter and slide mechanism shall not exceed 1% at 3.0 in.wg. Leakage into or out of the housing shall be less than 1% at 3.0 in.wg.
 - .2 Accuracy of pneumatic pressure fittings, when used to evaluate a single-stage, or multiple filter stages, shall be accurate within +/- 3% at 0.6 in.wg.
 - .3 Housing integrity to listed performance values shall be available on request from the housing manufacturer.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Comply with Manufacturer's requirements for the installation of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.

3.02 INSTALLATION OF FILTERS

- .1 Provide all required air filters, located and arranged as shown and scheduled.
- .2 Provide all required filter assembly frames and install to prevent air by-pass and to permit easy filter removal. Construct frames from the same material as the plenum, casing or duct the filters are associated.
- .3 When air handling systems are complete and ready for start-up and testing, but building finishes are not complete and cleaning is not complete, provide minimum 20% average dust spot efficient (atmospheric) temporary glass fibre media in place of permanent filters prior to fan start-up, and provide temporary media over all return air openings in dirty, dusty, incomplete areas.
- .4 Prior to application for a Certificate of Substantial Performance, and when the systems are ready for air balancing, remove temporary media and install permanent filters.

3.03 INSTALLATION OF AIR FILTER HOUSING

- .1 Install air filter housing in duct main where shown on the drawings.
- .2 Install air filter housing in accordance with manufacturer's instructions.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with requirements of Section 20 08 10 Mechanical Commissioning

1.02 SCOPE OF WORK OF THIS SECTION

- .1 Provision of HVAC system heat exchangers and all related ancillaries.

1.03 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the installation of pressure piping and heat transfer systems for hydronic heating and cooling applications.

1.04 SUBMITTALS

- .1 Submit shop drawings for the following Products:
 - .1 Plate & Frame Heat Exchangers;
 - .2 Shell & Tube Heat Exchangers.

1.05 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Trade Contractor is to review all discrepancies and verify the locations of all existing services that are being extended, and the routing of new services.
- .2 Report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Trade Contractor.
- .3 Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 PLATE AND FRAME HEAT EXCHANGERS

- .1 General: Plate heat exchangers shall be suitable for potable water applications and shall be designed, constructed, tested, and "U" stamped in accordance with Section VIII, Division 1 of the ASME Pressure Code. A U-1 form and picture of the nameplate shall be furnished.
- .2 Frame Construction Requirements: Provide single pass designs with all connections on the head (fixed pressure plate).
- .3 The head (fixed pressure plate) and follower (loose pressure plate) shall be constructed of carbon steel in sufficient thickness and strength to operate within the designated design and test pressures. Welded reinforcements or stiffeners will not be allowed on the heat exchanger pressure plates .
- .4 Lifting lugs designed to support the entire flooded weight of the plate heat exchanger shall be included on all heat exchanger with 4" connections or greater.
- .5 The plate heat exchanger shall be flushed clean at factory prior to shipment. All connections shall be factory sealed to prevent the entrance of foreign material during transit.
- .6 Connection Requirements:
 - .1 Connections equal to or less than 2" shall be male NPT type.
 - .2 All plate heat exchangers with connections greater than 2" shall be equipped with studed connections conforming to ANSI B16.5.

- .3 Connections shall be clearly marked on the plate heat exchanger and shall correspond to vendor drawings.
- .7 Tightening Bolt Requirements:
 - .1 Frame tightening bolts, constructed of SA193 B7 with SA194 B2H nuts, will be mechanically retained to prevent accidental side removal. Tightening bolts will be equipped with a captive nut at the head (fixed pressure plate) and a keyed working nut at the follower (loose pressure plate) to allow for easy opening and closing of the plate heat exchanger.
 - .2 Tightening bolts are to be zinc plated. Rust prevention lubrication is not an acceptable substitute as it can be removed over time and use.
 - .3 Thrust bushings (ball bearing box washers) shall be located at all critical closing bolts on plate heat exchangers with 10" connections or greater. The thrust bushings allow for easy opening and closing of the plate heat exchanger without damaging the epoxy coating of the follower (fixed pressure plate).
 - .4 The bolting system shall be designed so that only four (4) main tightening bolts are required for the opening and closing of a plate heat exchanger.
- .8 Plate Requirements:
 - .1 Heat transfer plates shall be (2) two pieces of 0.35mm plates (double wall) pressed in one-step, no multi-stage pressing of one plate is allowed. No additional material should be added to the single metal plate sheet e.g. local reinforcements in hanger area or in gasket grooves.
 - .2 Heat transfer plates shall be permanently marked to identify material and origin.
 - .3 The design shall be such that the plate can withstand the maximum operating pressure with no pressure on the adjacent plates.
 - .4 Plate material shall be 316 Stainless Steel
- .9 Gasket Requirements:
 - .1 Gasketing system shall be non-glued.
 - .2 Inactive port gasket areas shall be vented to the exterior in such a manner that no mixing can occur between the fluid circuits.
 - .3 Gaskets shall include alignment shoulders to assist heat transfer plate alignment.
- .10 Acceptable Manufacturers: Flo-Fab, Kelvion Inc., Alfa Laval, S.A. Armstrong, Bell & Gossett, or equal approved by the Consultant.

2.02 SHELL AND TUBE HEAT EXCHANGERS

- .1 General: Steam to Water, shell and tube heat exchanger.
- .2 Heat exchanger shall be mounted on a carbon steel frame work and supplied with a suitably sized, ASME rated mild steel receiver, to handle the pumping load of the system so as not to cause any retention of condensate in the shell of the heat exchanger.
- .3 Heat exchanger shall be shell and tube, U bend removable bundle.
- .4 The following materials of construction shall be utilized:
 - .1 Front head: Cast Iron.
 - .2 Baffles: Steel
 - .3 Tie Rods/Spacers: Steel
 - .4 Shell: Steel
 - .5 Gasket Material: Compressed Fibre
 - .6 Tubes: 3/4" OD Seamless Copper
 - .7 Tubesheet : Steel

- .5 The tube side shall be constructed based on a 150 PSIG design pressure at 375°F.
- .6 The shell side shall be constructed based on a 150 PSIG design pressure at 375°F.
- .7 The ASME U symbol shall be stamped on the heat exchangers. Each unit shall be registered with the National Board of Boiler and Pressure Vessel Inspectors.
- .8 Capacity as indicated in the schedule.
- .9 Tubeside velocity shall not be more than 5.4 ft per second.
- .10 Fouling factors shall be +0.00063.
- .11 Shell diameter shall not be less than 4" (100mm).
- .12 Maximum bundle length shall be no more than 8 feet (2400 mm); unless otherwise noted.
- .13 Heat exchanger shall be provided with float thermostatic steam trap, sensing chamber, steel check valves, isolating valves and all ancillary pipe work.
- .14 Unit shall be factory assembled and tested and be ready to be fitted into the installation by connecting the steam supply, steam supply into the exchanger and condensate outlet away from the pump.
- .15 Unit shall be capable of draining condensate from the heat exchanger when the system is under vacuum and also when the back pressure on the system is greater than the steam pressure within the shell of the heat exchanger.
- .16 Acceptable Manufacturer: Flo-Fab, Taco, Spirax Sarco, S.A. Armstrong, ITT Bell & Gossett, or approved equal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Comply with Manufacturer's requirements for the installation of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.
- .3 Locate equipment as shown on the drawings to provide connection arrangement and accessibility for servicing.
- .4 Provide clearances on all sides of equipment as required by the Manufacturer's Installation Instructions.
- .5 Install items of equipment with due regard to Architectural treatment, and ensure all items are level and finished in keeping with good workmanship.
- .6 Provide chemical treatment by-pass connections at heat exchangers on heating and cooling circuits as directed by chemical treatment supplier.
- .7 Provide branch take-offs from mains of heating and cooling pipes with shut off valves.
- .8 Install and connect remote components and other similar ancillary devices specified or supplied loose with the equipment. Install in serviceable locations as shown on the equipment manufacturer's installation details, and where shown on the drawings.

3.02 HEAT EXCHANGERS

- .1 Provide package type plate and frame heat exchangers where shown and/or required.
- .2 Provide package type shell and tube heat exchangers where shown and/or required.
- .3 Provide a line size strainer or pump suction diffuser at the primary side inlet connection to each plate and frame heat exchanger.
- .4 Secure each heat exchanger in place on a prime coat painted welded structural steel stand to a concrete housekeeping pad.

3.03 TESTING

- .1 Meet testing requirements of all Authorities Having Jurisdiction (AHJs). Obtain certification and certify tests not required by AHJs. Perform not less than the following tests.
- .2 Prove hydronic piping tight under a hydrostatic test of 150% of design working pressure but not less than 700kPa (100 psi). Test without pressure drop for a period of not less than 4 hours.
- .3 Perform tests before equipment is covered or concealed.
- .4 Remove all components which will not withstand test pressure and replace after tests.
- .5 Eliminate leaks or remove and refit defective parts. Do not caulk threaded or welded joints.
- .6 After work is completed, adjust and put all parts of the system into proper working order. Adjust all valves to achieve specified heating capacities. Leave the complete job ready for regular operation, all to the satisfaction of the Consultant.
- .7 After the testing period, drain the system, and before water treatment is introduced into the system, clean out all dirt pockets and strainers.
- .8 Provide lubricating oils, packing, and other accessories, for proper operation of the system.
- .9 The final test and acceptance shall not be made until the work is finally completed.

3.04 EQUIPMENT START UP

- .1 Follow manufacturer's instructions and have manufacturer's representative present to certify the installation.
- .2 Check each item of equipment to ensure proper piping connections, to verify proper operation.

3.05 WATER BALANCING

- .1 Refer to Section 20 05 95.
- .2 Provide flow measurement ports as shown on detail drawings and piping schematics in locations as directed by the Testing Adjusting and Balancing ("TAB") Trades. Provide additional balancing valves where recommended by the TAB Trades.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .2 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .3 Comply with requirements of Section 20 05 70 Motors, Motor Starters, Motor Control Centres, Variable Frequency Drives and Wiring
- .4 Comply with the requirements of Section 25 10 10 BAS Control Network
 - .1 Comply with all requirements including those referenced in Article "BAS Integration with Third Party Devices"

1.03 WORK PERFORMED BY THIS SECTION

- .1 Provision of Air to Air Recovery Systems

1.04 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the construction and installation of Air to Air Recovery Systems.
- .2 Submittals: Submit shop drawings for the following Products:
 - .1 Air to Air Recovery Systems and all components and accessories

1.05 REFERENCE STANDARDS

- .1 Provide fan ratings based on tests meeting ASHRAE and AMCA procedures and provide only fans carrying the AMCA seals. No fan will be accepted which has a point of rating not listed in the published data or which is not rated for air and sound performance.
- .2 Fans shall be factory balanced, statically and dynamically to AMCA Standards.
- .3 Factory finish coat over primer on all parts. Spray paint before assembly and repaint after reassembly.
- .4 Units shall be designed and constructed to meet the following standards:
 - .1 CSA Z317.2-15 Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Health Care Facilities. Note: Not all the requirements in this CSA Standard are summarized in this Section of Specification. Manufacturer shall make reference to and comply with this CSA standard.
 - .2 ASHRAE 51-07 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
 - .3 ASHRAE 90.1 – 2010 Standard for Energy Efficient Design for New Buildings.
 - .4 AMCA Standard 300-2006 Reverberant Room Method for Sound Testing of Fans.
 - .5 AMCA Standard 301-2006 Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 - .6 ARI Standard 575-94 Method of Measuring Machinery Sound Levels within Equipment Rooms.
 - .7 ARI Standard 350-2000 Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment.
 - .8 ASHRAE Standard 68-97/ AMCA Standard 330-97 Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
 - .9 ASHRAE 52.2
 - .10 ANSI Standard 221.47

- .11 ARI 850-93 Section 7.4
- .12 CGA, ETLC, CSA or UL/ULC certified for prewired equipment
- .13 NRCA Standard for Roof Curbs
- .14 NFPA 90A for flame and smoke spread for adhesives

1.06 ACOUSTICAL PERFORMANCE

- .1 Acoustical performance shall be established by AMCA standard 330, ASHRAE Standard 68 or ARI 260P procedures.
- .2 Sound data shall be supplied that does not exceeds levels requirements indicated on schedules or fan performance data sheets; any sound data presented as 'sones' or 'Bels' is not acceptable.

1.07 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

1.08 SUMITTALS

- .1 Submit product Shop Drawings in accordance with requirements of Section 20 01 10 with the following information:
 - .1 General layout drawing with plan and elevation views including all relevant dimensions,
 - .2 Performance schedule including airflow, heating and cooling capacities, electrical data, unit weight.
 - .3 Energy recovery wheel performance characteristics including:
 - .1 sensible and latent energy recovery efficiency,
 - .2 frost point based on design conditions,
 - .3 speed range in RPM.
 - .4 Fan energy consumption:
 - .1 kW of supply and exhaust fans at design condition,
 - .2 watts per CFM calculation defined as:
$$(\text{design condition supply fan watts} + \text{design condition exhaust fan watts}) / \text{supply fan airflow}$$
 - .5 Full fan curve.
 - .6 Sound power data by octave band for all openings and radiated through cabinet.
 - .7 Electrical schematics including field wiring connections.
 - .8 Component details including construction method and materials.
 - .9 Control point schematic and complete written sequence of operation.
 - .10 Curb mounting details.

1.09 ACCEPTABLE MANUFACTURERS

- .1 Swegon (Passive House Certified Component)
- .2 Ventacity (Passive House Certified Component)
- .3 Other Passive House accredited air to air recovery systems as approved by the Consultant.

PART 2 - PRODUCTS

2.01 AIR TO AIR RECOVERY SYSTEMS

.1 Casing

- .1 Cabinet shall be nominal 2" double wall panel with 3.0lb density glass fibre insulation. Insulation shall have a flame spread of rating not exceeding 25 and a smoke developed rating not exceeding 50. Cabinet exterior shall be 20 gauge pre-painted steel that meets or exceeds 650hour salt spray test based on ASTM B117. Liners and other steel components shall be galvalume AZ180 or equivalent. All seams shall be sealed to provide air tight casing.
- .2 Doors shall be nominal 50mm double wall panel with the same construction as the cabinet. Doors shall be fitted with flush mounted lockable two stage handles. Panel deflection shall not exceed L/240 at 125% of design static pressure, minimum +/- 1.25 kPa. Deflection shall be measured at the midpoint of the panel height.
- .3 The unit will be designed for service and maintenance on one side only to allow for a compact installation.
- .4 Units shall be tested in accordance with EN 1886 or equivalent and meet the following criteria:
 - .1 Casing air leakage = A (Air tightness class L2); Under 1.6 in.wg air leakage rate shall be no more than 3 cfm/100 sq.ft and under 2.8 in.wg air leakage rate shall be no more than 10 cfm/sq.ft.
 - .2 Thermal transmittance = T3;
 - .3 Thermal bridging factor = TB3; The ratio between the lowest temperature difference between any point on the external surface and the mean air-to-air temperature difference. Unit shall meet 0.6 bridging
 - .4 Environmental Class C4.
- .5 Units shall be designed so they can be unbolted and broken down into sections for access to restricted locations.
- .6 Provide SS 304 drain pans with cross break and pitch to drain connection. Provide extended drain pans under cooling coil section to avoid drift carryover.
- .7 All dampers shall have extruded heavy gauge 6063 aluminium frame that includes jamb seals. Blades will be airfoil shaped extruded aluminium with rubber blade seals. Damper blades shall be insulated with expanded polyurethane foam providing R-2.29 and include a thermal break. Linkage shall be installed in the frame outside the airstream.

.2 Fans

- .1 Fans shall be axial- centrifugal type with EC direct drive motor suitable for variable speed operation. Fan and motor assembly shall be mounted on common base with 25mm (1") deflection Rubber in shear isolation. on common base with 25mm (1") deflection spring isolation. Fan shall be connected to fan bulkhead by a canvas type flex connector.
- .2 Locate fan and motor internally on a steel base. Factory mount motor on a slide base that can be slid out of unit. Fan motors shall be permanent magnet, synchronous motor type with integral digital motor controller.
- .3 Provide self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Provide grease fittings attached to fan base assembly near access door.
- .4 DOAS unit must not have unit sound power levels exceeding maximum Passive House Standards.

.3 Bearings and Drives

- .1 Fan motors shall be permanent magnet, synchronous motor type with integral digital motor controller. Fan bearings shall be serviceable type with an L-10 life of 40,000 hours.

- .2 All fans shall be equipped with integral airflow monitoring system connected to the unit controller.
- .4 Coils
 - .1 Provide access to coils from connection side of unit for service and cleaning. Enclose coil headers and return bends fully within unit casing. Fabricate coil connections, vents and drains to extend beyond unit casing including grommets for an airtight unit casing. Coils shall be removable through side panels and/or top panels of unit without removal and disassembly of entire section.
 - .2 Provide dual sloped 304 stainless steel drain pan located underneath and extending downstream of coil and intermediate drain pans.
 - .3 Coil performance shall be as scheduled. Coil performance data shall be certified in accordance with ARI Standard 410 where applicable.
 - .4 Construction:
 - .1 Tubes: Copper.
 - .2 Fins: Aluminum mechanically bonded to tubes.
 - .3 Headers: Seamless copper with vent and drain connections.
 - .4 Casing: 16-gauge, galvanized steel channels with 16-gauge center and end supports.
 - .5 Cooling/dehumidification and heating coils where water is the fluid shall be circuited drainable with a vent connection at the highest point and a drain connection at the lowest point. Coil headers shall be copper with steel male pipe connections.
 - .6 For water coils supply 2-way modulating control valves complete with valve actuators for field installation. Include wiring harness with quick connect wiring harness for both valve power source and control signals.
 - .7 Dehumidification coil section shall include passive wrap around heat pipe for passive reheat
- .5 Humidifier Section
 - .1 Provide a 1200 (48") long blank section, complete with access door and drain base, suitable for field installation of an electronic humidifier as Specified in Section 23 84 13.
- .6 Filters
 - .1 Provide filter box section with side loading MERV 8 pleated pre-filter section on exhaust side.
 - .2 Unit shall include side loaded cartridge filter rack suitable for 560mm (22"), ten (10) pocket MERV 13 bag filters on the fresh air side with MERV 8 pre-filters. Filters will be held in position by an expanding locking device.
- .7 Energy Recovery Device
 - .1 Unit shall include AHRI 1060 certified rotary heat exchanger that transfers both sensible and latent energy. Wheel shall be constructed of corrugated aluminium coated with Zeolite. Desiccant material shall be 4A or smaller molecular sieve. Wheel supports shall be galvanized steel with a rigid steel hub. Cassette shall be heavy duty reinforced galvanized steel with a built in purge section. Bearings shall be permanently sealed type. Rotary heat exchanger shall include adjustable face and peripheral brush seals. Drive motor shall be variable speed type integrated into unit controller.
 - .2 Dry Bulb temperature recovery efficiency to be not lower than indicated on schedules.
 - .3 Humidity recovery efficiency to be not lower than indicated on schedules.
 - .4 $\geq 75\%$ heat recovery efficiency is required for Passive Compliance. Heat recovery efficiency must be confirmed either according to PHI or through Passive House calculation procedure including ERV performance derating.

- .5 Rotary Heat Exchanger carry over must not exceed 0.45% and be certified to EN308: 1997.
- .6 Provide airflow monitor to measure outdoor airflow through enthalpy wheel. Monitor shall be integrated into unit controller. Airflow accuracy shall be minimum $\pm 5\%$ of design airflow.
- .7 The heat recovery wheel must be equipped with dual drive belts for redundancy.
- .8 The energy recovery wheel must be Carbon Trusts ETL listed and eligible for ECA.
- .8 Cross Contamination (EATR) Control
 - .1 Units shall include and utilize the following means to maintain cross contamination (EATR) at less than 0.5% of the supply airflow through the use of brush seals, rotor purge sector, variable speed rotor control to vary the rotor speed with supply airflow modulation, and return air opening pressure balance plates to ensure the correct pressure balance within the unit to ensure purge airflow from the outside airstream to the exhaust airstream:
 - .1 Units shall include standard pressure balancing plates at return air opening. These plates are to be set at startup, based on the pressure differential between supply and return air, to ensure purge airflow moves from the supply airstream to the exhaust airstream. Pressure gradient across the rotor seal must be between 0 and 0.08" and deliver EATR less than 0.5% as certified by 3rd party verification.
 - .2 Unit controls shall include built-in Air Quality Control algorithms. This feature includes standard algorithms in the unit controller and an optional factory installed modulating damper on the return airstream. The unit controls shall constantly monitor the pressure differential between supply and return air and maintain the pressure differential between 0 and 0.08" over the entire operating airflow range.
- .9 Digital Controls
 - .1 Unit shall include an integrated microprocessor based unit controller. The controls shall be located in the integral controls cabinet. All controls shall operate off a transformer from the main power supply for single point power connection. All internal controls and sensors shall be factory prewired and tested. The microprocessor shall have dual Ethernet ports with an internal firewall to allow remote access via third party without compromising the clients internal Network.
 - .2 ERV units must utilize built-in controls and ERV wheel speed control algorithms that use wheel speed modulation to:
 - .1 Control supply air temperature
 - .2 Prevent wheel frost development – Wheel frost control shall be done by reading wheel pressure differential. With an increase in pressure drop due to frost accumulation the wheel speed will slow providing wheel defrost. Frost controls based upon exhaust air temperature shall not be allowed due to loss of energy savings
 - .3 Modulate wheel speed as supply airflow modulates to ensure maximum purge efficiency and absolute minimum airflow cross-contamination at less than 0.45% EATR at all airflow conditions.
 - .3 Provide airflow monitor to measure outdoor airflow through enthalpy wheel. Monitor shall be integrated into unit controller. Airflow accuracy shall be minimum $\pm 5\%$ of design airflow.
 - .4 Provide temperature sensors at all four (4) cardinal point positions on the ERV wheel. Display outside air temperature and return air temperature on the unit handheld, touchscreen controls interface panel and provide all four (4) temperature readings via BACnet output to the BAS.
 - .5 Provide factory mounted pressure sensors to measure filter pressure drop across pre- filter and main filter. Pressure drop shall be digitally feedback to controller for utilization in control and alarm sequencing. Unit controller shall monitor filter pressure level and report when filter changes are required.

- .6 Include each unit with a touch pad type human interface that allows monitoring and control of all unit functions. Human interface shall communicate with unit controller by hardwire connection. Human interface shall be unit mounted.
- .7 The control system will regulate temperatures, airflows and other functions as required. Unit controller shall be pre-programmed with factory test software for all possible functions. Controller shall utilize "plug and play" feature that will automatically load and operate any necessary algorithm based on components and accessories that are connected to the controller such as air flow monitors, damper actuators, fans, rotary energy recovery, water control valves, etc.
- .8 The controller shall provide the following;
 - .1 Control of fans correcting for both changes in total static pressure and air density in both VAV and constant airflow applications.
 - .2 Real time total unit power consumption (fans, ERV wheel motor and controls) as "watts/CFM" monitored through the BAS.
 - .3 Fan performance monitoring.
 - .4 Ventilation airflow monitoring and control.
 - .5 Airflow density correction for winter and summer conditions.
 - .6 Energy recovery optimization including operation of rotary energy recovery device.
 - .7 Supplemental heating and cooling when included.
 - .8 Integration to VRF condensing units when included.
 - .9 Frost protection certified to meet the frost protection requirements of Passive House Institute
 - .10 Recirculation module when included.
 - .11 Monitoring alarms, faults and maintenance points including filter changeout.
 - .12 Time and date schedules.
 - .13 Building pressurization.
 - .14 Humidity control.
 - .15 Data logging and trending.
- .9 The microprocessor unit controller shall have the ability to control two (2) independent zones complete with heating and cooling coils, control valves and all sensors to accomplish the independent control sequence.
- .10 Include wireless capability via built-in WiFi connection that will allow the client to access remotely via Smart Phone, laptop, tablet, and similar without supplemental software.
- .11 Controller shall be BACnet certified and also include Modbus communication capability.
- .12 Controller shall be BTL certified for BACnet IP and also include Modbus, and Metasys communication. Communication shall include monitoring, control, alarms, faults and maintenance information.
- .13 Provide factory installed and tested contactors, overloads, fusing, motor speed controllers for supply, exhaust and rotary energy recovery device. Include all necessary control transformers.
- .14 Supply all necessary temperature and pressure sensors complete with plug in wiring harnesses for proper option of unit.
- .10 Unit Electrical
 - .1 Provide unit mounted non-fused disconnect switch with single point power connection for main ERV.

PART 3 - EXECUTION

3.01 INSTALLATION

- .1 Installation of air-to-air recovery systems shall be in strict accordance with manufacturer's instructions and the requirements of the Authorities Having Jurisdiction (AHJs).
- .2 Install floor mounted air handling units on a flat surface leveled within 3mm. Air handlers shall be mounted on housekeeping pads. Height of pad to be sufficient to allow for proper draining of deep P-trap sized to account for pressure differential between air handling unit interior and drain termination.
- .3 Provide condensate traps in accordance with manufacturers recommendations.
- .4 Install air handling units to allow proper service to all components.
- .5 Provide drain valves and vent cocks to each coil.
- .6 Arrange units for floor mounting complete with vibration isolators
- .7 Provide flexible duct connections between the equipment and duct connections
- .8 The equipment including coils, fans, and similar components shall be cleaned thoroughly before performing testing and balancing procedures.
- .9 Return/Exhaust side of all HVAC equipment shall be isolated from the surrounding environment during construction activities.
- .10 Protect acoustic lining and insulation as well as pre-lined and insulated ductwork from moisture accumulation and damage. This applies both to stored material and installed systems.

3.02 HUMIDIFIERS

- .1 The humidifier grid shall be installed at the factory of the air handling units. Installation instruction shall be provided to air handling unit manufacturer for reference.
- .2 Humidifier factory representative shall review shop drawing and installation to ensure absorption distance is maintained and humidifiers are installed in accordance with the manufacturer's instructions.
- .3 Provide a factory-trained service technician without additional charge to start and commission the humidifiers. In addition, factory shall allow for job site review of each air handling unit to carry out start-up, commissioning and instruct Owner's representatives; dates will be determined by owner's representative.

3.03 START-UP SERVICE

- .1 Provide a factory-trained service technician to start and commission the units. In addition, factory shall allow for each unit to carry out start-up, commissioning and instruct Owner's representatives; dates will be determined by Owner's representative. These shall be in addition to the field pressure testing of the air handling units.
- .2 Manufacturer shall allow for additional site visits to ensure compliance of the installation; these are in addition to those specified for start-up, testing and commissioning noted above. Dates will be assigned by Owner's representative.
- .3 Provide a start-up log by the manufacturer to document the unit start-up.

END OF SECTION 23 72 10

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .2 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .3 Comply with requirements of Section 20 05 70 Motors, Motor Starters, Motor Control Centres, Variable Frequency Drives and Wiring
- .4 Comply with the requirements of Section 25 10 10 BAS Control Network
 - .1 Comply with all requirements including those referenced in Article "BAS Integration with Third Party Devices"

1.03 WORK PERFORMED BY THIS SECTION

- .1 Provision of Packaged Rooftop Air-Conditioning Units.

1.04 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the construction and installation of Packaged Rooftop Air-Conditioning Units.
- .2 Submittals: Submit shop drawings for the following Products:
 - .1 Packaged Rooftop Air-Conditioning Units including all components and accessories

1.05 REFERENCE STANDARDS

- .1 Packaged air-cooled condenser units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.
- .2 Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- .3 Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- .4 Unit shall be certified in accordance with ANSI Z21.47b/CSA 2.3b and ANSI Z83.8/CSA 2.6, Safety Standard Gas-Fired Furnaces.
- .5 Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- .6 Unit shall be certified by ETL and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label. The nameplate, safety labels and warnings will be in English and French.
- .7 Unit shall be approved for use in and outside High Velocity Hurricane Zones (HVHZ) by the Florida Building Code (FL# 15031), when using the required steel rooftop curb and attachment methods. Maximum allowable lateral wind pressure is +100psf/-100psf.
 - .1 Maximum allowable uplift is +50psf/-50psf. Positive and negative required design pressures calculated for use with this system shall be determined by others on a job specific basis, in accordance with the governing code.
 - .2 Site specific pressures shall be less than or equal to the listed positive or negative allowable lateral wind design pressure and allowable uplift values for the product.

1.06 SUBMITTALS

- .1 Product Data:

- .1 Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements.
- .2 Installation, Operation, and Maintenance manual with start-up requirements shall be provided.
- .2 Shop Drawings:
 - .1 Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details.
 - .2 Computer generated fan curves for each fan shall be submitted with specific design operation point noted.
 - .3 Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.07 DELIVERY, STORAGE, AND HANDLING

- .1 Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- .2 Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- .3 Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation, and Maintenance manual.

1.08 WARRANTY

- .1 Manufacturer shall provide a limited "parts only" warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less.
- .2 Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for Installation, Operation, and maintenance have been followed.
- .3 Warranty excludes parts associated with routine maintenance, such as belts and filters.

1.09 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- .1 Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, gas heaters, exhaust fans, and unit controls.
- .2 Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit.
 - .1 Run test report shall be supplied with the unit in the service compartment's literature pocket.
- .3 Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- .4 Unit components shall be labeled, including refrigeration system components and electrical and controls components.

- .5 Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
- .6 Installation, Operation, and Maintenance manual shall be supplied within the unit.
- .7 Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
- .8 Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

2.02 CONSTRUCTION

- .1 All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
- .2 Unit insulation shall have a minimum thermal resistance value of R-13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
- .3 Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel, and prevents exterior condensation on the panel.
- .4 Unit shall be designed to reduce air leakage and infiltration through the cabinet as follows:
 - .1 Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360.
 - .2 Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage.
 - .3 Deflection shall be measured at the mid-point of the panel height and width.
 - .4 Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage.
 - .5 Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
- .5 Roof of the air tunnel shall be sloped to provide complete drainage.
- .6 Cabinet shall have rain break overhangs above access doors.
- .7 Access to filters, dampers, cooling coils, reheat coil, heaters, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
- .8 Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- .9 Units with cooling coils shall include double sloped 304 stainless steel drain pans.
- .10 Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
- .11 Unit shall include lifting lugs on the top of the unit.
- .12 Unit base shall be fabricated of 1 inch thick double wall, impact resistant, rigid polyurethane foam panels.
- .13 Unit shall include factory wired control panel compartment LED service lights.

2.03 ELECTRICAL

- .1 Unit shall have a 5kAIC SCCR.
- .2 Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
- .3 Unit shall be provided with a factory installed and field wired 115V, 20 amp GFI outlet in the unit control panel.

- .4 Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

2.04 SUPPLY FANS

- .1 Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
- .2 Blowers and motors shall be dynamically balance and mounted on rubber isolators.
- .3 Motor shall be in accordance with Section 20 05 70 and shall include shaft grounding.

2.05 EXHAUST FANS

- .1 Exhaust dampers shall be sized for 100% relief.
- .2 Fans and motors shall be dynamically balanced.
- .3 Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
- .4 Unit shall include direct drive, axial flow exhaust fans. Blades shall be adjustable pitch.
- .5 Motor shall be in accordance with Section 20 05 70 and shall include shaft grounding.

2.06 COOLING COILS

- .1 Evaporator Coils:
 - .1 Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
 - .2 Coils shall have interlaced circuitry and shall be 6 row high capacity.
 - .3 Coils shall be hydrogen or helium leak tested.
 - .4 Coils shall be furnished with factory installed expansion valves.

2.07 REFRIGERATION SYSTEM

- .1 Unit shall be factory charged with R-410A refrigerant.
- .2 Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
- .3 Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
- .4 Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
- .5 Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
- .6 Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
- .7 Unit shall include a variable capacity scroll compressor on all refrigeration circuits which shall be capable of modulation from 10-100% of its capacity.
- .8 Lead refrigeration circuits shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

2.08 CONDENSERS

- .1 Air-Cooled Condenser:

- .1 Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
- .2 Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
- .3 Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
- .4 Coils shall be hydrogen or helium leak tested.
- .5 Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockout.

2.09 GAS HEATING

- .1 Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.
- .2 Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
- .3 Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
- .4 Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
- .5 High Turndown Modulating Natural Gas Furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller.
- .6 Combustion blowers and gas valves shall be capable of modulation.
- .7 Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air duct work.
- .8 Supply air temperature set point shall be adjustable on the electronic controller within the controls compartment.
- .9 Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet.
- .10 Heat trace shall be included on the condensate drain
- .11 Outdoor Airflow Monitoring:
 - .1 Unit shall include outside airflow measuring station and airflow signal processor that communicates directly with the factory provided control systems or can also be used with customer provided controls with a 0-10 VDC output signal. LonTalk and BACnet may also be available for some applications. Monitoring size is dependent on the cfm.

2.10 FILTERS

- .1 Unit shall include 4 inch thick, pleated panel filters with an ASHRAE MERV-13 rating, upstream of the cooling coil.
- .2 Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV-8 rating, upstream of the 4 inch standard filters.
- .3 Unit shall include a clogged filter switch.
- .4 Unit shall include a Magnehelic gauge mounted in the controls compartment.

2.11 OUTSIDE AIR/ECONOMIZER

- .1 Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals.

- .2 Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper.
- .3 Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511.
- .4 Damper assembly shall be controlled by spring return enthalpy activated fully modulating actuator.
- .5 Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.

2.12 CONTROLS

- .1 Factory Installed and Factory Provided Controller
 - .1 Unit controller shall be capable of controlling all features and options of the unit.
 - .2 Controller shall be factory installed in the unit controls compartment and factory tested.
 - .3 Controller shall be capable of stand-alone operation with unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 - .4 Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 - .5 Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 - .6 Constant Volume Controller:
 - .1 Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
 - .2 With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
 - .7 Unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software.
 - .8 Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, set point adjustment, sensor status viewing, and occupancy scheduling available from a single unit.
 - .9 Connection between unit controllers shall be with a modular cable.
 - .10 Controller shall be capable of communicating and integrating with a LonWorks or BACnet network.

2.13 ACCESSORIES

- .1 Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.

2.14 CURBS

- .1 Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.
- .2 Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
- .3 Seismic curb (with duct support rails) shall be provided for field installation.

PART 3 - EXECUTION

3.01 GENERAL

- .1 Manufacturer's installation instructions, and Operation, and Maintenance (O&M) manual shall be supplied with the equipment.

- .2 Installing Trades shall install equipment in strict accordance with the Manufacturer's installation instructions and the requirements of the Authority Having Jurisdiction.
- .3 Install and connect remote components including thermostats, humidistats, control panels, level controllers, flow proving switches, vibration switches, and any other similar ancillary devices specified or supplied loose with the equipment. Install in serviceable locations as shown on the equipment manufacturer's installation details, and where shown on the drawings.
- .4 Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

3.02 START-UP SERVICE

- .1 Provide a factory-trained service technician to start and commission the units. In addition, factory shall allow for each unit to carry out start-up, commissioning and instruct Owner's representatives; dates will be determined by Owner's representative. These shall be in addition to the field pressure testing of the air handling units.
- .2 Manufacturer shall allow for additional site visits to ensure compliance of the installation; these are in addition to those specified for start-up, testing and commissioning noted above. Dates will be assigned by Owner's representative.
- .3 Provide a start-up log by the manufacturer to document the unit start-up.

END OF SECTION

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- 3.02 TESTING, DEHYDRATION, CHARGING AND START-UP OF REFRIGERANT SYSTEM**
- 3.03 INSTALLATION OF SPLIT SYSTEM AIR CONDITIONING EQUIPMENT**

PART 1 - GENERAL

1.01 RELATED WORK

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements and all Documents referenced therein.
- .3 Comply with requirements of Section 20 01 50 Mechanical Basic Materials and Methods.
- .4 Comply with the requirements of Section 25 10 10 BAS Control Network
 - .1 Comply with all requirements including those referenced in Article "BAS Integration with Third Party Devices"

1.02 WORK INCLUDED

- .1 Provided for complete and operational split system air conditioning units.
- .2 Refrigeration piping arrangement shall ensure:
 - .1 Compressor and oil and liquid return to compressor under load without harm to compressor.
 - .2 Minimum pressure drops.
 - .3 Restricted refrigerant migration during inoperative cycles.
 - .4 Accessories and piping prevent excessive compressor cycling.
 - .5 Pipe routing and isolation to avoid line breakage, excessive vibration and sound transmission to conditioned space.
 - .6 Maintenance of clean and dry systems.
- .3 Provide proper operation of safety controls and automatic controls provided by Mechanical Trades.
- .4 Match outdoor and indoor units with operating controls, electronic digital controls and communication system by one manufacturer.
- .5 Do not mix manufacturers of indoor and outdoor units.

1.03 QUALITY ASSURANCE

- .1 Systems shall be installed by trades with certificates of proficiency as refrigeration mechanics.
- .2 Comply with applicable codes, laws and regulations.
- .3 Conform to CSA-B52, Code for Mechanical Refrigeration and CSA-B131.5, Code for Refrigerant Piping.
- .4 Equipment shall be in accordance with ANSI/AHRI Standard 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- .5 System components shall bear CSA label and be factory tested and certified.

1.04 SHOP DRAWINGS

- .1 Provide shop Drawings in accordance with Section 20 01 10.
- .2 Shop Drawings for equipment shall include:
 - .1 Fan performance showing design operations point, r/min, power, etc.
 - .2 Dimensional data including weights, service space and clearance requirements.
 - .3 Schematic layout of refrigerant piping showing all piping components required for satisfactory operation and maintenance of the system(s), including but not limited to:
 - .1 pipe sizes,
 - .2 charging valve,
 - .3 isolating valves,

- .4 sight glasses,
- .5 strainers,
- .6 driers,
- .7 traps,
- .8 all other ancillaries necessary for the proper function of the system.
- .4 Complete installation instructions.
- .5 Electrical circuit diagrams including field-wired components and requirements for specific installation.
- .6 Electrical voltages, phase and power requirements.
- .7 Complete control wiring diagram and power requirements.
- .8 Programming instructions for inclusion in maintenance manuals.
- .3 Schematic diagram must be reviewed with and approved by air conditioning equipment supplier prior to submittal to Consultant.

PART 2 - PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONING EQUIPMENT

- .1 Factory assembled and tested, package type equipment consisting of an indoor evaporator unit and an exterior condensing unit in accordance with drawing schedule, CSA or ETL listed and labelled, AHRI rated and certified and with a minimum system efficiency of 13 SEER.
- .2 Wall mounting evaporator assembly consisting of a white moulded high-strength plastic cabinet with front access panel, a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction and which closes when fan operation is stopped, motorized vertical vanes controlled remotely, and a mounting plate supplied loose. Evaporator complete with:
 - .1 double inlet, forward curve fan(s) direct driven by a single 4-speed motor;
 - .2 removable and washable return air filter;
 - .3 factory pressure tested multi-angled coil of non-ferrous construction with aluminium fins, copper tubes with silver alloy solder joints, and an insulated condensate drain pan sloped to a drain connection for positive drainage.
- .3 Factory run tested, weatherproof condensing unit equipped with a control board to interface with indoor unit and perform all necessary operation functions. Pre-charge unit with refrigerant type noted for a minimum of 21 m (70') of refrigerant tubing. Unit is to be capable of operation at -18°C (0°F) without additional low ambient controls, and capable of a height difference between condensing unit and evaporator of 30 m (100'). Each condensing unit complete with:
 - .1 galvanized steel plate cabinet with an electrostatically applied thermally fused polyester powder finish, and an ABS plastic fan grille;
 - .2 draw-through direct driven balanced fan with horizontal air discharge, mounted in front of coil, arranged to pull air across coil, and equipped with a raised fan guard;
 - .3 "L" shaped coil with copper tubes and aluminium fins, factory pressure tested, complete with an integral metal guard and refrigerant flow controlled by a linear expansion valve metering orifice controlled by a microprocessor controlled step motor;
 - .4 vibration isolated DC rotary compressor driven by an inverter circuit to dynamically control compressor speed to match room load, complete with an accumulator, high pressure safety switch, and circuitry to permit a minimal amount of current to be applied to motor to maintain enough heat during off cycle to prevent liquid from accumulating.
- .4 System controls consisting of a microprocessor in each indoor and outdoor unit, and an indoor wall mounted controller site connected to indoor evaporator unit. System is to be capable of automatic restart after power interruption, and have self-diagnostics ability and indication of total compressor run time, and following:

- .1 Indoor unit microprocessor is capable of monitoring return air temperature and evaporator coil temperature, receiving and processing commands from wall mounted controller, providing emergency operation, and controlling outdoor unit through its microprocessor and interface board;
- .2 controller is complete with an integral temperature sensor, able to perform input and output functions necessary to operate system, and equipped with following:
 - .1 liquid crystal display to indicate diagnostic codes for both indoor and outdoor units, compressor run time, a weekly timer with up to 8 pattern settings per day, set temperature, room temperature, refrigerant piping temperatures, compressor operating conditions, and linear expansion valve opening pulses, sub-cooling and discharge super heat;
 - .2 On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louvre Swing button, a Ventilation button, a Test Run button, and a Check Mode button.
- .5 Suitable anchoring connection hardware factory installed on equipment to suit requirements of Section entitled Seismic Control and Restraint.
- .6 Acceptable manufacturers are:
 - .1 Mitsubishi Electric Sales Canada Inc.;
 - .2 LG Electronics Canada Inc.;
 - .3 Panasonic Canada Inc.;
 - .4 Fujitsu General America Inc.;
 - .5 Daikin Industries Ltd.
 - .6 Approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- .1 Provide split system air conditioning units in accordance with manufacturer's installation requirements and the requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Where specialist pipe fittings branching off to the indoor evaporator units are necessary, these branches shall be supplied by the unit Manufacturer. No other fittings are acceptable.

3.02 TESTING, DEHYDRATION, CHARGING AND START-UP OF REFRIGERANT SYSTEM

- .1 Connect outdoor condensing unit and indoor evaporator unit with refrigerant piping in accordance with piping shop drawing schematic. Provide any required additional refrigerant.
- .2 At completion of installation, pressurize system with nitrogen or refrigerant and check for leaks. Repair leaks and re-test. Dehydrate system and charge with refrigerant. Start-up system and check operation.
- .3 Carry out check using detailed check sheets provided by Equipment Manufacturer. Include completed and signed checklists in Operating and Maintenance Manuals.
- .4 If installation is completed in winter season, pump down refrigerant where applicable and repeat procedure at start of next cooling season.
- .5 Provide documentation for proper operation and maintenance of system. Provide on-site instruction period for Owner's personnel with Consultant's representative.
- .6 The pressure testing and the evacuation shall be carried out strictly according to the Manufacturer's installation instructions.
- .7 The final refrigerant charging and the commission of the system shall be carried out by the Mechanical Trades.

3.03 INSTALLATION OF SPLIT SYSTEM AIR CONDITIONING EQUIPMENT

- .1 Provide split system air conditioning equipment consisting of an exterior condensing unit and an indoor evaporator.
- .2 For condensing units mounted at grade, secure condensing unit in place, level and plumb, on vibration isolation pads on a concrete housekeeping pad.
- .3 For condensing units mounted on the roof, secure condensing unit in place, level and plumb, on vibration isolation pads on pressure treated wooden sleepers as indicated.
- .4 Provide flexible connections in all piping connections to equipment.
- .5 Mount indoor evaporator unit. Confirm exact location prior to roughing-in.
- .6 Provide all equipment with isolation valves at each piping connection.
- .7 Refrigerant pipe work shall be installed in a neat and workmanlike manner. All refrigeration pipe work shall be supported on galvanized cable tray, width to accommodate pipe work and controls cable.
- .8 Pipe work supports should be through entire length according to good practice; on horizontal pipe work, the bracketing should be over the thermal insulation to allow pipe movement due to contraction and expansion.
- .9 The vertical pipe work shall be bracketed at no more than 40" (1000 mm) centers and the horizontal at no more than 60" (1,500 mm) centers. The provision of special supports shall be incorporated in drop rods or pipe clips in pipe work supports.
- .10 Provide suitable isolation valving as required for the system configuration to enable minimized draw/refilling of refrigerant.
- .11 All refrigerant pipe work shall be insulated with Armaflex Class "O" insulation as manufactured by Armstrong Industries. The joints or headers shall be insulated with the pre-formed insulation supplied with these fittings. Insulation exposed to atmospheric conditions shall be protected with two coats of special Armstrong Adhesive and care should be taken that every part of the insulation is sealed to maintain a vapour barrier.
- .12 All installed pipe work lengths shall be accurately measured and recorded on the form provided in the removable access panel within the outdoor units and the operating and maintenance manuals. (This information is required for the accurate calculation of the refrigerant charge for the system).
- .13 Install loose control components and perform required control wiring between condensing unit and evaporator in conduit in accordance with manufacturer's control wiring schematic and wiring standards of electrical work.
- .14 Where required, provide Building Automation System (BAS) integration.
- .15 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with control set-up and abnormal events.

END OF SECTION 23 81 26

CONTENTS

PART 1 - GENERAL

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PART 1 - GENERAL

1.01 RELATED WORK

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with the requirements of Section 20 01 10 Mechanical General Requirements and all Documents referenced therein.
- .3 Comply with the requirements of Section 20 01 50 Mechanical Basic Materials and Methods.
- .4 Comply with the requirements of Section 23 23 10 Refrigerant Piping
- .5 Comply with the requirements of Section 25 10 10 BAS Control Network
 - .1 Comply with all requirements including those referenced in Article "BAS Integration with Third Party Devices"

1.02 WORK INCLUDED

- .1 Provided for complete and operational Variable Refrigerant Flow ("VRF") multi-split refrigeration systems.
- .2 Refrigeration piping arrangement shall ensure:
 - .1 Compressor and oil and liquid return to compressor under load without harm to compressor.
 - .2 Minimum pressure drops.
 - .3 Restricted refrigerant migration during inoperative cycles.
 - .4 Accessories and piping prevent excessive compressor cycling.
 - .5 Pipe routing and isolation to avoid line breakage, excessive vibration and sound transmission to conditioned space.
 - .6 Maintenance of clean and dry systems.
- .3 Provide proper operation of safety controls and automatic controls provided by Mechanical Trades.
- .4 Match outdoor and indoor units with operating controls, electronic digital controls and communication system by one manufacturer. Do not mix manufacturers of indoor and outdoor units.

1.03 QUALITY ASSURANCE

- .1 Systems shall be installed by tradesmen with certificates of proficiency as refrigeration mechanics.
- .2 Comply with applicable codes, laws and regulations. Conform to CSA-B52, Code for Mechanical Refrigeration and CSA-B131.5, Code for Refrigerant Piping.
- .3 System components shall bear CSA label and be factory tested and certified.

1.04 SHOP DRAWINGS

- .1 Provide shop Drawings in accordance with Section 20 01 10.
- .2 Shop Drawings for equipment shall include:
 - .1 Fan performance showing design operations point, r/min, power, etc.
 - .2 Dimensional data including weights, service space and clearance requirements.
 - .3 Schematic layout of refrigerant piping showing all piping components required for satisfactory operation and maintenance of the system(s), including but not limited to:
 - .1 pipe sizes,
 - .2 charging valve,
 - .3 isolating valves,

- .4 sight glasses,
- .5 strainers,
- .6 driers,
- .7 traps,
- .8 all other ancillaries necessary for the proper function of the system.
- .4 Complete installation instructions.
- .5 Electrical circuit diagrams including field-wired components and requirements for specific installation.
- .6 Electrical voltages, phase and power requirements.
- .7 Complete control wiring diagram and power requirements.
- .8 Programming instructions for inclusion in maintenance manuals.
- .3 Schematic diagram must be reviewed with and approved by air conditioning equipment supplier prior to submittal to Consultant.

PART 2 - PRODUCTS

2.01 GENERAL

- .1 System Description
 - .1 The variable capacity, heat pump heat recovery air conditioning system shall be a Mitsubishi VRF (Variable Refrigerant Flow) air source zoning system. The systems shall be the (simultaneous cooling and heating) split system heat pump with extended winter range down to -25°C
 - .2 Acceptable manufactures shall be Mitsubishi, Daikin, LG, or approved equal.
- .2 Quality Assurance
 - .1 The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
 - .2 All wiring shall be in accordance with the National Electrical Code (N.E.C.).
 - .3 The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
 - .4 A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
- .3 Delivery, Storage and Handling
 - .1 Unit shall be stored and handled according to the manufacturer's recommendation.
- .4 Warranty
 - .1 The units shall be covered by the manufacturer's limited warranty for a period of one (1) year from date of installation if the systems are:
 - .1 Installed by a contractor that has successfully completed the manufacturers two (2) day service course, AND
 - .2 verified with a completed commissioning report submitted to and approved by the manufacturers Service Department, then the units shall be covered by an extended manufacturer's limited warranty for a period of ten (10) years from date of installation.
 - .2 In addition the compressor shall have a manufacturer's limited warranty for a period of ten (10) years from date of installation.
 - .3 If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

- .4 This warranty shall not include labor.
- .5 All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.
- .6 The VRF system shall be installed by a contractor with extensive VRF install and service training. The mandatory contractor service and install training should be performed by the manufacturer.
- .7 The VRF system provided shall be specified and provided for "Low Ambient" operation, with the Hyper Heat package.

2.02 UNIT CABINET

- .1 The cabinet(s) shall be fabricated of hot-dip galvanized steel sheet for corrosion resistance.
- .2 The cabinet shall have the option of all field connections (refrigerant, water, line voltage and control wiring) on the top or left side of the unit.
- .3 The water-source units can be mounted side-by-side or stacked (with proper structural supports) depending on selected connection locations.
- .4 The cabinet shall have the option of drain line connections either in the front or the back.

2.03 REFRIGERANT

- .1 R410A or R-32 refrigerant shall be used.
- .2 Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

2.04 ELECTRICAL

- .1 The outdoor unit electrical power shall be 208 volts, 3-phase, 60 hertz.
- .2 The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-253 volts.
- .3 The outdoor unit shall be controlled by integral microprocessors.
- .4 The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
- .5 The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

2.05 CONTROLS

- .1 This unit shall use controls provided by VRF manufacturer to perform functions necessary to operate the system.
- .2 Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
- .3 Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
- .4 Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
- .5 Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
- .6 Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 - .1 Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

- .2 Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.06 NETWORK CONTROLS

- .1 Overview
 - .1 The Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.
- .2 Electrical Characteristics
 - .1 The controls network shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.
- .3 Wiring:
 - .1 Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
 - .2 Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.
 - .3 Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.
 - .4 Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
- .4 Wiring type:
 - .1 Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
 - .2 Network wiring shall be CAT-5 with RJ-45 connection.
- .5 City Multi Controls Network
 - .1 The City Muti Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus.
 - .2 The Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces.

PART 3 - EXECUTION

3.01 GENERAL

- .1 Provide Variable Refrigerant Flow ("VRF") systems in accordance with VRF manufacturer's installation requirements and the requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Where specialist pipe fittings branching off to the indoor VRF heads are necessary, these branches shall be supplied by the unit Manufacturer. No other fittings are acceptable.

3.02 TESTING, DEHYDRATION, CHARGING AND START-UP OF REFRIGERANT SYSTEM

- .1 Connect air source heat pump and indoor VRF head with refrigerant piping in accordance with piping shop drawing schematic. Provide any required additional refrigerant.

- .2 At completion of installation, pressurize system with nitrogen or refrigerant and check for leaks. Repair leaks and re-test. Dehydrate system and charge with refrigerant. Start-up system and check operation.
- .3 Carry out check using detailed check sheets provided by Equipment Manufacturer. Include completed and signed checklists in Operating and Maintenance Manuals.
- .4 If installation is completed in winter season, pump down refrigerant where applicable and repeat procedure at start of next cooling season.
- .5 Provide documentation for proper operation and maintenance of system. Provide on-site instruction period for Owner's personnel with Consultant's representative.
- .6 The pressure testing and the evacuation shall be carried out strictly according to the Manufacturer's installation instructions.
- .7 The final refrigerant charging and the commission of the system shall be carried out by the Mechanical Trades.

3.03 INSTALLATION OF VARRIABLE REFRIGERANT FLOW (VRF) EQUIPMENT

- .1 Provide VRF equipment consisting of an exterior air source heat pump unit and an indoor VRF head.
- .2 For air source heat pump units mounted at grade, secure air source heat pump unit in place, level and plumb, on vibration isolation pads on a concrete housekeeping pad.
- .3 For air source heat pump units mounted on the roof, secure air source heat pump unit in place, level and plumb, on vibration isolation pads on pressure treated wooden sleepers as indicated.
- .4 Provide flexible connections in all piping connections to equipment.
- .5 Mount indoor VRF head. Confirm exact location prior to roughing-in.
- .6 Provide all equipment with isolation valves at each piping connection.
- .7 Refrigerant pipe work shall be installed in a neat and workmanlike manner. All refrigeration pipe work shall be supported on galvanized cable tray, width to accommodate pipe work and controls cable.
- .8 Pipe work supports should be through entire length according to good practice; on horizontal pipe work, the bracketing should be over the thermal insulation to allow pipe movement due to contraction and expansion.
- .9 The vertical pipe work shall be bracketed at no more than 40" (1000 mm) centers and the horizontal at no more than 60" (1,500 mm) centers. The provision of special supports shall be incorporated in drop rods or pipe clips in pipe work supports.
- .10 Provide suitable isolation valving as required for the system configuration to enable minimized draw/refilling of refrigerant.
- .11 All refrigerant pipe work shall be insulated with Armaflex Class "O" insulation as manufactured by Armstrong Industries. The joints or headers shall be insulated with the pre-formed insulation supplied with these fittings. Insulation exposed to atmospheric conditions shall be protected with two coats of special Armstrong Adhesive and care should be taken that every part of the insulation is sealed to maintain a vapour barrier.
- .12 All installed pipe work lengths shall be accurately measured and recorded on the form provided in the removable access panel within the outdoor units and the operating and maintenance manuals. (This information is required for the accurate calculation of the refrigerant charge for the system).
- .13 Install loose control components and perform required control wiring between air source heat pump unit and VRF head in conduit in accordance with manufacturer's control wiring schematic and wiring standards of electrical work.
- .14 Where required, provide Building Automation System (BAS) integration.

- .15 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with control set-up and abnormal events.

END OF SECTION 23 81 29

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PART 3 - EXECUTION

- 3.01 GENERAL**
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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with the requirements of Section 20 01 10 Mechanical General Requirements
- .2 Comply with the requirements of Section 20 10 50 Basic Materials and Methods
- .3 Comply with the requirements of Section 20 05 95 Testing Adjusting and Balancing
- .4 Comply with the requirements of Section 20 08 10 Mechanical Commissioning
- .5 Comply with the requirements of Section 25 10 10 BAS Control Network
 - .1 Comply with all requirements including those referenced in Article "BAS Integration with Third Party Devices"

1.03 WORK PERFORMED BY THIS SECTION

- .1 Supply, install and commission air source heat pump chiller(s), and related ancillary equipment and Services specified.

1.04 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the installation of air source heat pump chillers and ancillary equipment.
- .2 Unit shall meet or exceed energy efficiency per ASHRAE 90.1

1.05 SUBMITTALS

- .1 Product Data: For each type of product indicated. Include rated capacities, pressure drop, performance curves with selected points indicated, furnished specialties, and accessories.
- .2 Shop Drawings: Complete set of manufacturer's prints of equipment assemblies, control panels, sections and elevations, and unit isolation. Include the following:
 - .1 Assembled unit dimensions.
 - .2 Weight and load distribution.
 - .3 Required clearances for maintenance and operation.
 - .4 Sizes and locations of piping and wiring connections.
 - .5 Wiring Diagrams: For power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
- .3 Submit product data indicating options and specialties, electrical requirements, and wiring diagrams and connections. Indicate accessories, valves, strainers, and thermostatic valves required for the complete system.
- .4 Submit rigging, installation, and startup procedures. Include operations and maintenance data for the chiller and all ancillaries. Include location, size, and type of field piping connections.
- .5 Submit performance data indicating energy input versus cooling load output from 100 to 25 percent of full load with constant entering condenser water temperature.
- .6 Submit compressor and product data in table form indicating impeller speed (RPM), number of bearings, type of bearings, high speed impeller shaft RPM, sound pressure level per AHRI 575-2008 (dB), number of stages, number of sets of inlet guide vanes, amount of refrigerant charge (lb), and amount of oil required (US gallons).
- .7 Operation and Maintenance Data: Each unit to include operation and maintenance manual.

1.06 REGULATORY REQUIREMENTS

- .1 Conform to AHRI Standard 550/590 code for rating and testing of water chillers.
- .2 Conform to UL 1995 for Safety for Heating and Cooling Equipment.

- .3 Conform to ANSI/ASME SECTION VIII Boiler and Pressure Vessel Code for construction and testing of centrifugal chillers as applicable.
- .4 Conform to latest revision of ANSI/ASHRAE STANDARD 15 code for construction and operation of refrigeration equipment.
- .5 Unit shall bear the AHRI Certification Label for the specific type of chiller as applicable.

1.07 DELIVERY, STORAGE, HANDLING AND EQUIPMENT ROOM REQUIREMENTS

- .1 The successful Trade Contractor shall comply with manufacturer's installation instructions for rigging, chiller loading, local transportation requirements, unloading, storage, and final setting.
- .2 The successful Trade Contractor shall protect chiller and controls from physical damage. Leave factory shipping covers in place until installation. The entire unit must be shrink wrapped with an environmentally recyclable material standard. The material shall include an imbedded desiccant to minimize/eliminate internal moisture.
- .3 The chiller shall ship with a dry nitrogen charge to eliminate potential charge loss during delivery and construction.
- .4 The refrigerant must be shipped separately from the chiller.
- .5 The refrigerant monitoring system shall be active at the job site prior to the charging of the chiller.
- .6 The chiller should ship with a full charge of oil.

1.08 WARRANTY

- .1 Standard Warranty:
 - .1 Provide a parts and labor warranty for twenty four (24) months from delivery, or twelve (12) months from equipment startup, whichever occurs first.
 - .2 The original equipment purchase shall provide a refrigerant warranty for the duration of the first twelve (12) months of operation following start-up.
 - .3 This warranty will provide for replacement parts and refrigerant, if needed, and any labour costs associated with replacement parts and refrigerant.
 - .4 If the reason for refrigerant loss is found to be a defect in material or workmanship by the Chiller Manufacturer or the successful installation Trade Contractor, restore the Chiller to the proper refrigerant charge.
- .2 Extended Warranty:
 - .1 Prior to the expiration of the Standard Warranty, the Chiller Manufacturer shall submit to the Original Equipment Owner the following options to extend the Warranty:
 - .1 Whole unit parts;
 - .2 Whole unit labor;
 - .3 Refrigerant;
 - .4 Motor/transmission/compressor parts;
 - .5 Motor/transmission/compressor labor.
 - .2 At the Owner's discretion the optional extended the warranty may be selected for a period of between two (2) and seven (7) years.

1.09 MAINTENANCE SERVICES

- .1 All inspections and service of units shall be accomplished by factory trained and authorized servicing technicians.
- .2 All labor for leak checking the chiller according to the manufacturer's IOM and documentation must be included.

- .3 In conjunction with and supporting Factory Warranty, Original Equipment Manufacturer ("OEM") shall furnish complete factory authorized service and maintenance for applied chillers for one year from the Date of Substantial Completion. All work shall be done by manufacturer's commercial warranty agent.
- .4 OEM shall provide and report quarterly, semiannual, and annual maintenance in compliance with or better than ASHRAE Standard 180-2008.
- .5 Include maintenance items as recommended in manufacturer's operating and maintenance data.
- .6 Submit copy of service call work orders and summary report to the owner, including description of work performed, operating performance status and noted exceptions.

PART 2 - PRODUCTS

2.01 AIR SOURCE HEAT PUMP CHILLERS

- .1 General
 - .1 The Equipment Vendor shall supply air source heat pump chillers as shown on the Equipment Schedules. The units shall produce the specified performance per the scheduled data in accordance with the latest revision of AHRI 550/590. The unit shall bear the AHRI certification label as applicable.
 - .2 Each module shall be assembled on an integral white painted formed sheet metal steel frame. The required number of modules shall be assembled to a bank in factory.
 - .3 Each module shall be fully charged with refrigerant and factory tested for controller functions prior to shipment.
 - .4 The chiller system must be built for single point power supply connection.
 - .5 The power distribution panel shall incorporate a circuit breaker for overload protection to each chiller module.
 - .6 Electrical supply to each module shall consist of flexible conduit.
 - .7 No electrical connection to a module shall carry the load of more than that module.
 - .8 The electrical supply connections for each module shall be factory assembled and shipped with each module for field connection into the power distribution panel.
- .2 Frame
 - .1 Frame shall be constructed of formed sheet metal externally coated with white painted finish and internally coated in black.
- .3 Cabinet
 - .1 Formed sheet metal externally coated with white painted finish and internally coated in black. The panels shall be easily removable for servicing via stainless steel fasteners and retaining clips.
- .4 Compressors
 - .1 Two hermetically sealed, scroll compressors connected in series, on each compressor with rotalock connections, oil level sight glass, suction gas-cooled motor with solid-state sensors in the windings for overload protection, and circuit breaker protection.
 - .2 Compressors shall be mounted to the heavy gauge steel frame with rubber-in-shear vibration isolators.
- .5 Evaporators
 - .1 Single circuit brazed plate heat exchangers for use as evaporator in cooling or condenser in a heat pump operation.
 - .2 The fluid connections shall use Victaulic roll grooved couplings and neoprene gasket, for service convenience and ease of installation and shall be insulated with ¾" closed cell insulation.
- .6 Isolation Valves

- .1 Manual butterfly isolation valves shall be installed on the brazed plate heat exchanger inlet and discharge to isolate the module for servicing the strainer, flow switch and evaporator while allowing the remaining modules to continue to operate.
- .7 Filters
 - .1 A 40-mesh industrial grade filter strainer shall be factory installed between the header system and brazed plate heat exchanger and condenser inlet.
 - .2 The strainer shall be serviceable by isolation valves that permit each strainer to be removed and cleaned without shutting down fluid flow or power to the entire system and allowing the remaining modules to continue to operate.
 - .3 In-line strainers that require complete system shutdown for service and isolation are not acceptable
- .8 Condenser Fan Motors
 - .1 The condenser fan motors shall be maintenance free, quiet, highly efficient Electronically Commutated Motors (ECM) with energy reduction capabilities of up to 35%.
 - .2 These variable speed fan assemblies shall vary fan motor RPM to maintain the refrigeration pressure of the heat pump modules and allow operation of the heat pump down to -20°F ambient.
- .9 Transformer Included
 - .1 A 600V/3Ø/60Hz to 460V/3Ø/60Hz or 575V/3Ø/60Hz to 208V/3Ø/60Hz transformer shall be included on each module for all ECM fans on that module.
- .10 Condenser Fan Diffuser
 - .1 Each fan contains a diffuser that shall improve the efficiency and reduce the noise of the ECM fans.
 - .2 By increasing the fan efficiency, the motor speed can be reduced thereby lowering the sound pressure.
- .11 Condenser Coil
 - .1 Aluminum fins mechanically bonded to coppers tubes with integral subcooling circuits.
 - .2 Fin spacing shall not exceed 16 fins per inch.
 - .3 The coils shall be factory tested to a minimum of 600 psig.
- .12 Liquid Piping
 - .1 The fluid piping shall be Schedule 40 steel and be insulated using closed cell pipe insulation to prevent condensation.
 - .2 The chiller shall have service valves for the independent isolation of each heat exchanger, without affecting the fluid flow to the remaining heat exchangers.
 - .3 Each heat pump shall connect to the adjacent module using Victaulic type roll grooved steel couplings and neoprene gaskets.
 - .4 Any type of module-to-module connection external to the modules is unacceptable.
- .13 Refrigerant Piping
 - .1 Refrigerant piping shall be Type K seamless copper, insulated with closed cell pipe insulation on the suction lines.
- .14 Refrigerant Accessories
 - .1 Each refrigerant circuit shall include compressor rotalock service valves, solenoid valves for compressor pumpdown, and Schrader service valves in the suction, discharge, and liquid lines, liquid line sight glass with moisture indicator and a filter dryer.
- .15 Controls
 - .1 The bank controller shall incorporate the Master microprocessor controller.

- .2 The bank controller shall communicate with the unit controllers on the bank via a local network communications protocol.
 - .3 The bank controller shall read all analog and fault port values from all unit controllers and shall pass these values to the Building Automation System via BACnet, Modbus or Lonworks protocols.
 - .4 Each unit control system shall include operational switches for each compressor; high- and low-pressure transmitters to provide indication of refrigeration pressures; high and low refrigeration pressure alarms including shutting shut down the responsible compressor(s); anti-short cycling compressor timers; connection to Building Automation System through a BACnet gateway.
- .16 Microprocessor
- .1 The microprocessor shall provide the following minimum functions and alarms: alarms:
 - .1 Adjustable fluid temperature set point
 - .2 High and low fluid temperature alarm set points
 - .3 Water inlet and outlet temperature
 - .4 Suction and discharge refrigeration pressures
 - .5 Compressor run status
 - .6 Current alarm status
 - .7 Alarm logging with minimum of previously 20 logged alarms with time and date of each occurrence
 - .8 Remote start stop input
 - .9 Dry contact for general alarm
- .17 Heat Trace Cable Installation
- .1 Heat Trace Cable shall be installed in the drain pan and from drain pan to drain by installing contractor to ensure drainage during defrost from the heat pump unit.
 - .2 Any pipe from unit drain pan to drain shall be insulated and heat traced by installing contractor.

2.02 FACTORY WITNESS TESTING

- .1 For factory witness tests, the Owner or his designated representative(s) shall be notified fourteen (14) days in advance to witness the factory performance test. The Chiller Manufacturer representative shall assume all expenses incurred by the Owner or his representative(s) (up to four [4] attendees) to witness the test.
- .2 One of each size chiller shall be factory performance tested with the proposed refrigerant under full-load conditions in an AHRI certified test facility. The manufacturer shall supply a certified test report to confirm performance as specified. Proper AHRI certification documents for the manufacturer's test loop shall be made available for inspection upon request.
- .3 The factory test instrumentation shall be per AHRI Standard 550/590, and the calibration of all instrumentation shall be traceable to the National Institute of Standards and Technology (NIST, formerly NBS).

2.03 ACCEPTABLE MANUFACTURERS

- .1 Acceptable Heat Recovery Chiller Manufacturers are:
 - .1 Trane;
 - .2 York (JCI);
 - .3 McQuay;
 - .4 Carrier;
 - .5 Multi-stack

- .6 Owner approved manufacturer.

PART 3 - EXECUTION

3.01 GENERAL

- .1 All startup, maintenance and monitoring functions shall be provided confirming that equipment has been correctly installed in position on site and passes specification checklist prior to equipment becoming operational and covered under Original Equipment Manufacturers ("OEM") warranty.
- .2 Start-up shall be done in strict accordance with manufacturer's specifications and requirements.
 - .1 Provide a complete log of all operating parameters.
 - .2 Assure actual performance matches with submittals and computerized selection programs for other than submittal conditions.
 - .3 Submit a hard copy of the service report and logs.
- .3 Provide a minimum of eight (8) hours of training, four (4) hours of training over two (2) days. Training shall be a combination of classroom and hands on instruction.
- .4 For the duration of the warranty, during operation, there shall be physical on-site inspections in three (3) month intervals; perform the following during each inspection:
 - .1 Check the general operation of the unit.
 - .2 Provide a complete log as in "Start-up" item above.
 - .3 Check operation of the control circuit.
 - .4 Check operation of the lubrication system.
 - .5 Check operation of the motor and starter.
 - .6 Analyze the record data. Compare the data to the original design conditions and make any adjustments as necessary to return Chiller to original design conditions.
 - .7 Review operating procedures with operating personnel.
 - .8 Do one oil analysis and submit the written report. Change the oil and filter as required in the published manufacturer's literature.
 - .9 Complete all recommended maintenance and tests as documented in the manufacturer's published literature.
 - .10 Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies.
 - .11 At the final inspection (to be performed within 30 days of warranty expiration), assure that the chillers are functioning correctly and that all warranty items are resolved to the customer's satisfaction.

3.02 EQUIPMENT INSTALLATION REQUIREMENTS

- .1 Receive equipment to the Site of the Work. Set equipment on temporary bases to avoid contact with the ground. Protect equipment from damage.
- .2 Provide for all rigging and hoisting of chillers into place as shown on the drawings and in accordance with the Chiller manufacturer's installation instructions.
- .3 Comply with manufacturer's requirements for the installation of all equipment.
- .4 Locate equipment as shown on the drawings to provide connection arrangement and accessibility for servicing.
- .5 Provide clearances on all sides of equipment as required by the manufacturer's Installation Instructions, or the Authorities Having Jurisdiction, whichever is more stringent.
- .6 Install items of equipment with due regard to Architectural treatment, and ensure all items are level and finished in keeping with good workmanship.

- .7 Provide line size, or minimum 2" (50mm) chemical treatment flushing connections, and equipment bypass connections, in heating and cooling circuits, and where directed by chemical treatment supplier.
- .8 Provide branch take-offs from mains of chilled water and condenser water piping with shut off valves.
- .9 Install and connect remote components including thermostats, humidistats, control panels, level controllers, flow proving switches, vibration switches, and any other similar ancillary devices specified or supplied loose with the equipment. Install in serviceable locations as shown on the equipment manufacturer's installation details, and where shown on the drawings.
- .10 Field wire chiller power and control wiring.
- .11 Provide piping with isolation valve, pressure gauge, and thermometer at each evaporator supply and return piping connection, and each condenser water supply and return piping connection.
- .12 Extend refrigerant relief vent piping, as required, to terminate outdoors in accordance with CSA B52.

END OF SECTION 23 81 43

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .2 Comply with requirements of Section 20 01 50 Basic Materials and Methods.

1.03 SCOPE OF WORK OF THIS SECTION

- .1 Provision of HVAC terminal heating and cooling devices and all related ancillaries.

1.04 SUBMITTALS

- .1 Submit shop drawings for the following Products:
 - .1 Fan coil units;
 - .2 Radiant heating ceiling panels;
 - .3 Unit heaters;
 - .4 Cabinet Unit Heaters;
 - .5 Duct mounted re-heat coils.

1.05 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division Contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 MAXIMUM SURFACE TEMPERATURE

- .1 Unless noted otherwise, equipment manufacturer shall ensure the maximum equipment surface temperature within contact zones defined in ASTM C1055 "Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries" does not exceed 110°F (44°C).

2.02 HORIZONTAL, LOW PROFILE, DIRECT DRIVE FAN COIL UNITS

- .1 Provide horizontal low profile direct drive fan coil units where indicated on the plans and the following specifications;
- .2 General:
 - .1 Provide horizontal low profile direct drive fan coil units in accordance with the Equipment Schedules.
 - .2 Units shall be completely factory assembled, tested and shipped as one piece.
 - .3 All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. All unit dimensions for each model and size shall be considered maximums.
 - .4 Units shall be ETL listed in compliance with UL/ANSI Standard 1995, and be certified as complying with the latest edition of AHRI Standard 440.
- .3 Construction:
 - .1 All unit chassis shall be fabricated of heavy gauge galvanized steel panels able to meet 125 hour salt spray test per ASTM B-117. All exterior panels shall be insulated with 1/2"

- thick insulation with a maximum k value of .24 (BTU - in) / (hr - ft² - °F) and rated for a maximum air velocity of 500 f.p.m.
- .2 Insulation must meet all requirements of ASTM C1071 (including C665), UL 181 for erosion, and carry a 25/50 rating for flame spread/smoke developed per ASTM E-84, UL 723 and NFPA 90A.
- .3 All concealed units shall have a minimum 1½" duct collar on the discharge.
- .4 Plenum and exposed units shall have a minimum ¾" duct collar on the return.
- .5 All exposed units shall have exterior panels fabricated of galvanized steel.
- .6 The fan and filter bottom access panel shall be attached with quarter turn quick open fasteners to allow for easy removal and access for service.
- .7 Unit mounting shall be by hanger brackets provided at four locations.
- .8 Hanger brackets shall include rubber grommet isolators with brass eyelets for threaded rod.
- .4 Sound:
 - .1 Units shall have published sound power level data tested in accordance with AHRI Standard 350-2000 (non-ducted equipment) and AHRI Standard 260-2001 (ducted equipment).
- .5 Fan assembly:
 - .1 Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance.
 - .2 The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit.
 - .3 The entire fan assembly shall be able to come out of the unit by removing two screws and unplugging the motor.
 - .4 Plenum unit fan assemblies shall be easily serviced through an access panel provided.
 - .5 Provide Electronically Commutated (EC) Motor capable of operation with low voltage 3 speed thermostat.
 - .6 Motor shall come factory programmed and configured for 3 speed operation. Each speed shall be manually adjustable in the field.
 - .7 All manual speed adjustments shall be stored in non-volatile memory.
 - .8 Motor shall be capable of accepting a 2-10 VDC output from BAS.
 - .9 Motor bearings shall be rated for L10-40,000 hours.
- .6 Coils:
 - .1 All cooling and heating coils shall optimize rows and fins per inch to meet the specified capacity.
 - .2 Coils shall have seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin.
 - .3 Fins shall have high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover.
 - .4 All coils shall be hydrostatically tested at 450 PSIG air pressure under water, and rated for a maximum of 300 PSIG working pressure at 200°F.
 - .5 Direct expansion cooling coils shall include a fixed orifice metering device.
 - .6 All evaporator coils shall be factory sealed and charged with a minimum 5 PSIG nitrogen or refrigerated dry air.
 - .7 Steam coils shall be standard steam type suitable for temperatures above 35°F and 15 PSIG maximum working pressure.

- .7 Drain pans:
 - .1 Primary condensate drain pans shall be single wall, heavy gauge galvanized steel for corrosion resistance, and extend under the entire cooling coil.
 - .2 Drain pans shall be of one-piece construction and be positively sloped for condensate removal.
 - .3 Drain pans on concealed models shall be field reversible for right or left hand connections.
 - .4 The drain pan shall be externally insulated with a fire retardant, closed cell foam insulation.
 - .5 The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.
- .8 Filters:
 - .1 All plenum and exposed units shall be furnished with a minimum 1" nominal glass fiber MERV 10 disposable filter.
 - .2 Filters shall be tight fitting to prevent air bypass.
 - .3 Plenum unit filters shall be easily removable from the bottom of the unit without the need for tools.
- .9 Electrical:
 - .1 Units shall be furnished with 208V/1/60 single point power connection.
 - .2 Provide a hinged electrical enclosure in the bottom of the unit for access to all electrical components, terminal blocks and wiring.

2.03 HORIZONTAL DIRECT DRIVE FAN COIL UNITS

- .1 Provide horizontal concealed direct drive fan coil units where indicated on the plans and the following specifications;
- .2 General:
 - .1 Provide horizontal concealed direct drive fan coil units in accordance with the Equipment Schedules.
 - .2 Units shall be completely factory assembled, tested and shipped as one piece.
 - .3 All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery.
 - .4 All unit dimensions for each model and size shall be considered maximums.
 - .5 Units shall be ETL listed in compliance with UL/ANSI Standard 1995, and be certified as complying with the latest edition of ARI Standard 440.
- .3 Construction:
 - .1 All unit chassis shall be fabricated of heavy gauge galvanized steel panels able to meet 125 hour salt spray test per ASTM B-117.
 - .2 All exterior panels shall be insulated with 1/2" thick fiberglass insulation with a maximum k value of .24 (BTU • in) / (hr • ft² • °F) and rated for a maximum air velocity of 5000 f.p.m.
 - .3 Insulation must meet all requirements of ASTM C1071 (including C665), UL 181 for erosion, and carry a 25/50 rating for flame spread/smoke developed per ASTM E-84, UL 723 and NFPA 90A.
- .4 Sound:
 - .1 Manufacturer shall provide AHRI 260 sound power data at any specified airflow and static pressure.
- .5 Fan assembly:

- .1 Unit fan shall be a dynamically balanced, forward curved; DWDI centrifugal type constructed of galvanized steel for corrosion resistance.
- .2 Motors shall be high efficiency, permanently lubricated sleeve bearing, with UL and CSA listed automatic reset thermal overload protection and three separate horsepower taps.
- .3 The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit.
- .4 The entire fan assembly shall be able to come out of the unit by removing four nuts per fan and unplugging the motor(s).
- .5 Plenum unit fan assemblies shall be easily serviced through the filter opening or through the bottom panel.
- .6 Provide an electronic fan speed controller as an aid in balancing the fan capacity. The speed controller shall have a turn down stop to prevent the possibility of harming the motor bearings, and incorporate electrical noise suppression to minimize noise on the incoming power lines.
- .6 Coils:
 - .1 All coils shall be ARI 410 certified and tagged with an ARI 410 label.
 - .2 All cooling and heating coils shall optimize rows, circuit count, and fin density to meet the specified capacity.
 - .3 Coils shall have seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin.
 - .4 Fins shall have high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover.
 - .5 All coils shall be hydrostatically tested at 450 PSIG air pressure under water, and rated for a maximum of 300 PSIG working pressure at 200°F.
 - .6 Direct expansion cooling coils shall include a fixed orifice distributor. All evaporator coils shall be factory sealed and charged with a minimum 5 PSIG nitrogen or refrigerated dry air.
 - .7 Steam coils shall be standard steam type suitable for temperatures above 35°F and 15 PSIG maximum working pressure.
 - .8 All coils shall be provided with a manual air vent fitting to allow for coil venting.
 - .9 Heating coils shall be furnished in the reheat or preheat position.
- .7 Drain Pans:
 - .1 Primary condensate drain pans shall be single wall; heavy gauge galvanized steel for corrosion resistance, and extend under the entire cooling coil.
 - .2 Drain pans shall be of one-piece construction and be positively sloped for condensate removal.
 - .3 Drain pan shall be removable without the use of tools.
 - .4 The drain pan shall be externally insulated with fire retardant, closed cell foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.
- .8 Filters:
 - .1 All plenum and exposed units shall be furnished with a minimum 1" nominal glass fiber MERV 10 disposable filter.
 - .2 Filters shall be tight fitting to prevent air bypass.
 - .3 Plenum and exposed unit filters shall be easily removable from the bottom of the unit without the need for tools.

- .9 Electrical:
 - .1 Units shall be furnished with single point power connection.
 - .2 Provide an electrical junction box with terminal strip for motor and other electrical terminations.
 - .3 The factory mounted terminal wiring strip consists of a multiple position screw terminal block to facilitate wiring terminations for the electric control valves and thermostats.

2.04 BELT DRIVE FAN COILS UNITS

- .1 Provide belt driven blower fan coil units where indicated on the plans and the following specifications;
- .2 General:
 - .1 Provide belt driven blower fan coil units in accordance with the Equipment Schedules.
 - .2 Units shall be completely factory assembled and tested and shipped as one piece except where noted.
 - .3 All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. All unit dimensions for each model and size shall be considered maximums.
 - .4 All units shall be of "draw-thru" design with coils, fans, motor, and drain pan completely contained within the unit cabinet.
 - .5 Electric heat to be in the blow-thru configuration.
 - .6 Units shall be cETL listed in compliance with UL/ANSI Std. 1995.
 - .7 All unit coils shall meet or exceed the scheduled cooling and heating capacity, selected and rated in accordance with AHRI 410.
- .3 Construction:
 - .1 All units shall be fabricated of minimum 18 gauge galvanized steel, able to withstand a 125 hour salt spray test per ASTM B-117. Panels shall be die-formed "multibend" construction for optimum strength and rigidity.
 - .2 All exterior panels shall be single wall insulated with 1 inch thick fiberglass insulation, rated for a maximum air velocity of 5000 f.p.m.
 - .3 Insulation must meet all requirements of ASTM C1071 (including C665), UL181 for erosion, and carry a 25/50 rating for flame spread/smoke developed per ASTM E-84, UL723 and NFPA 90A. In addition to using adhesive complying with NFPA 90A, the insulation shall incorporate a secondary mechanical fastener attached to the unit casing wall. Adhesive as the only method of fastening the insulation to the casing is not acceptable.
 - .4 All access panels shall be fully insulated and attached with standard fasteners on at least two opposite sides. No single access panel shall be larger than 30" x 36" for safety and ease of handling. No coil or drain piping or electrical connections shall pass through any access panel.
 - .5 Each unit shall be furnished with a one-piece heavy gauge G90 steel or optional IAQ stainless steel drain pan with welded corner construction. Drain pan shall be insulated with minimum 1/8" closed cell foam. All units shall be provided with 9/16" diameter hanger rod holes in the top and bottom panels for "through-bolt" type suspension installation.
 - .6 All units shall have a minimum 1" duct collar on both the discharge and return.
- .4 Fan and Motor Assembly:
 - .1 All units shall be furnished with double inlet forward curved centrifugal blowers statically and dynamically balanced for smooth operation. Blower wheels shall be mounted directly on the motor shaft. Belt driven blowers are not acceptable.

- .2 Fan motors shall be electronically commutated with thermal overload protection and a constant torque operation. RPM control shall not be acceptable. Motors shall feature permanently lubricated ball bearings and operate on three or single phase power.
- .3 All motors to be installed, factory programmed and wired to the control panel.
- .4 All motors shall be isolated, depending on motor size, via belly band or torsion flex mount to the blower housing.
- .5 All motor wiring is to be terminated in a junction box, external to the unit casing.
- .6 All motors to be operated by single-speed or multi-speed local or remote controller.
- .5 Coils:
 - .1 All unit coils shall be rated in accordance with AHRI 410.
 - .2 All coils shall be ½" (12mm) O.D. seamless copper tubes with collared aluminum fins. All tubes shall be mechanically expanded to provide an efficient bond between tube and fin. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Valve core type vent fittings shall not be accepted.
 - .3 All chilled water, hot water, and direct expansion (DX) coils shall have aluminum fins and 0.016" tube wall thickness.
 - .4 All coils shall be hydrostatically tested with air under water at 450 PSIG minimum pressure and rated for a maximum of 300 PSIG working pressure at 200°F.
 - .5 All steam coils shall have 0.025" tube wall thickness.
 - .6 All steams coils shall be suitable for 15 PSIG maximum operating pressure.
- .6 Filter Rack Assembly:
 - .1 All units shall be furnished with a flat filter rack with hinged access on both sides designed to accept a 2" nominal standard sized filters.
 - .2 All units shall be provided with nominal 2" MERV 10 disposable filters factory installed. One complete set of spare throwaway filters shall be provided for each unit.
- .7 Electrical Control:
 - .1 The unit fan motor shall be completely factory wired to an external electrical enclosure. Each unit shall include fan control package with 24 volt control voltage. Each unit shall include a motor control board, motor circuit fusing, control circuit transformer and terminal strip for connection of field wiring.
 - .2 Four speed motor control shall be provided with potentiometer type adjustment. Unit to be compatible with three speed control thermostat.
 - .3 Calibrated airflow curves shall be provided near the control box to aid in testing and balancing.
 - .4 A main incoming power non-fused disconnect switch with lock-out-tag-out ready feature shall be factory furnished and wired by the unit manufacturer for single point power connection.

2.05 RADIANT HEATING CEILING PANELS

- .1 T-bar ceiling mounted linear radiant heating ceiling panels, each complete with:
 - .1 extruded aluminum with ½" (13mm) diameter copper tubing mechanically attached to the white aluminium faceplate;
 - .2 a non-hardening heat conductive paste between the copper tubing and aluminium faceplate;
 - .3 cross channel braces, centre clips and end clips as required;
 - .4 piping return bends and interconnects as required;
 - .5 panel sections as required.

2.06 UNIT HEATERS

- .1 CSA certified hot water unit heaters, each complete with:
 - .1 casing-vertical units: top and bottom heavy-gauge circular steel plates, the top plate equipped with a depression for the motor and an opening for motor cooling air, threaded hanger rod connections, the bottom plate equipped with a die-formed fan venturi and a bolt-on adjustable air deflector, both plates bolted together with a circular heating coil in between.
 - .2 casing – horizontal units: minimum 0.95 mm thick die-formed steel front and back casing halves with formed ribs and rounded corners. Both halves to be secured together top and bottom with screws, equipped with threaded hanger rod connections at the top, a formed fan venturi with bolt-on wire grid guard in the back, and a rectangular formed discharge opening with adjustable horizontal and vertical air deflectors in the front.
 - .3 casing finish: factory applied, consisting of electrostatically applied baked power epoxy on cleaned and primed casing surfaces.
 - .4 heating coil: constructed for 200 psig (1380 kPa) working pressure suitable for steam or hot water according to the application, factory leak tested, consisting of minimum 5/8" (16mm) OD, minimum 0.03" (0.71mm) wall thickness, seamless copper tubing mechanically expanded into and permanently bonded to continuous plate type aluminium fins. Equip coils with screwed steel supply and return piping connections and silver brazed tube joints.
 - .5 fan and motor: continuous duty TEFC motor direct connected to a balanced propeller type fan wheel with aluminium blades secured to a steel hub complete with local ON/OFF disconnect switch.
 - .6 two-way (modulating) control valve shipped loose for field installation.

2.07 CABINET UNIT HEATERS

- .1 CSA certified hot water cabinet unit heaters, each complete with:
 - .1 cabinet: of welded fabrication, constructed from one-piece top and sides, and one-piece partition panels and backsheet, both die-formed from single sheets of minimum 1.2 mm thick furniture grade steel and complete with minimum 825 mm space at each end for piping and wiring, stamped grilles where required, and, for surface floor and wall mounted cabinets, key lock access doors for access to valves and speed controls;
 - .2 front panel: 1.5 mm thick removable front panel with tamperproof fasteners, stamped grille where required and insulation applied to the inside face;
 - .3 cabinet finish: for all exposed surfaces, a baked enamel prime coat finish applied to cleaned metal surfaces;
 - .4 heating coil: constructed for 200 psig (1380 kPa) working pressure suitable for steam or hot water according to the application, factory leak tested, consisting of seamless copper tubing mechanically expanded into and permanently bonded to continuous plate type aluminium fins, and equipped with screwed steel supply and return piping connections and silver brazed tube joints;
 - .5 fan and motor: a removable galvanized steel fan board with centrifugal, forward curved, formed aluminium fan wheel(s) with galvanized steel housings, direct connected to a continuous duty, three-speed permanent split capacitor motor complete with local ON/OFF disconnect switch;
 - .6 duct connection collars: for cabinets where indicated, duct connection collars;
 - .7 filter: a disposable 1" (25mm) MERV 8 filter upstream of heating coil;
 - .8 two-way (modulating) control valve shipped loose for field installation.

2.08 DUCT MOUNTED REHEAT COILS

- .1 Provide duct mounted re-heat coils as noted on the Drawings and in accordance with the performance requirements indicated on the Equipment Schedules.

- .2 Provide minimum face areas shown in Coil Schedule.
- .3 AHRI rated and certified hot water reheat coils, each drainable, self-venting, factory tested and constructed as follows:
 - .1 Minimum 5/8" (16mm) OD copper tubes permanently bonded to aluminum fins (hydraulically or mechanically expanded) equipped with same end supply and return pipe connections;
 - .2 Coils shall have a minimum 10 fins per inch, fins shall be at least .0045" thick;
 - .3 0.020" tube wall thickness, with supply and return connections shall be on the same end of the coil;
 - .4 Coils shall be constructed for 200 psig (1380 kPa) working pressure suitable for steam or hot water according to the application;
 - .5 flanged galvanized steel casings arranged to prevent air bypass around the coil and factory punched for duct connection flanges or slip/drive joint collars.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Comply with Manufacturer's requirements for the installation of all specified equipment and all requirements of the Authorities Having Jurisdiction ("AHJs").
- .2 Provide all required labour necessary for the installation of control components and devices supplied by Controls Trades. Include all additional labour necessary for the successful completion of point-to-point verification of devices, and performance verification of devices and systems as part of the project commissioning requirements.
- .3 Locate equipment as shown on the drawings to provide connection arrangement and accessibility for servicing.
- .4 Provide clearances on all sides of equipment as required by the Manufacturer's Installation Instructions.
- .5 Install items of equipment with due regard to Architectural treatment, and ensure all items are level and finished in keeping with good workmanship.
- .6 Install and connect remote components such as thermostats, humidistats, control panels, level controllers, and other similar devices supplied with the equipment. Install in locations as shown on the Drawings.
- .7 Provide pipe flanges or unions at connections to all terminal HVAC devices.
- .8 Provide minimum 3/4" (20mm) drain valves with threaded cap downstream of the supply piping isolation valve, and upstream of the return piping isolation valve at all terminal HVAC devices.
- .9 Provide screwdriver or key type manual air vents at each terminal HVAC devices including fan coil unit, radiant ceiling heating panel, , unit heater, cabinet unit heater, convactor, wallfin heating element section, duct mounted re-heat coil, and CAV and VAV box re-heat coil.

3.02 FAN COIL UNITS

- .1 Position units per manufacturer's requirements. Suspend ceiling mounted units from slab above with isolation hangers. Provide flexible duct connections for ducted units.

3.03 RADIANT HEATING CEILING PANELS

- .1 Field measure wall-to-wall wall-fin enclosures and ceiling radiant panels.
- .2 Provide end panels and filler pieces for wall-fin front panels to complete a neat, workmanlike installation.
- .3 Provide gaskets at the rear of each wall-mounted hydronic terminal unit.
- .4 Install all enclosures horizontal and level.
- .5 Support units top and bottom, on wall mounted brackets.

- .6 Wallfin cabinets running wall-to-wall or column-to-column shall have each end screwed to a piece of $\frac{3}{4}$ " (20 mm) plywood formed to the cabinet cross section and securely fastened to the wall. Provide plywood. Alternatively provide factory-fabricated steel mounting brackets for the same purpose.

3.04 DUCT MOUNTED REHEAT COILS

- .1 Install re-heat coils in accordance with typical coil connection details.

3.05 TESTING

- .1 Meet testing requirements of all Authorities Having Jurisdiction. Obtain certification and certify tests not required by authorities. Perform not less than the following tests.

3.06 EQUIPMENT START-UP

- .1 Follow manufacturer's instructions and have manufacturer's representative present to certify the installation.
- .2 Check each item of equipment to ensure proper piping connections, electrical connections, pump rotation and similar, to verify proper operation.
- .3 After work is completed, adjust and put all equipment into proper working order. Adjust all valves and dampers to achieve specified performance capacities. Leave the complete job ready for regular operation, all to the satisfaction of the Consultant.

3.07 INSTALLATION OF CONTROL DEVICES AND INSTRUMENTATION

- .1 Install all control devices and instrumentation for the hydronic systems as shown on the drawings, specified in Section 25 30 10 for items supplied by the Controls Trades.

3.08 TESTING ADJUSTING AND BALANCING ("TAB")

- .1 Refer to Section 20 05 95.
- .2 Provide flow measurement ports as shown on detail drawings and piping schematics in locations as directed by the Testing Adjusting and Balancing ("TAB") specialist.
- .3 Provide balancing valves and balancing dampers where specified and as directed by the TAB specialist.
- .4 Provide any system adjustments and modifications as recommended by the TAB Trades to achieve required system performance.

END OF SECTION

CONTENTS

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- 2.01 RADIANT FLOOR HEATING SYSTEM**
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- 3.01 RADIANT FLOOR SYSTEM INSTALLATION**
- 3.02 GLYCOL SNOW MELTING SYSTEM INSTALLATION**

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Mechanical Basic Materials and Methods.

1.02 DESCRIPTION

- .1 Furnish and install, in accordance with the recommendations of the manufacturer, "in-slab" hydronic heat distribution system(s) for radiant floor heating and glycol snow melting.

1.03 REFERENCES

- .1 ASTM F876 Standard specification for cross linked polyethylene (PEX) Tubing.
- .2 ASTM F877 Cross linked polyethylene (PEX) plastic hot and cold water distribution systems.
- .3 CAN/CSA-B137.5 Cross linked polyethylene (PEX) tubing systems for pressure applications.

1.04 SUBMITTALS

- .1 The Mechanical Trades shall confirm complete and final CAD layout drawings as per bid documents showing tubing patterns, manifold locations, appropriate cross sections, and special installation techniques.
- .2 Prepare an exact detailed layout of the components for approval after award of tender prior to construction. The layout must meet or exceed the performance noted in these bid documents.

1.05 SUPERVISION

- .1 Supervision of the system installation shall be provided by an approved installation supervisor from the manufacturer.
- .2 The supervisor will monitor the system pressure test, immediately following installation to ensure the integrity of the system.
- .3 A specification sheet shall be provided as part of the warranty, outlining the system performance characteristics.

1.06 WARRANTY

- .1 System(s) shall be covered by a ten (10) year Limited System Performance Warranty.
- .2 The warranty requires that system design, installation supervision and witnessing of the pressure test all be performed by authorized personnel.
- .3 The manifolds and fittings shall carry a five (5) year non prorated warranty against failure due to a defect in material or workmanship.
- .4 Controls and electrical components shall carry a two (2) year non-prorated warranty against failure due to defect in material or workmanship.
- .5 The tubing shall carry a twenty five (25) year non-prorated warranty against failure due to manufacturing defect or exposure to stress cracking agents.
- .6 This warranty is to include tubing embedded in concrete.
- .7 Warranty shall apply to all defects arising from defects in material manufacturing. Liability is subject to the installation being performed in a qualified manner according to General Installation Guidelines and in compliance with specific installation guidelines and in compliance with installation instructions and applicable technical standards.
- .8 A specification sheet shall be provided as part of the warranty, outlining the system performance characteristics.
- .9 Warranty shall be transferrable to subsequent Owners.

PART 2 - PRODUCTS

2.01 RADIANT FLOOR HEATING SYSTEM

- .1 Tubing:
 - .1 Tubing embedded in concrete shall be high density cross linked polyethylene tubing in accordance with ASTM F877 as certified by NSF or CSA. All tubing shall be fully cross linked to the specified standard prior to shipment from the manufacturing facility.
 - .2 All piping shall be rated at 180°F maximum working temperature and up to 100 psi working pressure in accordance with ASTM standard F876 and F877. Tubing shall have 100% thermal memory when heated to 130°C (266°F).
 - .3 The minimum bend radius for cold bending of the tubing shall not be less than five (5) times the outside diameter. Bends with a radius less than stated will require the use of a bend support by the tubing manufacturer.
 - .4 Tubing shall be provided with an oxygen diffusion barrier. Oxygen diffusion barrier shall be capable of limiting oxygen diffusion through the tube to no greater than 0.10/g/cu.m/day at 104°F water temperature.
 - .5 Steel, copper, polybutylene, polypropylene, nitrile, polyester, rayon, neoprene and rubber piping are not acceptable.
- .2 Fittings and Manifolds:
 - .1 Tubing fittings shall be manufactured of dezincification resistant brass. These fittings must be supplied by the tube manufacturer. The tube fitting consists of a barbed insert, a serrated compression ring and a nut and be capable of connecting to the manifold or tube splice.
 - .2 Manifolds shall be of cast bronze construction and shall have integral loop balancing and loop control valves. Supply and return manifolds shall be able to vent air from the system and shall be provided with support (mounting) brackets. Manifolds shall be isolated from supply and return piping with valves that are suitable for isolation and balancing.
- .3 Controls:
 - .1 The system shall be controlled by the Building Automation System (BAS). Refer to the Controls specification and operating sequences.
- .4 Radiant Floor Heating Capacity:
 - .1 The in-floor radiant heating system shall be provided in the locations shown on the drawings. The in-floor radiant heating system shall provide the heat densities noted on the drawing/ equipment schedules but should not be lower than 32 BTUH/sq.ft (101 W/sq.m) throughout the area where it is installed and shall heat the slab to a temperature no higher than 90°F (32.2°C).
- .5 Pre-Assembled Mixing Control Panels:
 - .1 For each area of snow melting/radiant floor heating, provide a pre-assembled mixing control panel.
 - .2 Each panel shall consist of a compact, pre-piped mechanical system with connections to the supply and the return manifolds, in-line circulating pump in accordance with Section 23 21 23, check valves, isolation valves, supply and return temperature gauges, pressure bypass valve and a 24V activated 3-way modulating mixing valve with discharge temperature controls.
 - .3 The pre-assembled mixing control panel shall be in a compact insulated foam box ready for field mounting with supplied brackets.
 - .4 The mixing control panel shall include integral temperature control to control the local supply fluid temperature through BAS control.
 - .5 Provide all required transformers and relays required by BAS to control pumps and control valves.
 - .6 Each panel location shall come complete with slab temperature sensor.

- .7 Sensors shall be installed in appropriate locations within the zone to allow proper of monitoring of slab conditions.
- .8 Sensor shall be installed such that they can be replaced through non-destructive means if a sensor failure should occur.
- .9 Sensor termination points shall be within pre-assembled mixing control panels.
- .6 Acceptable Manufacturers:
 - .1 Uponor,
 - .2 Rehau,
 - .3 Or approved equal.

2.02 GLYCOL SNOW MELTING SYSTEM

- .1 Tubing:
 - .1 Tubing embedded in concrete shall be high density cross linked polyethylene tubing in accordance with ASTM F877 as certified by NSF or CSA. All tubing shall be fully cross linked to the specified standard prior to shipment from the manufacturing facility.
 - .2 All piping shall be rated at 180°F maximum working temperature and up to 100 psi working pressure in accordance with ASTM standard F876 and F877. Tubing shall have 100% thermal memory when heated to 130°C (266°F).
 - .3 The minimum bend radius for cold bending of the tubing shall not be less than five (5) times the outside diameter. Bends with a radius less than stated will require the use of a bend support by the tubing manufacturer.
 - .4 Tubing shall be provided with an oxygen diffusion barrier. Oxygen diffusion barrier shall be capable of limiting oxygen diffusion through the tube to no greater than 0.10/g/cu.m/day at 104°F water temperature.
 - .5 Steel, copper, polybutylene, polypropylene, nitrile, polyester, rayon, neoprene and rubber piping are not acceptable.
- .2 Fittings and Manifolds:
 - .1 Tubing fittings shall be manufactured of dezincification resistant brass. These fittings must be supplied by the tube manufacturer. The tube fitting consists of a barbed insert, a serrated compression ring and a nut and be capable of connecting to the manifold or tube splice.
 - .2 Manifolds shall be of cast bronze construction and shall have integral loop balancing and loop control valves. Supply and return manifolds shall be able to vent air from the system and shall be provided with support (mounting) brackets. Manifolds shall be isolated from supply and return piping with valves that are suitable for isolation and balancing.
- .3 Controls:
 - .1 The system shall be controlled by the Building Automation System (BAS). Refer to the Controls specification and operating sequences.
- .4 Snow Melting Capacity:
 - .1 The snow melting system shall be provided in the locations shown on the drawings. The snow melting systems shall provide the heat densities noted on the drawing/ equipment schedules but should not be lower than 205 BTUH/sq.ft (646 W/sq.m) throughout the area where it is installed and shall heat the slab to a temperature no higher than 39°F (4°C).
- .5 Pre-Assembled Mixing Control Panels:
 - .1 For each area of snow melting/radiant floor heating, provide a pre-assembled mixing control panel.
 - .2 Each panel shall consist of a compact, pre-piped mechanical system with connections to the supply and the return manifolds, in-line circulating pump in accordance with Section 23 21 23, check valves, isolation valves, supply and return temperature gauges, pressure

- bypass valve and a 24V activated 3-way modulating mixing valve with discharge temperature controls.
- .3 The pre-assembled mixing control panel shall be in a compact insulated foam box ready for field mounting with supplied brackets.
- .4 The mixing control panel shall include integral temperature control to control the local supply fluid temperature through BAS control.
- .5 Provide all required transformers and relays required by BAS to control pumps and control valves.
- .6 Each panel location shall come complete with slab temperature sensor; and for snow melting systems, temperature sensors and snow sensors.
- .7 Sensors shall be installed in appropriate locations within the zone to allow proper of monitoring of slab conditions.
- .8 Sensor shall be installed such that they can be replaced through non-destructive means if a sensor failure should occur.
- .9 Sensor termination points shall be within pre-assembled mixing control panels.
- .6 Acceptable Manufacturers:
 - .1 Uponor,
 - .2 Rehau,
 - .3 Or approved equal.

PART 3 - EXECUTION

3.01 RADIANT FLOOR SYSTEM INSTALLATION

- .1 Tubing shall be embedded in concrete and shall be secured to a welded wire fabric or approved alternate fabric with wire ties provided by the pipe manufacturer.
- .2 Spacing of wire ties shall be a maximum of 900mm for straight lengths of tubing and a minimum of three (3) ties per 180° turn.
- .3 Contractor to supply field coordination and supervision of the water pressure testing of the field tubing.
- .4 Provide compressed air, inert gas or 80 psi water source for pressure testing.
- .5 Manufacturer's Representative shall be on site during all concrete pours. The system shall be pressure tested at 80psi for minimum of six (6) hours prior to and during the concrete application.
- .6 Test equipment to be supplied by and installed by the contractor. Pressure test using compressed air or inert gas is not acceptable.
- .7 Repair kits shall be on-site during the pour to allow for immediate repair of leaks should they occur during the concrete application period
- .8 In the event of freezing weather, the contractor shall install a glycol solution to the prescribed percentage to prevent any possibility of freezing the tubing system.
- .9 The system shall be thoroughly checked for possible tubing punctures by the authorized supervisor and shall be repaired by the contractor prior to and during the concrete application.
- .10 At all expansion joint penetrations provide sleeves for tubing.
- .11 Where tubing is light/UV sensitive, do not expose tubing to ultraviolet light for extended periods of time either in storage or during construction. Tubing exposure shall be under total exposure period stipulated by the manufacturer.
- .12 Tubing shall be installed by an installer that has been trained by the radiant heating supplier.
- .13 Provide start-up assistance to balance flow in the circuits and confirm proper control sequence. Submit start-up report to the Engineer.

- .14 Coordinate the timing of related activities.
- .15 The sequence should be: installation of rebar/wire mesh, field looping, tying tubes to rebar/wire mesh and pour of concrete.

3.02 GLYCOL SNOW MELTING SYSTEM INSTALLATION

- .1 Tubing shall be embedded in concrete and shall be secured to a welded wire fabric or approved alternate fabric with wire ties provided by the pipe manufacturer.
- .2 Spacing of wire ties shall be a maximum of 900mm for straight lengths of tubing and a minimum of three (3) ties per 180° turn.
- .3 Contractor to supply field coordination and supervision of the water pressure testing of the field tubing.
- .4 Provide compressed air, inert gas or 80 psi water source for pressure testing.
- .5 Manufacturer's Representative shall be on site during all concrete pours. The system shall be pressure tested at 80psi for minimum of six (6) hours prior to and during the concrete application.
- .6 Test equipment to be supplied by and installed by the contractor. Pressure test using compressed air or inert gas is not acceptable.
- .7 Repair kits shall be on-site during the pour to allow for immediate repair of leaks should they occur during the concrete application period
- .8 In the event of freezing weather, the contractor shall install a glycol solution to the prescribed percentage to prevent any possibility of freezing the tubing system.
- .9 The system shall be thoroughly checked for possible tubing punctures by the authorized supervisor and shall be repaired by the contractor prior to and during the concrete application.
- .10 At all expansion joint penetrations provide sleeves for tubing.
- .11 Where tubing is light/UV sensitive, do not expose tubing to ultraviolet light for extended periods of time either in storage or during construction. Tubing exposure shall be under total exposure period stipulated by the manufacturer.
- .12 Tubing shall be installed by an installer that has been trained by the radiant heating supplier.
- .13 Provide for draining the system and/or evacuating piping using compressed air.
- .14 Charge system with 40/60% propylene glycol.
- .15 Provide start-up assistance to balance flow in the circuits and confirm proper control sequence. Submit start-up report to the Engineer.

END OF SECTION

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- 1.01 GENERAL REQUIREMENTS**
- 1.02 WORK PERFORMED BY THIS SECTION**
- 1.03 QUALITY ASSURANCE**
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PART 3 - EXECUTION

- 3.01 GENERAL**
- 3.02 INSTALLATION**
- 3.03 FIELD QUALITY CONTROL**

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .4 Comply with the requirements of Section 25 10 10 BAS Control Network
 - .1 Comply with all requirements including those referenced in Article "BAS Integration with Third Party Devices"

1.02 WORK PERFORMED BY THIS SECTION

- .1 Provision of Humidifiers.

1.03 QUALITY ASSURANCE

- .1 Qualifications: execute work of this section only by skilled tradesmen regularly employed in the construction and installation of Humidifiers.
- .2 Submittals: Submit shop drawings for the following Products:
 - .1 Humidifiers, as specified below, including all components and accessories

1.04 REFERENCE STANDARDS

- .1 Humidifiers shall be designed and constructed to meet the following standards:
 - .1 ISO 9001-2000.
 - .2 CSA Z317.2 (2015) - Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Health Care Facilities.
 - .3 ANSI/AHRI 640 (2005) – Performance Rating of Commercial and Industrial Humidifiers
 - .4 ASHRAE 90.1 (2010) - Standard for Energy Efficient Design for New Buildings.
 - .5 CGA, ETLC, CSA or UL/ULC certified for prewired equipment
 - .6 ANSI/NFPA 70 - National Electrical Code.

1.05 SITE VISIT

- .1 Visit the site prior to tender and verify all conditions. Prior to submitting price, the Mechanical Division contractor is to review all discrepancies and verify the locations of all existing services that are being extended and the routing of new services. Also report all ambiguities, discrepancies, departures from building by-laws and/or from good practice. Failure to do so will result in all additional costs being the responsibility of the Mechanical Division Contractor. Include for any alternate routing of new or rerouting of existing services to accommodate all site conditions in the tender price.

PART 2 - PRODUCTS

2.01 ELECTRIC STEAM HUMIDIFICATION SYSTEM

- .1 Provide resistive element humidifier generating mineral-free, sterile steam for use with potable, De-ionized (DI), or Reverse Osmosis (RO) water.
- .2 Packaged unit, wall mounted, atmospheric steam generation using resistive heating element. Electrode technology and boiler steam (pressure steam) technology not acceptable.
- .3 Unit(s) to be complete with:
 - .1 Touchscreen controller with standard building automation connectivity:
 - .1 Intuitive touchscreen control with color graphic user interface.

- .2 Standard building automation communication protocols BACnet IP, BACnet MSTP (Slave) and Modbus. Additional hardware required for building automation communication not acceptable.
- .3 Standard manufacturer's online connectivity for remote monitoring and factory diagnostic.
- .4 Embedded web interface for easy configuration and remote monitoring from any computer with a web browser over a local area network (LAN) connection.
- .5 USB interface for new software/feature upload and download of operational information.
- .6 Single or dual channel analog signal acceptance, supporting both demand and transducer control. Ability to control setpoint from humidifier control when using transducer controls.
- .2 Packaged system with resistive element technology:
 - .1 Incoloy based resistive heating element for steam production.
 - .2 Modulating output between 4% and 100% of rated capacity.
 - .3 Control accuracy of up to +/- 1% RH using optional Solid State Relay control and high precision humidistat.
 - .4 Dual magnetic electronic float system, located outside of the boiling water to ensure accurate water level control and reduced maintenance.
 - .5 Self-diagnostics during start-up of system to prevent unsafe operation of the unit(s):
 - .1 Fill valve check.
 - .2 Float level check.
 - .3 Drain pump check.
 - .6 Durable powder coated steel cabinet with zero side clearance requirement for minimal footprint.
 - .7 Insulating air gap between plumbing and electrical compartment for increased electronic reliability.
 - .8 Standard internal drain water tempering to ensure maximum 140°F [60°C] drain water. External drain water cooler not acceptable.
 - .9 Integral fill cup with minimum 1-inch [25 mm] air gap to prevent back siphoning.
 - .10 Automatic off-season shut-down [after 3 days of "no call"] will completely drain the boiling tank[s] and automatically restart on call for humidity.
 - .11 Integral design allowing easy installation and access for servicing.
- .4 Optional Accessories:
- .5 Acceptable Manufacturers: Condair, Dri-Steem, Pure Humidifier Co, or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- .1 Air handling units with humidifier section shall be shipped as a complete packaged system. Shop drawings shall be submitted as one complete system.
- .2 Provide a factory-trained service technician without additional charge to start and commission the humidifiers. In addition, factory shall allow for job site review of each humidifier to carry out start-up, commissioning and instruct Owner's representatives; dates will be determined by owner's representative.

3.02 INSTALLATION

- .1 Install components plumb and level, in accordance with approved shop drawings, product installation details and manufacturer's recommendations.
 - .1 Install humidifiers and components per manufacturers' instructions.
 - .2 Seal humidifier duct penetrations with flange.
 - .3 Install with required clearance for service and maintenance.
- .2 Install humidity sensor as indicated on the floor plans and/or control sequences.
- .3 Terminate water supply overflow over nearest funnel and floor drain (FFD).
- .4 For humidifiers installed in ductwork, install access doors or panels in adjacent to humidifiers for servicing.
 - .1 Provide waterproof duct up and downstream of humidifier.
 - .2 Install drain connection at low point in duct, extend drain and terminate over nearest funnel and floor drain (FFD).
- .5 For humidifiers installed in air handling units, the humidifier grid shall be installed at the air handling unit factory.
 - .1 Installation instruction shall be provided to air handling unit manufacturer for reference.

3.03 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Manufacturer's Field Services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .2 Schedule site visits, to review Work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Upon completion of the Work, after cleaning is carried out.
- .2 Start-up:
 - .1 General: In accordance with project General Requirements, supplemented as follows:
 - .1 Steam lines are sloped to ensure steam condensate is drained away from the humidifier.
 - .2 Vapour lines and manifolds are sloped to ensure condensate is drained away from the duct system.
 - .3 Visually check distribution manifold to ensure:
 - .1 Even distribution of vapour.
 - .2 Freedom from water deposits.
 - .2 Adiabatic humidifier reverse osmosis (RO) water treatment system shall have a BactiQuant (BQ) water field test, using an enzyme targeted analysis; testing shall be performed by a BQ Certified manufacturer's technician.
 - .1 The field test shall consist of, an enzyme activity which shall be measured by use of a highly sensitive fluorescence technology, and shall quantify the amount of microbial enzymes. The fluorescence signal shall be directly proportional to the content of bacteria.
 - .2 The BQ test shall be completed in less than 60 minutes with passed results, indicating a clean hygienic system; should test results shows BQ values higher than 57, the system must be disinfected according to manufacturer's instructions

- .3 The field test must be a verified method by the United States Environmental Protection Agency (US-EPA). No Heterotrophic plate counts, nor ATP methods for bacterial test will be accepted.
- .3 Verification Reports:
 - .1 Submit Verification Reports indicating factory-trained service technician's acceptance of the humidifier installation, operation, and Owner's training is complete.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with the requirements of Section 20 01 10 Mechanical General Requirements
- .2 Comply with the requirements of Section 20 10 50 Basic Materials and Methods
- .3 Comply with the requirements of Section 20 05 70 Motors, Motor Starters, and Wiring
- .4 Comply with the requirements of Section 20 05 95 Testing Adjusting and Balancing
- .5 Comply with the requirements of Section 20 08 10 Mechanical Commissioning
- .6 Comply with the requirements of Section 25 10 10 BAS Control Network
- .7 Comply with the requirements of Section 25 30 10 BAS Instrumentation and Devices
- .8 Comply with the requirements of Section 25 56 26 Integrated Lighting System Controls

1.03 SCOPE OF WORK

- .1 Provide all detailed design, labour, materials, products and service to supply Building Automation System (BAS) with Direct Digital Control (DDC), and Energy Management (EMS) for building mechanical and electrical systems.
- .2 The entire BAS shall be peer-to-peer networked, stand-alone, distributed control in accordance with American National Standards Institute/American Society of Heating, Refrigerating and Air Conditioning Engineers (ANSI/ASHRAE) Standard 135-2004, BACnet – A Data Communication Protocol for Building Automation and Control Networks.
- .3 Be responsible for the complete installation of the Building Automation System (BAS) for this project and guarantee its proper function.
- .4 Include software and hardware, wiring, and computing equipment. The BAS shall be compatible with future control Products for ten (10) years or more.
- .5 Power wiring for all electric motors shall be by the Mechanical Trade Contractor unless indicated otherwise by the Construction Manager.
- .6 Provide sufficient resources to complete the Work within the Agreement time. Any required overtime and similar costs to complete the project by the agreed completion date is included in the Bid price.
- .7 Mechanical Trades will provide electromagnetic starters with required number of ancillary contactors unless supplied as an integral part of the Equipment. Where integral starters are supplied with Equipment, provide all additional wiring and ancillary devices to achieve specified equipment performance and control sequences.
- .8 Electrical Trades will provide lighting fixtures to be controlled by the Integrated Lighting Systems Control specified in Section 25 56 26.
- .9 Provide instruction on the revised system's operation to the Owner's maintenance personnel; allow for eight (8) days of on site and classroom instruction.
- .10 Arrange for all the necessary inspections and approvals of built-up control systems and relay panels by the Authorities Having Jurisdiction ("AHJ's"). All electrical equipment, material and its installation shall conform to the current requirements of the AHJ's including:
 - .1 Ontario Electrical Safety Code ("OESC")
 - .2 Ontario Building Code ("OBC")
 - .3 Ontario Fire Code ("OFC")
 - .4 Canadian Standards Association ("CSA")

- .11 Generally control systems, algorithms and sequence programming shall follow requirements outlined in ASHRAE Guideline 35 - High-Performance Sequences of Operation for HVAC Systems. Any proposed deviations from the Standard shall be reviewed with the Consultant prior to implementation on site.

1.04 BAS TRADE REQUIREMENTS

- .1 The BAS Trades shall co-ordinate and take the lead role in the onsite testing, supervision of assembly and Commissioning of the installation and verification of the performance of the BAS.
- .2 The BAS Trades shall ensure that all equipment meets all design and Code requirements prior to shipment from the BAS Trades shop.
- .3 The BAS Trades shall provide specialized expertise during the installation, Start-up and Commissioning of the BAS as follows:
 - .1 On-site technical supervision of the BAS Trades during installation and assembly of the equipment as per BAS component manufacturer's instructions.
 - .2 On-site technical supervision of the BAS Trades for calibration of equipment and systems prior to commencement of any system testing.
 - .3 Review of the electrical and communication wiring.
 - .4 Technical supervision of Start-up and Commissioning of the BAS.
 - .5 Completion of all forms necessary for Acceptance of the equipment by Owner and Consultant.
 - .6 Submission of BAS shop drawings and preparation of Operating and Maintenance ("O&M") Manuals.
 - .7 Owner's training for operation and maintenance of BAS equipment and ancillary components.

1.05 GENERAL BUILDING AUTOMATION SYSTEM ("BAS") DEFINITIONS

- .1 The following terms and references appear throughout the Division 25 Specifications, and the Control Sequences issued with the Documents and provide additional background information as to the intent of the functionality of the Building Automation System (BAS).
 - .1 **Actuator:** A mechanical device that is used to operate a final control element in a control system (e.g., Control Valve, or Damper) based on an electric, electronic, or pneumatic signal from a Controller.

Actuators may attach to the valve stem or damper shaft through a linkage or be direct coupled connecting directly to the stem or shaft, and can be two separate devices or together they can be one device.

The direction of shaft rotation on loss of control signal varies for spring-return Actuators. The direction can be clockwise (CW) or counterclockwise (CCW) as viewed from the drive end of the Actuator. Actuator controlled Control Valves and Dampers also vary as to whether they open or close on a loss of control signal. This depends on the specific Actuator, linkage arrangement, and Control Valve or Damper selected.

Actuators are available with various timings to drive through full stroke such as 15, 30, 60, 120, or 240 sec. In general, the timing is selected to meet the application requirements (e.g., an Actuator with 240 sec timing might be used to control the Variable Frequency Drive (VFD) for a fan in a floating control system).
 - .1 **Electric Actuator:** Electric actuators consist of an electric motor coupled to a gear train and output shaft. Typically, the shaft drives through 90 degrees or 160 degrees of rotation depending on the application. For example, 90-degree stroke Actuators are used with Dampers, and 160-degree stroke actuators are used with Control Valves. Limit switches, in the Actuator, stop the motor at either end of the stroke, or current limiters sense when the motor is stalled at the end of the stroke. Actuator gear trains are factory lubricated for life requiring no additional lubrication.

The Electric Actuator's motor may be electrically reversible by the controller for some applications. Electric Actuators with a return spring enables the output shaft to return to the normal position on loss or interruption of power; a solenoid brake may be used on spring-return actuators to hold the Actuator in the control position.

- .2 **Air Handling Unit (AHU):** Equipment that conditions air either through filtration, heating, humidifying, cooling, de-humidifying, or any combination thereof, and delivers it to an air distribution system.
- .3 **Algorithm:** A calculation method that produces a control output by operating on an Error signal or a time series of Error signals. Also see Control Algorithms.
- .4 **Analog:** Continuously variable (e.g., the outdoor air temperature is an Analog value).
- .5 **Analog Input (AI):** continuously variable input value, usually from a Sensor, referenced to a Controller.
- .6 **Analog Output (AO):** continuously variable output value, usually a control signal sent to an Actuator, referenced to a Controller.
- .7 **Analog-to-Digital (A/D) Converter:** The part of a microprocessor based controller that changes an analog input signal to a digital value for use by the microprocessor in executing software programs. Analog input values typically come from temperature, pressure, humidity, or other types of sensors or transducers.
- .8 **Application Software:** Programs that provide functions such as direct digital control, energy management, lighting control, event initiated operations, and other alarm and monitoring routines.
- .9 **Authority (Reset Authority or Compensation Authority):** A setting that indicates the relative effect a compensation sensor input has on the main Setpoint (expressed in percent).
- .10 **Authority Having Jurisdiction (AHJ):** An organization, office, or individual responsible for enforcing the requirements of a Code or Standard, or for approving equipment, materials, an installation, or a procedure. There may be more than one AHJ.
- .11 **Automatic Control System:** A system that reacts to a change or imbalance in the Controlled Variable it controls by adjusting other variables to restore the system to the desired balance.
- .12 **Binary:** A term applied to a signal or device that has only two discrete positions or states. When used in its simplest form, as in a "binary signal" (as opposed to "analog signal"), the term denotes an "on-off" or "high-low" state, i.e., one which does not represent continuously varying quantities. A Digital signal (value of 1 or 0) is an example of a Binary signal.
- .13 **Building Automation System (BAS):** A system that controls the comfort and safety of a buildings assets and environment, and which centralizes the monitoring, operations; management of a building to achieve a more efficient operation overall.
- .14 **Building Automation and Control Network (BACnet) Protocol:** A BAS communications protocol developed by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
- .15 **Building Control Unit (BCU):** A PC or other device used primarily by building operation personnel for everyday building operations. This processor can access points or data in all the lower level controllers and other BCUs on the network. The processor at this level typically incorporates colour operator terminal displays and plug-in function boards to accommodate additional operator terminals, printers, memory expansion, and communications links.
- .16 **Building Operator:** Building operations staff familiar with the operating and maintenance requirements of the building equipment and/or systems infrastructure.
- .17 **Commissioning:** The process of designing, achieving, verifying, and documenting the performance of a building, or building system(s), or other building infrastructure element to meet the operational needs of the building, and to confirm building system or element's performance capabilities align with the design documentation within the of the design and

the Owner's functional criteria. Commissioning also includes training of operating personnel. Also see Integrated System Testing (IST) requirements.

- .1 **Mechanical System Commissioning:** The process of documenting and verifying the performance of mechanical systems so that systems operate in conformity with the design intent. Refer to Specification 20 08 10 Mechanical Commissioning for additional requirements.
- .18 **Communications Protocol:** A set of conventions used to govern the format and content of data transmitted between Processors.
- .19 **Configurable Controller:** A controller with a set of selectable programs with adjustable parameters but without the ability to modify the programs.
- .20 **Contact Arrangement:** The electric switch configuration of a controller, relay, contactor, motor starter, limit switch, or other control device. Contacts which complete circuits when a relay is energized (pulled in) are called normally open (NO) or "in" contacts. Contacts which complete electric circuits when a relay is de-energized (dropped out) are called normally closed (NC) or "out" contacts. Many contact arrangements are available depending on the control device.
- .21 **Control Algorithms:**
 - .1 **Compensation Control:** A process of automatically adjusting the control Setpoint of a given Controller to compensate for changes in a second measured variable (e.g., outdoor air temperature). For example, the hot water temperature in a perimeter radiation system is normally reset upward as the outdoor air temperature decreases. Also called "Reset Control".
 - .2 **Derivative Control:** A control Algorithm that changes the output of a Controller in proportion to the rate of change of the Error.
 - .3 **Enhanced Proportional-Integral-Derivative (EPID) Control:** A control Algorithm that enhances the standard PID algorithm by allowing the designer to enter a startup output value and error ramp duration in addition to the gains and Setpoints. These additional parameters are configured so that at startup the PID output varies smoothly to the control point with negligible overshoot or undershoot.
 - .4 **Integral Control:** A method of changing the output of a controller by an amount proportional to the Error and the duration of that Error.
 - .5 **Proportional Control:** A control Algorithm or method in which the final control element moves to a position proportional to the Error.
 - .6 **Proportional-Integral (PI) Control:** A control Algorithm that combines the proportional (proportional response) and integral (reset response) control Algorithms. Reset response tends to correct the offset resulting from proportional control. Also called "proportional-plus- reset" or "two-mode" control.
 - .7 **Proportional-Integral-Derivative (PID) control:** A control algorithm that enhances the PI control algorithm by adding a component that is proportional to the rate of change (derivative) of the Error. Compensates for system dynamics and allows faster control response. Also called "three- mode" or "rate-reset" control.
- .22 **Control Modes:**
 - .1 **Modulating Control:** When an actuator is energized, it moves the damper or valve a distance proportional to the sensed change in the controlled variable. For example, a thermostat with a 10-degree throttling range moves the actuator 1/10 of the total travel for each degree change in temperature.
 - .2 **On/Off Control:** See Two-Position Control.
 - .3 **Two-Position Control:** When an actuator is energized it moves the valve or damper to one of the extreme positions either full ON or full OFF with no intermediate

- operating positions available. The valve or damper position remains unchanged until conditions at the controller have moved through the entire range of the differential.
- .4 **Floating Control:** When an actuator is energized, it moves the damper or valve until the controller is satisfied. The actuator maintains that position until the controller senses a need to adjust the output of the valve or damper.
- .23 **Control Point:** See Process Variable.
- .24 **Control Valve:** A device used to control the flow of fluids such as steam, water or aqueous glycol solution.
- .25 **Controlled Variable:** The quantity or condition of a medium measured by a Sensor and controlled by the BAS through a Controller. For example, temperature, relative humidity, pressure.
- .26 **Controller:** Controllers receive inputs from sensors. A Controller compares the input signal with the desired condition (Setpoint), determines the proper Corrective Action, and generates an output signal to operate a controlled device. A sensing device (eg. temperature, humidity, pressure sensor) inputs, at regular intervals, changes in the controlled, or process variable, to the Controller.
- .1 **Electronic Controller:** A solid-state device usually consisting of a power supply, a sensor amplification circuit, a process/comparing circuit, an output driver section, and various components that sense changes in the controlled variable and derive a control output which provides a specific control function. In general, adjustments such as setpoint and throttling range necessary for the process can be done at the controller via potentiometers and/or switches.
- .2 **Microprocessor Controller:** A microprocessor controller uses digital logic to compare input signals with the desired result and computes an output signal using
- .27 **Corrective Action:** Control action taken by the BAS resulting from a change in the Controlled Variable; initiated when the Controlled Variable deviates from Setpoint beyond the Deadband value.
- .28 **Damper:** A device used to control the flow of air in a duct or through a wall louver.
- .29 **Dashboard:** A high-level visualization tool(s) that displays a building's operating data, performance analytics and other useful information, at a Workstation, and intended to make it easy for operators to quickly visualize and prioritize their work. Information presented will allow operators to respond to changing operational parameters with a focus on building occupant comfort, energy usage, costs, Key Performance Indicators (KPIs), trends, and alarm management, and comparisons with similar buildings or building uses. Multiple dashboards may be provided for each building stakeholder or stakeholder group. Each stakeholder group must determine what information to present for each dashboard, and how it is to be presented.
- .30 **Deadband:** A range of measurement in which no corrective action is taken by the Controller. See also "Zero Energy Band".
- .31 **Demand:** the highest amount of power use (average KW over an interval) recorded for a building or service in a selected time frame.
- .32 **Detector:** See Sensor
- .33 **Deviation:** See Error.
- .34 **Digital:** A term used to describe a series of on and off, or Binary, pulses arranged to represent continuous values or discrete states. Processors operate using digital language.
- .35 **Digital-to-Analog (D/A) Converter:** The part of a microprocessor based controller that changes digital values from a software program to analog output signals for use in the control system. The analog signals are typically used to position actuators or actuate transducers and relays.

- .36 **Direct Digital Control (DDC):** A control loop in which a digital controller periodically updates a process as a function of a set of measured control variables and a given set of control algorithms.
- .37 **Digital Control:** A control loop in which a microprocessor- based controller directly controls equipment based on sensor inputs and setpoint parameters. The programmed control sequence determines the output to the equipment.
- .38 **Digital (Binary) Input (DI):** a two-state (On-Off) value, usually associated with a switch or state, referenced to a controller.
- .39 **Digital (Binary) Output (DO):** a two-state (On-Off) value, usually associated with starting or stopping equipment or generating an alarm, referenced to a controller.
- .40 **Dynamic Display Data:** Data displayed on a Workstation which periodically updates, such as temperature or ON/OFF status. The data updates automatically at a rate appropriate for the point or it may be updated manually.
- .41 **Electric Control:** A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature-sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer. The controller signal usually operates or positions an electric actuator or may switch an electrical load directly or through a relay included in the circuit.
- .42 **Electronic Control:** A control circuit that operates on low voltage and uses solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator. Electronic devices are primarily used as sensors. The controller usually furnishes fixed control routines based on the logic of the solid-state components.
- .43 **Energy Management System (EMS):** The portion of the BAS that performs Energy Management System functions used for energy metering data acquisition, data storage, analysis, display and reporting of energy use.
- .44 **Error:** Deviation of the measured value of the Controlled Variable from the Setpoint. Also called Deviation or Offset.
- .45 **Ethernet:** a communications network that facilitates transmission of data between nodes across multiple networks in different contexts.
- .46 **Field Equipment Controller (FEC):** A microprocessor-based controller that controls centrally located HVAC equipment such as variable air volume (VAV) supply units, built-up air handlers, and central chiller and boiler plants. Field Equipment Controllers interface with controlled equipment directly through sensors and actuators, or indirectly through communications links with Zone Level Controllers (ZLCs). Field Equipment Controllers typically have an input/output (I/O) device capability, a library of control programs, and may control more than one mechanical system from a single controller, and may contain an integral Operating Terminal. In a BAS, these controllers provide processing of point data for higher-level processors such as Building Control Units (BCUs) and Management Level Processors (MLPs). FECs typically include energy management programs. FECs shall have local connectivity capability to a Laptop PC or Mobile User Interface.
- .47 **Final Control Element:** A device such as a Control Valve or Damper that acts to change the value of the Manipulated Variable. An Actuator positions the Final Control Element.
- .48 **Fire Alarm Control Unit or Fire Alarm Control Panel:** A system component that receives inputs from automatic and manual fire alarm devices. Fire Alarm Control Unit might also supply power to detection devices, transponders, or off-premises transmitter(s). The Fire Alarm Control Unit also operates releasing circuits or solenoids, to provide transfer of power to the notification appliances, or transfer of condition to relays or devices connected to the Fire Alarm Control Unit. A Fire Alarm Control Unit can be a local fire alarm data-gathering panel or a master control unit.

- .49 **Fire Alarm System (FAS):** Components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals.
- .50 **Gateway(s):** Software used to translate one application's protocol data (i.e., BACnet) to another (e.g., Modbus or LonTalk). Gateway software can be installed as a "driver" in a BAS controller (i.e., for Modbus), or provided by a separate Gateway device (i.e., for LonTalk) allowing the BAS to effectively Integrate with Third Party Devices.
- .51 **Input/ Output (I/O):** the communication signal between an information processing systems; Inputs are the signals or data received by the system and Outputs are the signals or data sent from it.
- .52 **Instrumentation:** A collection of Sensors, or their application, for the purpose of observation, measurement, control, or any combination of these.
- .53 **Integral Action:** An action in which there is a continuous linear relationship between the amount of increase (or decrease) on the output to the final control element and the deviation of the controlled variable to reduce or eliminate the deviation or offset.
- .54 **Integrate or Integration:** The process of ensuring information from Third Party Devices properly communicates with the BAS. Also see Gateway(s).
- .55 **Integrated Systems Testing (IST):** Integrated testing of fire protection and life safety systems completed in accordance with the requirements of CAN/ULC-S1001.
- .56 **Lag:** A delay in the effect of a changed condition at one point in the system, or some other condition to which it is related. Lag is also, the delay in response of the sensing element of a control due to the time required for the sensing element to sense a change in the sensed variable.
- .57 **Limit Sensor:** A device that senses a variable that may be other than the controlled variable and over rides the Main Sensor at a preset high or low limit.
- .58 **Linkage:** A device that connects an Actuator to a Damper or Control Valve. To open and close a Damper, the typical linkage consists of an actuator crank-arm, ball-joints, pushrod, and damper crank-arm. In a Control Valve application, the linkage connects the Actuator to the Control Valve and translates the rotary output of the Actuator to the linear action of the Control Valve stem.
- .59 **Load:** In a heating or cooling system, the heat transfer that the system called upon to provide. Also, the work that the system must perform.
- .60 **Local Area Network (LAN):** a communication network that transmits data between Processors, Sensors and other devices that are relatively close geographically.
- .61 **LonMark Standard:** A communications standard for control networks developed by the Echelon Corporation and the LonMark Interoperability Association.
- .62 **Loop:** A combination of two or more Instruments or control functions arranged so that signals pass from one to another for the purpose of measurement and/or control of a Process Variable.
- .63 **Main Sensor:** The primary Sensor measuring the medium to be controlled.
- .64 **Management Level Processor (MLP):** Management Level Processors (MLPs) reside at the top of the BAS system hierarchy, exercising control and management over the connected sub-systems. An MLP is typically a server with a desktop workstation used by management personnel to collect, store, and process data for reports on energy use, operating costs, and alarm activity. The MLP can access points or data in all the lower level processors and controllers. Many of the functions of the MLP may be incorporated into a Building Control Unit (BCU). MLPs shall have local connectivity capability to a Laptop PC or Mobile User Interface
- .65 **Manipulated Variable:** The quantity or condition of media or energy controlled and/or regulated by the BAS to achieve a desired change in the Controlled Variable's condition.

- .66 **Measured Variable:** A variable that is measured and may be Controlled (e.g., discharge air is measured and controlled, outdoor air is only measured).
- .67 **Microprocessor Based Control:** A control circuit that operates on low voltage and uses a microprocessor unit, digital input and output connections, A/D and D/A converters, a power supply, and software to perform logic and control functions, such as operating a Relay or providing an output signal to position an Actuator. Electronic devices are used primarily as Sensors. The Controller may also provide flexible DDC and energy management Algorithms.
- .68 **Mobile User Interface:** BAS network access for operator using Smart Phone Device or Tablet.
- .69 **Modulating:** Varying or adjusting by small increments and decrements.
- .70 **Negative Compensation:** A compensating action where a decrease in the compensation variable has the same effect as an increase in the controlled variable. For example, in a heating application as the outdoor air temperature decreases, the control point of the controlled variable increases. Also called Reverse Compensation, Winter Reset or Winter Compensation.
- .71 **Normally Closed (NC):** position of device in a de-energized state.
- .72 **Normally Open (NO):** position of device in a de-energized state.
- .73 **Occupied Zone:** The area in a room or building in which most human activity takes place, considered by ASHRAE to be between 3 and 72 inches from the floor and 2 feet from walls or fixed equipment.
- .74 **Operating Software:** The main operating system and programs that schedule and control the execution of all other programs in a microprocessor-based controller. This includes routines for input/output (I/O) scanning, A/D and D/A conversion, scheduling of application programs, and access and display of control program variables.
- .75 **Operator Workstation (OWS):** a computer terminal that used to access the BAS network. Operator Workstations are for use by a single Building Operator and are password protected.
- .76 **Peer-to-peer:** Control devices exist and communicate equally on same network. Devices on a LAN use peer-to-peer communication.
- .77 **Positive Compensation:** A compensating action where an increase in the compensation variable has the same effect as an increase in the controlled variable. For example, in a cooling application, as the outdoor air temperature increases, the control point of the controlled variable increases. Also called Direct Compensation, Summer Reset or Summer Compensation.
- .78 **Process Variable:** The actual value of the Controlled Variable (Setpoint plus or minus Error) received from a Sensor.
- .79 **Processor:** A communications device that receives a data from multiple Controllers and/or Sensors, performs logic and Control Algorithms with the data received, and creates an output data signal for use by multiple Controllers, and by Building Operators. All Processors shall have local connectivity capability to a Laptop PC or Mobile User Interface. Management Level Processors (MLPs), Building Control Units (BCUs), Field Equipment Controllers (FECs), and Zone Level Controllers (ZLCs) are examples of Processors.
- .80 **Proportional Band:** In a proportional controller, the control point range through which the Controlled Variable must pass to drive, or move, the final Control Element through its full operating range. Proportional Band is expressed in percent of primary Sensor span, usually expressed in a quantity of engineering units ((e.g., degrees Fahrenheit, percent relative humidity, pounds per square inch). As called Throttling Range and Modulating Range.
- .81 **Relay:** A relay uses an electric, pneumatic, or hydraulic signal to operate a Switch, allowing it to control a high-powered circuit with a low-powered signal. Relays are used to control circuits in applications where the control signal (low voltage) needs to be isolated from the circuit it controls (higher voltage). For example a motor starter.

- .82 **Remote Setpoint Adjustment:** A means for adjusting a Setpoint from a remote location, in lieu of adjusting it at the Controller itself. The means of adjustment may be manual with a panel or space mounted potentiometer, or automatic when a separate device provides a signal (voltage or resistive) to the Controller.
- .83 **Repeatability:** The closeness of agreement between the results of successive measurements of the same medium, carried out under by the same measurement procedure; with the same measuring instruments used under the same conditions; at relatively short intervals of time.
 - .1 **Non-Repeatability:** Deviation from Repeatability.
- .84 **Repeater:** Connects two communications network segments together to amplify the signals extending the length of the communication network. A Repeater provides a degree of electrical isolation and protection from electrical disturbances on the opposing side of the unit. A short or communications disruption created on one side of a Repeater will not affect the communications on the other side of the Repeater.
- .85 **Reset:** A control function that attempts to return a system or device to its normal state.
- .86 **Response Time:** The time it takes an element to respond to a change in the value of the measured variable or to produce a change in the output signal.
- .87 **Router:** Provides the electrical isolation and amplification functions of a Repeater, but also filters the transmission of data packets based on domain and sub-net addressing. This logically separates the two communication networks and filters the traffic between them. The filter function of the Router isolates data communication traffic and enhances the bandwidth utilization on the primary communications network. A Router separates the communications network into two different "channels", one on either side of the Router.
- .88 **Sensing Element:** A device or component that detects and measures the value of the Controlled Variable.
- .89 **Sensor:** A device, that includes a Sensing Element, placed in the medium to be measured or controlled. A Sensor will change the output signal in relation to a physical change in the sensed medium (e.g., temperature, humidity). Also known as a Detector.
- .90 **Setpoint:** An input variable on the Controller scale at which the Controller is set to the desired value (e.g., the desired room temperature set on a Temperature Sensor or Thermostat). The Setpoint may be manually set, or a value reset by a programmed Algorithm. The Setpoint value is expressed in the same units as the Controlled Variable.
- .91 **Step Control:** Control method in which a multiple-switch assembly sequentially switches equipment (e.g., electric heat, multiple chillers) as the controller input varies through the proportional band. Step controllers may be actuator driven, electronic, or directly activated by the sensed medium (e.g., pressure, temperature).
- .92 **Switch(es):** A device that opens or closes a circuit, allowing or preventing the flow of electricity.
 - .1 **Double Pole Double Throw (DPDT) Switch:** Two separate switches that operate simultaneously, each with a normally open and a normally closed contact and a common connection.
 - .2 **Single-Pole Single Throw (SPST) Switch:** A switch that only has one of either a normally open or a normally closed contact.
 - .3 **Single-Pole Double-Throw (SPDT) Switch:** A switch combining both normally open and normally closed switch contacts.
- .93 **Testing Adjusting and Balancing (TAB):** also see Section 20 05 95
 - .1 **Air Side:** adjusting air flow rates through air distribution system devices, such as fans and diffusers, by manually adjusting the position of dampers, splitters vanes, extractors, etc., or by using automatic control devices, such as constant air volume or variable air volume boxes.

- .2 **Hydronic Side:** adjusting water flow rates through hydronic distribution system devices, such as pumps and coils, by manually adjusting the position valves, or by using automatic control devices, such as automatic flow control valves.
- .94 **Third Party Devices:** Equipment or systems having their own integral control that are required to Integrate with the BAS. Third Party Devices shall use an open protocol to communicate relevant input and output data, or a Gateway shall be provided to ensure an equivalent data communication pathway. Examples of Third Party Devices are Variable Frequency Drives (VFDs), Chillers, Boilers, Computer Room Air Conditioning (CRAC) Units, Lighting Control Systems, Security Systems, and systems of similar complexity.
- .95 **Time Constant:** The time required for a dynamic component, such as a sensor, or a control system to reach 63.2 percent of the total response to an instantaneous (or “step”) change to its input. Typically used to judge the responsiveness of the component or system.
- .96 **Transducer:** A general term for a device that receives information in the form of one or more physical quantities from a Sensor, modifies the information and/or its form, and produces a resultant output signal.
- .97 **Transformer:** A device used to change voltage from one level to another. For control circuits this is usually line voltage to low voltage. Transformers can be used only on ac power.
- .98 **Transmitter:** A device that senses the low-level output of a Sensor or Transducer and generates a higher-level output signal for use by a Controller, Actuator or display device. A Sensor may or may not be integral with the Transmitter.
- .99 **Turndown:** Expressed as the ratio of maximum flow to minimum controllable flow. For example, in an air system with a maximum airflow of 2000 cfm and minimum controllable airflow of 400 cfm, the turndown is 5:1; for example, in a hydronic system, if the system requires a 66 usgpm maximum flow through the valve and since the minimum accurately controllable flow is 3 usgpm, the turndown is 22:1.
- .100 **Uninterruptible Power Supply (UPS):** A UPS power source is a type of continual power system that provides automated backup electric power to a load when the input power source or mains power fails. A UPS differs from a traditional emergency power supply system, or standby generator, in that a UPS will provide near-instantaneous protection from input power interruptions by switching to energy stored in battery packs, super-capacitors or flywheels.
- .101 **Variable Frequency Drive (VFD):** A specialized motor controller that varies the frequency and/or voltage of the electrical service to the motor varying the speed of the motor as part of a Control Algorithm. See Specification Section 20 05 75 Variable Frequency Drives for additional requirements.
- .102 **Variable Speed Drive (VSD):** See Variable Frequency Drive (VFD).
- .103 **Voltage:**
- .1 **Line Voltage:** A term which refers to the normal electric supply voltage. Line voltage can be used directly in some control circuits or can be connected to the primary side of a step down transformer to provide power for a low-voltage control circuit. Most line-voltage devices function at their rated voltage +10%/–15%. Line-voltage devices should be tested and listed by an appropriate approval agency.
- .2 **Low Voltage:** A term which applies to wiring or other electrical devices using 30 volts or less. Low-voltage control devices usually function on 24V ac +10%/–15%.
- .104 **Zone Level Controller (ZLC):** A microprocessor-based controller that controls distributed or unitary HVAC equipment such as VAV terminal units, fan coil units, and heat pumps. At the Zone Level, sensors and actuators interface directly with the controlled equipment. These controllers typically have relatively few connected I/O devices, standard control sequences, and are dedicated to specific applications. In a BAS, Zone Level Controllers (ZLCs) provide processing of point data for higher level processors. ZLCs shall have local connectivity capability to a Laptop PC or Mobile User Interface

- .105 **Zone (Zoning):** A defined area in a building from which a signal can be received, an area to which a signal can be sent, an area in which a form of control can be executed. The practice of dividing a building into sections, or zones, for heating and cooling comfort control, or an area protected by a life safety system. The term is used to create a relationship between monitored inputs to actuation outputs and peripherals.
- .2 **Instrumentation Definitions:** the following terms are used in addition to the General Building Automation System Definitions, and are used to describe common Input and Output signals to the BAS; however, terms may also be used to describe other control system components and functions.
 - .1 **Aquastat:** see Liquid Immersion Temperature Sensor.
 - .2 **Dewpoint Temperature Sensor:** A virtual point that measures and responds to changes in actual moisture content of the ambient air generated from an Algorithm using analog inputs from dry-bulb temperature and humidity Sensors, a Dewpoint temperature value input signal is sent to a Controller.
 - .3 **Dry-bulb Temperature Sensor:** A device that measures and responds to changes in dry-bulb temperature of the ambient air surrounding the Sensor and inputs a signal to a Controller. Also called a Thermostat.
 - .4 **Enthalpy Sensor:** A virtual point that measures and responds to changes in the energy content of the ambient air generated from an Algorithm using analog inputs from dry-bulb temperature and humidity Sensors, an Enthalpy value input signal is sent to a Controller.
 - .5 **Flow Measuring Station (FMS):** A device containing multiple static pressure sensors and multiple total pressure sensors manifolded separately for instantaneously measuring average pressures across the face of a duct.
 - .6 **Flow Meter:** A device that measures and responds to changes in the volumetric flow.
 - .1 **Flow Meter (Wet):** A device that measures and responds to changes in the volumetric flow of the liquid surrounding the Sensor and inputs a signal to a Controller.
 - .2 **Flow Meter (Dry):** A device that measures and responds to changes in the volumetric flow of the air, gas or steam surrounding the Sensor and inputs a signal to a Controller.
 - .7 **Humidity Sensor:** A device that measures and responds to changes in relative humidity of the ambient air surrounding the Sensor and inputs a signal to a Controller. Also called a Humidistat.
 - .8 **Liquid Immersion Temperature Sensor:** A device that measures and responds to changes in the temperature of the liquid surrounding the Sensor and inputs a signal to a Controller. Also called an Aquastat.
 - .9 **Liquid Level Sensor:** A device that detects the presence of, and/or measures the height of a liquid.
 - .10 **Pressure Sensor:**
 - .1 **Differential Pressure Sensor:** a device that measures the pressure difference between a gas or a fluid's condition relative to a different condition. Examples include a differential pressure measured between the supply and return chilled water piping mains serving a mechanical room, or the difference between an infectious patient hospital bedroom and the adjacent corridor.
 - .2 **Static Pressure Sensor or Tube:** A sensing device with holes perpendicular to the fluid flow stream that measures the fluid static pressure relative to the ambient surroundings.
 - .3 **Total Pressure Sensor or Tube:** A sensing device with holes facing the fluid flow stream that measures the fluid total pressure relative to the ambient surroundings.

- .4 **Velocity Pressure Sensor:** a device that measures the velocity pressure of a flowing fluid. A Velocity Pressure Sensor can also be a virtual point sensor that subtracts the Static Pressure of a flowing fluid from the Total Pressure.
- .11 **Thermostat:** see Dry-bulb Temperature Sensor.
- .12 **Wet-bulb Temperature Sensor:** A virtual point that measures and responds to changes in the moisture content of the ambient air generated from an Algorithm using analog inputs from dry-bulb temperature and humidity Sensors, a wet-bulb temperature value input signal is sent to a Controller.
- .3 **Air Side System Definitions:** the following terms are used in addition to the General Building Automation System Definitions, and used primarily for control in air conditioning, air handling, and air distribution systems, however, terms may also be used to describe other control system components and functions.
- .1 **Airflow:** The rate at which a volume of air moves through a duct. In this section, airflow is denoted Q and is measured in cubic feet per minute (cfm). Airflow is derived as follows:
$$Q = A \times V_{AVG}$$

Where:
Q = Airflow in cfm
A = Cross-sectional area of duct in square feet (sq.ft)
 V_{AVG} = Average velocity
- .2 **Constant Air Volume (CAV) Box:** The terminal device in a central supply fan system that maintains a fixed air volume delivered in the downstream ductwork regardless of varying discharge static pressure in the main upstream distribution ductwork.
- .3 **Constant Air Volume (CAV) System:** A central fan system arrangement in which air volume delivered in the duct does not vary or change.
- .4 **Dewpoint Temperature:** The temperature at which the air is fully saturated with water, or is at a 100% Relative Humidity condition. Measured virtually using an Algorithm that uses the Dry-bulb Temperature and the Relative Humidity.
- .5 **Dry-bulb Temperature:** The ambient air temperature measured by a temperature sensor that is freely exposed to the ambient air, but shielded from other heating or cooling effects.
- .6 **Duct Cross Sectional Area:** For round ducts, the duct cross-sectional area ($A = \pi \times [R^2]$), where R is the Radius (ft., or [in./12]), and the duct cross-sectional area is measured in square feet (sq.ft).
- Note: If duct dimensions are in inches (in.) and the result of the duct area is in square inches (sq.in.), divide the result by 144 sq.in/sq.ft to obtain square feet (sq.ft).
- .7 **Duct Diameter:** For round ducts, the diameter is twice the radius ($D = 2 \times R$).

For rectangular ducts, an equivalent diameter is derived from ASHRAE as follows:

$$D_{eq} = \frac{1.30 (ab)^{0.625}}{(a + b)^{0.250}}$$

Where:

D_{eq} = Equivalent Rectangular Duct Diameter (in.)

a = duct side length (in.)

b = duct opposite side length (in.)

- .8 **Electrostatic Air Cleaner:** A device that has an electrical charge to trap particles traveling in the airstream.
- .9 **Energy Recovery Ventilator (ERV):** a type of air-to-air heat exchanger combined with a ventilation system for bringing in fresh outside air, and preheated it at the same time with exhaust air. Also called a Heat Recovery Ventilator (HRV).
- .10 **Exhaust Air (EA):** Air from a space that is discharged to Outdoors and is not to re-enter the building.
- .11 **Fan Surge:** A condition that occurs when air passing over the fan blades causes a stall. A fan surge causes a fluctuation in duct static pressure and an increase noise level.
- .12 **Flow Differential:** The difference between supply and return airflows necessary to maintain a positive or a negative pressure in an area. For example, if supply airflow is 1800 cfm and return airflow is 1500 cfm, the differential (positive) is 300 cfm. The 300 cfm surplus leaves the building through exhaust fans or vents and exfiltration.
- .13 **Impact Tube:** A sensing device with a single opening that points directly into the airstream for measuring Total Pressure.
- .14 **Mixed Air (MA):** Typically a mixture of Outdoor Air (OA) and Return Air (RA) from the space.
- .15 **Outdoor Air (OA):** Unconditioned air brought in to the building from outdoors.
- .16 **Relative Humidity (RH):** The ratio of the quantity of water vapor in the air to the quantity of water vapor required for saturation at the same temperature. Measure with a Relative Humidity sensor.
- .17 **Return Air (RA):** Air entering an air handling system that has been returned from the occupied space.
- .18 **Return Air Volume (RAV) Box:** The terminal device in a central return fan system that modulates the air volume returned from a space. The RAV Box control may be arranged to maintain a constant airflow Setpoint, a varying air volume that tracks a VAV Box supply air Controller Setpoint, a Differential Pressure Setpoint, or other control Algorithm.
- .19 **Static Pressure (SP):** The pressure created by air (whether in motion or not) confined in an enclosed area such as a duct or building due to its potential energy. Static pressure is exerted perpendicularly on all interior walls of the enclosure (duct or building) with respect to a reference pressure outside the enclosure. When static pressure is above atmospheric pressure it is positive and when below atmospheric pressure it is negative.
- .20 **Supply Air (SA):** Conditioned air that has passed through a coil in an Air Handling Unit; Supply Air is typically Mixed Air that has been conditioned in an Air Handling Unit. Supply Air may also refer to air discharged from a supply duct outlet (register or diffuser) into a space. Also referred to as Discharge Air.
- .21 **Total Pressure (TP):** The algebraic sum of Velocity Pressure (VP) plus Static Pressure. Total pressure is derived:
$$TP = VP + SP$$
- .22 **Variable Air Volume (VAV) Box:** The terminal device in a central supply fan system that modulates the air volume delivered in the downstream ductwork, regardless of varying discharge static pressure in the main upstream distribution ductwork, to maintain a Setpoint.
- .23 **Variable Air Volume (VAV) System:** A central fan system in which airflow in the duct varies depending on the instantaneous load requirements of the connected VAV Boxes.
- .24 **Velocity:** The speed or rate of flow of the air stream in a duct. In this section, velocity is denoted V and is measured in feet per minute (fpm).
- .1 **Average Velocity:** The sum of the air velocities from equal area increments of a duct cross-section divided by the number of increments. Average velocity, denoted V_{AVG} , is derived:

$$V_{AVG} = \sum (V_1 + V_2 + V_3 + \dots + V_N) / N$$

Where:

N = Number of duct increments

- .2 **Peak Velocity:** The greatest air velocity occurring in an increment of a duct cross-section. Peak velocity is denoted V_{PK}
- .25 **Velocity Pressure (VP):** The pressure created by air moving at a velocity due to its kinetic energy. Velocity pressure, denoted VP, is always exerted in the direction of airflow and is always a positive value. Velocity pressure can be measured by the difference between total and static pressure. Also called Dynamic Pressure:

Velocity Pressure and Velocity are related by the equation:

$$V = \left(\sqrt{2G \times \frac{VP \text{ Dw}}{Da}} \times \frac{1 \text{ ft}}{12 \text{ in}} \right) \frac{60 \text{ sec}}{1 \text{ min}}$$

Where:

V = Velocity (ft./min)

G = Gravitational acceleration in feet per second squared (ft./sec²)

VP = Velocity pressure in inches of water gauge (in.wg.)

Dw = Density of water at a specified temperature measured in pounds per cubic foot (lb/cu.ft.)

Da = Density of the air flowing in the duct measured in pounds per cubic foot (lb/cu.ft.)

1ft./12 in. = Conversion factor to convert inches to feet

60 sec/1 min = Conversion factor to convert seconds to minutes

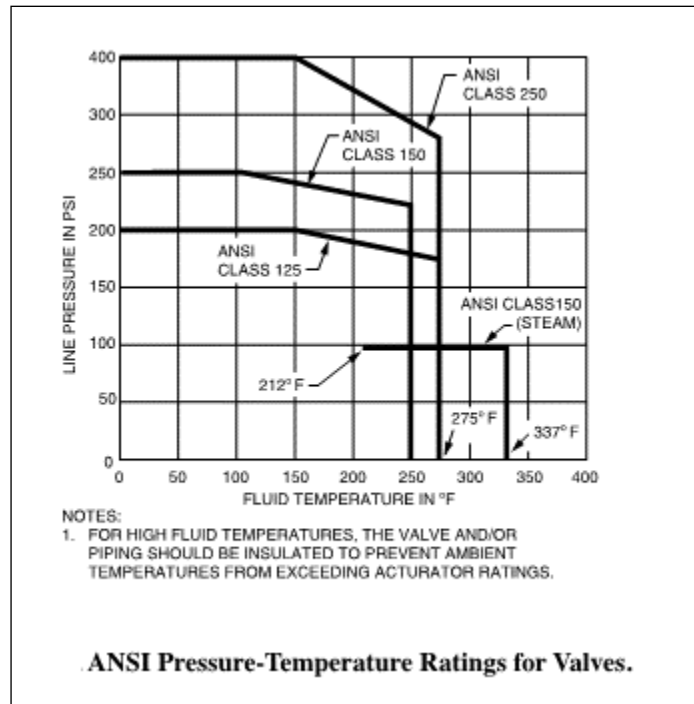
- .26 **Ventilation Air:** Conditioned Outdoor Air (OA) brought into the building with the primary intention that it be delivered to an occupied space.
- .27 **Wet-bulb Temperature:** The temperature at which air can no longer evaporate water, measured with a temperature sensor whose bulb is covered with a wet cloth, or virtually using an Algorithm that uses the Dry-bulb Temperature and the Relative Humidity.
- .4 **Control Damper Definitions:** the following terms are used in addition to the General Building Automation System Definitions, and Air Side System Definitions, and used primarily for control dampers used in air conditioning, air handling, and air distribution systems, however, terms may also be used to describe other control system components and functions.
- .1 **Blank-off Panel:** A sheet metal baffle or orifice placed inside the duct to reduce the duct size to the damper size.
- .2 **Damper:** A device used to regulate the flow of air in an HVAC system by modulating or two-position control.
- .3 **Opposed Blade Damper:** A damper constructed so adjacent blades rotate in the direction opposite to each other.
- .4 **Parallel Blade Damper:** A damper constructed so each blade rotates in the same direction as the blade next to it.
- .5 **Damper Leakage:** The amount of air passing through a damper with a given pressure drop and a given torque holding the damper closed.
- .6 **Damper Seals:** Construction features used to minimize the leakage through a damper.

- .7 **Damper System:** The damper plus the series resistance that relates to it (e.g., duct work, mixing boxes, diffusers, and coils).
- .8 **Drive Blade:** A damper blade that is positioned by an actuator connected by a linkage, axle, or jackshaft connected to the drive blade.
- .9 **Ideal Damper System:** A system with a linear relationship between the percent open damper position and the percent of full airflow.
- .10 **Opposed Blade Damper:** see Damper
- .11 **Parallel Blade Damper:** see Damper
- .5 **Hydronic Side System Definitions:** the following terms are used in addition to the General Building Automation System Definitions, and used primarily for control in hot water, chilled water, glycol, and potable (domestic) water systems, however, terms may also be used to describe other control system components and functions.
 - .1 **Approach:**
 - .1 **Air-cooled Condensing Unit Approach:** The difference between the liquid refrigerant temperature leaving the condenser and the entering air dry bulb temperature.
 - .2 **Heat Exchanger Approach:** The temperature difference between the entering Primary Side fluid and the leaving Secondary Side fluid.
 - .2 **Compressor:** A mechanical device for increasing a gas pressure.
 - .1 **Centrifugal Compressor:** A non-positive displacement compressor that uses centrifugal force to compress refrigerant vapors in a vapor-compression cycle chiller.
 - .2 **Positive Displacement Compressor:** A compressor that reduces the volume of a compression chamber to compress a gas; Reciprocating, Screw and Scroll Compressors are examples of Positive Displacement Compressors
 - .3 **Reciprocating Compressor:** A positive displacement compressor that uses the reciprocating motion of one or more pistons to compress a gas.
 - .4 **Screw Compressor:** A positive displacement compressor that uses the rotary motion of two meshed helical rotors to compress a gas.
 - .5 **Scroll Compressor:** A positive displacement compressor that uses the rotary motion of a spiral scroll to compress a gas.
 - .3 **Constant Speed Pumping:** A pumping system where the system pressure is maintained by a constant speed pump.
 - .4 **Differential Pressure Controller:** In a pumping network with varying demand (eg. heating of chilled water) a Differential Pressure Controller maintains a differential pressure Setpoint between the common supply and return legs of a piping network by varying the speed of the pump set.
 - .5 **Domestic Hot Water (DHW):** Potable water controlled at a constant supply temperature suitable for use in applications such as showers and hand washing stations.
 - .6 **Double Bundle Condenser:** A chiller condenser having two coils in the shell to allow the chiller to dissipate heat either to the cooling tower or to a heating load.
 - .7 **Head:** Pressure of a fluid
 - .1 **Head Pressure:** The pressure measured at the discharge of an operating pump or compressor.
 - .2 **Refrigerant Head:** The pressure difference between compressor suction and discharge pressures or the temperature difference between condensing and evaporating temperatures.
 - .3 **Static Head:** The pressure of a static fluid expressed as the height of the fluid or the height of another fluid it would support.

- .8 **Heat Exchanger:** Transfers hydronic energy from the Primary Side to a Secondary Side.
- .9 **Heat Transfer Station:** Arrangement of heat exchanger(s), pump(s) and controls for a secondary piping distribution network in a building.
- .10 **Hydrostatic Pressure:** The pressure due to the Head of a liquid column.
- .11 **Primary:** Thermal production of hydronic thermal energy such as heat pumps, chillers and boilers in a Central Plant.
- .12 **Primary Side:** Supply and return piping and pumping for hydronic medium (eg. chilled water, or heating water) from the Central Plant to remote heat transfer devices such as Heat Exchangers and AHU coils.
- .13 **Secondary:** Thermal consumption of hydronic thermal energy at remote heat transfer devices such as Heat Exchangers and AHU coils.
- .14 **Secondary Side:** Supply and return piping and pumping for hydronic heat transfer medium served from a Heat Transfer Substation to remote heat transfer devices and terminal units such as fan coil units and perimeter radiation elements.
- .15 **Variable Speed Pumping (VSP):** A pumping system where the flow/pressure is varied by changing the pump speed.
- .6 **Control Valve Definitions:** the following terms are used in addition to the General Building Automation System Definitions, and Hydronic Side System Definitions, and used primarily for control valves used in in hot water, chilled water, glycol, and potable (domestic) water systems, however, terms may also be used to describe other control system components and functions.
 - .1 **Ball Valve:** A ball valve has a precision ball between two seats within a body. Ball valves have several port sizes for a given body size and go from closed to open with a 90 degree turn of the stem. They are available in both two-way and three-way configurations. For HVAC applications, ball valve construction includes brass and cast iron bodies; stainless steel, chrome plated brass, and cast iron balls; resilient seats with larger port area for a given pipe size. Ball valves provide tight shut-off, while full port models have low flow resistance, and reduced port models can be selected for modulating applications.
 - .2 **Body:** The valve casting through which the controlled fluid flows.
 - .3 **Body Rating:**
 - .1 **Nominal:** The theoretical pressure rating, nominal body rating often has characteristics such as pressure-temperature ratings, wall thickness, and end connections that are determined by a society such as ANSI (American National Standards Institute). The figure below shows ANSI pressure-temperature ratings for valves. Note that the nominal body rating is not the same as the actual body rating.
 - .2 **Actual:** The correlation between safe, permissible flowing fluid pressure and flowing fluid temperature of the valve body (exclusive of the packing, disc, and other valve components). The nominal valve body rating is the permissible pressure at a specific temperature.

Example: A valve with an ANSI rating of 150 psi (ANSI Class 150) has an actual rating of 225 psi at 250°F.
 - .3 **Maximum Pressure and Temperature:** The maximum pressure and temperature limitations of fluid flow that a valve can withstand. These ratings may be due to valve packing, body, or disc material or actuator limitations. The actual valve body ratings are exclusively for the valve body and the maximum pressure and temperature ratings are for the complete valve (body and trim). Note that the maximum pressure and temperature ratings may be less than the actual valve body ratings.

Example: The body of a valve, exclusive of packing, disc, and other Trim, has a pressure and temperature rating of 125 psi at 335°F. If the valve contains a composition disc that can withstand a temperature of only 240°F, then the temperature limit of the disc becomes the maximum temperature rating for the valve.



- .4 **Butterfly Valve:** A valve with a cylindrical body, a shaft, and a rotating disc. The disc rotates 90 degrees from open to closed. The disc seats against a resilient body liner and may be manufactured for tight shut-off or made smaller for reduced operating torque but without tight close-off. For three-way applications, two butterfly valves are assembled to a pipe tee with linkage for simultaneous operation.
- .5 **Close Off Rating:** The maximum pressure drop that a valve can withstand without leakage while in the full closed position. The close-off rating is a function of actuator power to hold the valve closed against pressure drop, but structural parts such as the stem can be the limiting factor. The valve close-off rating is independent of the actual valve body rating. See Body Rating (Actual). For example, a valve with a close-off rating of 10 psi could have 40 psi upstream pressure and 30 psi downstream pressure. Note that in applications where failure of the valve to close is hazardous, the maximum upstream pressure must not exceed the valve close-off rating, regardless of the downstream pressure.
- .6 **Close Off Rating of Three-Way Valve:** The maximum pressure difference between either of the two inlet ports and the outlet port for mixing valves, or the pressure difference between the inlet port and either of the two outlet ports for diverting valves.
- .7 **Direction of Flow:** The correct flow of the controlled fluid through the valve is usually indicated on the valve body. If the fluid flow through the valve is incorrect, the disc can slam into the seat as it approaches the closed position. The result is poor control, excessive valve wear, and noisy operation. In addition, the actuator must work harder to reopen the closed valve since it must overcome the pressure exerted by the fluid on top of the disc rather than have the fluid assist in opening the valve by exerting pressure under the disc.
- .8 **Disc:** The part of the valve assembly that contacts the valve seat to close off flow of the controlled fluid. Some valve assemblies are built so the disc is replaceable. Replaceable discs are usually made of a composition material softer than metal.
- .9 **Double Seated Valve:** A valve with two seats, plugs, and discs. Double-seated valves are suitable for applications where fluid pressure is too high to permit a single-seated valve to close. The discs in a double-seated valve are arranged so that in the closed position there is minimal fluid pressure forcing the stem toward the open or closed position; the pressure on the discs is essentially balanced. For a valve of given size and port area, the double-seated valve requires less force to operate than the single-seated valve so the double-seated valve

can use a smaller actuator than a single-seated valve. Also, double-seated valves often have a large valves only. A limitation of double-seated valves is that they do not provide tight shut-off. Since both discs rigidly connect together and changes in fluid temperature can cause either the disc or the valve body to expand or contract, one disc may seat before the other and prevent the other disc from seating tightly.

- .10 **Equal Percentage:** A valve which changes flow by an equal percentage (regardless of flow rate) for similar movements in stem travel (at any point in the flow range).
- .11 **Flanged End Connections:** A valve that connects to a pipe by bolting a flange on the valve to a flange screwed onto the pipe. Flanged connections are typically used on various temperature ratings.
- .12 **Flow Coefficient (Capacity Index):** Used to state the flow capacity of a control valve for specified conditions; a control valve's flow coefficient, or C_v value, is determined based on the following formula:

$$C_v = Q \sqrt{\frac{1}{\Delta p} \cdot \frac{\rho}{\rho_w}}$$

Where:

Q = volumetric flow in US gallons per minute (usgpm).

ρ = fluid density in pounds per cubic foot (lb/cu.ft.).

ρ_w = density of water in pounds per cubic foot (lb/cu.ft.) within the temperature range of 40 to 100°F

Δp = static pressure loss across the valve in pounds per square inch (psi).

- .13 **Globe Valve:** A valve which controls flow by moving a circular disk against or away from a seat. When used in throttling control a contoured plug (throttling plug) extends from the center of circular disk through the center of the seat for precise control.
- .14 **Linear:** A valve which provides a flow-to-lift relationship that is directly proportional. It provides equal flow changes for equal lift changes, regardless of percentage of valve opening.
- .15 **Plug:** The part that varies the opening for the fluid to flow through the valve body.
- .16 **Port:** The opening in the valve seat.
- .17 **Pressure Drop:** The difference in upstream and downstream pressures of the fluid flowing through the valve.
- .18 **Pressure Drop (Critical):** The flow of a gaseous controlled fluid through the valve increases as the pressure drop increases until reaching a critical point. This is the critical pressure drop. Any increase in pressure drop beyond the critical pressure drop is dissipated as noise and cavitation rather than increasing flow. The noise and cavitation can destroy the valve and adjacent piping components.
- .19 **Quick Opening:** A valve that provides maximum possible flow as soon as the stem lifts the disc from the valve seat.
- .20 **Reduced Port Valve:** A valve with a capacity less than the maximum for the valve body. Ball, butterfly, and smaller globe valves are available with reduced ports to allow correct sizing for good control.
- .21 **Screwed End Connection:** A valve with threaded pipe connections. Valve threads are usually female, but male connections are available for special applications. Some valves have an integral union for easier installation.
- .22 **Seat:** The stationary part of the valve body that has a raised lip to contact the valve disc when closing off flow of the controlled fluid.

- .23 **Single Seated Valve:** A valve with one seat, plug, and disc. Single-seated valves are suitable for applications requiring tight shut-off. Since a single-seated valve has nothing to balance the force of the fluid pressure exerted on the plug, it requires more closing force than a double-seated valve of the same size and therefore requires more actuator force than a double-seated valve.
- .24 **Stem:** The shaft that runs through the valve bonnet and connects an actuator to the valve plug.
- .25 **Three Way Valve:** A valve with three ports. The internal design of a three-way valve classifies it as a mixing or diverting valve. Three-way valves control liquid in modulating or two-position applications and do not provide tight shut-off.
- .26 **Tight Shut Off/Close Off:** A valve condition in which no leakage of the controlled fluid occurs in the closed position. Generally, only single-seated valves provide tight shut-off. Double-seated valves typically have a one to three percent leakage in the closed position.
- .27 **Trim:** All parts of the valve that contact the controlled fluid. Trim includes the stem, packing, plug, disc, and seat; it does not include the valve body.
- .28 **Two Way Valve:** A valve with one inlet port and one outlet port. Two-way valves control water or steam in two- position or modulating applications and provide tight shut-off in both straight through and angle patterns.
- .29 **Valve Flow Characteristic:** The relationship between the stem travel of a valve, expressed in percent of travel, and the fluid flow through the valve, expressed in percent of full flow.

1.06 EQUIPMENT SUPPLIED FOR INSTALLATION BY MECHANICAL TRADES

- .1 BAS Trades shall install the following devices for equipment provided by Mechanical Trades:
 - .1 automatic control valve actuators,
 - .2 motorized damper actuators including associated damper end switches and relays.,
 - .3 liquid temperature sensors in hydronic system piping,
 - .4 liquid flow measuring devices in hydronic system piping,
 - .5 steam humidifier automatic control valve actuators,
 - .6 unit heater and cabinet unit heater line voltage thermostats
 - .7 Controllers for Variable Air Volume (VAV) Boxes, Constant Air Volume (CAV) Boxes Fan Powered (FP) Boxes, Fan Coil Units (FCU), and other terminal equipment. Arrange and pay for shipping to terminal unit manufacturer's facility for factory installation.

1.07 EQUIPMENT PROVIDED BY MECHANICAL TRADES OTHER THAN BAS TRADES

- .1 Mechanical Trades shall install the following devices supplied by the BAS Trades:
 - .1 temperature wells for controllers and sensors,
 - .2 automatic control valves,
 - .3 motorized control dampers,
 - .4 steam humidifiers and associated automatic control valves.

1.08 APPLICABLE STANDARDS

- .1 The following Standards are in addition to Codes, Standards and Regulations Specified on other Sections of the Specifications, and the requirements of the Authorities Having Jurisdiction (AHJs).
 - .1 ANSI/ASHRAE Standard 135 BACnet; A Data Communication Protocol For Building Automation And Control Network
 - .2 ANSI/CEA 709.1-D Control Network Protocol Specification
 - .3 Interfacing Standard:

- .1 Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EI (Electronic Industry Association) interfaces.
- .2 CSA T530: Building Facilities, Design Guidelines for Telecommunications (same as EIA/TIA 569).
- .3 IEEE 802.3 Ethernet 10Base-T LAN.

1.09 MANUFACTURERS AND INSTALLERS

- .1 Provide BAS with DDC and Energy Management capabilities for mechanical and electrical systems by a Control Vendor that:
 - .1 specializes in design, installation, commissioning and service of open protocol BAS systems,
 - .2 has completed five (5) projects of similar size and complexity within the preceding five (5) years,
 - .3 employs certified journeymen experienced in this type of work.
- .2 Acceptable Manufacturers:
 - .1 Delta Controls
 - .2 Reliable Controls
 - .3 or Owner Approved Vendor

1.10 CONTINUITY OF STAFF AND SUBCONTRACTORS

- .1 Project Manager is to be nominated at time of shop drawing submission and is to remain involved with project, from shop drawing preparation through to Acceptance, unless request for change is submitted and approved by the Owner.
- .2 Subcontractors listed in Bid Form submission are to execute the scope of work defined unless request for change is submitted and approved by the Owner.

1.11 LEED SUPPORT REQUIREMENTS

- .1 Provide services of LEED Accredited Professional to support and provide input to Owner's LEED team, for aspects related to the design, implementation and operation of the BAS. LEED professional to implement a project management process specifically for this project.
- .2 Incorporate LEED related monitoring and verification elements, including:
 - .1 general monitoring,
 - .2 specific energy meter monitoring in accordance with the project M&V plan;
 - .3 temperature and humidity monitoring
 - .4 flow monitoring,
 - .5 air quality and CO2 monitoring
 - .6 Assist the Owner by providing input and associated supporting documentation on BAS related LEED Points, to attain the target LEED Green Building Rating, including services for:
 - .1 Optimum energy performance
 - .2 Optimize energy performance
 - .3 Water efficient landscaping and storm water management
 - .4 Thermal comfort
 - .5 Measurement and verification
 - .6 Carbon Dioxide monitoring
 - .7 HCFC and Halons monitoring
- .3 Throughout the duration of the Project, provide the following submittals;

- .1 LEED format scorecard qualifying the BAS related LEED points
- .2 credit Summary Sheet for each LEED point
- .3 written back-up documentation for each Summary Sheet
- .4 any other LEED related submittal documentation required for the LEED application submission.
- .4 Coordinate with the owner's Commissioning Authority (CxA) for commissioning requirements related to LEED certification.

1.12 THE BUILDING AUTOMATION SYSTEM ("BAS")

- .1 General:
 - .1 The BAS shall be an integrated package developed and using control components from one controls manufacturer.
 - .2 Generally, and unless specified otherwise, HVAC equipment, shall be provided as "Thermostat-Ready" meaning that the Building Automation System (BAS) shall have direct control over terminal equipment, and custom fabricated air handling units (AHUs) and other similar built-up equipment that include dampers, control valves, heating and cooling stages without the requirement of BACnet, Lonworks or other type of communication interface. Factory installed interlocks, safeties and anti-cycle timers shall be provided as required.
 - .3 Owner approved equipment that incorporate third party controls provided as part of the Original Equipment Manufacturer (OEM) package, such as those provided with Variable Frequency Drives (VFDs), chillers, heat pumps, boilers, Computer Room Air Conditioning (CRAC) units, and similarly complex equipment, shall be provided with a BACnet interface gateway for communication with the BAS.
 - .4 The BAS shall be a graphic based system with operator access by department and floor.
 - .5 The BAS shall be capable of expanding in scope and size to accommodate all of other areas and/or systems of the development not included as part of this BAS project.
 - .6 The BAS shall have internet access and capability for remote dial-out.
 - .1 The BAS shall have Dashboard flexibility for systems monitoring capability from multiple remote locations.
 - .2 The BAS shall have the ability to monitor and produce reports from remote locations.
 - .7 Internet access to the system shall be provided for individual Building Operators.
 - .8 A representative of the controls Contractor shall, for a period of one (1) month after Substantial Performance, be on site to assist and train the building maintenance staff in the operations of the various control systems.
 - .9 Provide engineering design, installation, configuration and programming, testing and commissioning of BAS controllers, instrumentation, actuators, power and communication wiring and conduit.
 - .10 Provide training of owner's operations staff.
 - .11 All temperature units for BAS and controlled equipment shall be in °C (degrees Celcius).
 - .12 The new BAS is intended to provide monitoring, control and alarms for mechanical equipment including, but not limited to, the following:
 - .1 Boilers;
 - .2 Chillers including Heat Pump Chillers;
 - .3 Central supply air handling units ("AHU") and related components including:
 - Supply air fans with integral variable frequency drives (VFDs);
 - Return air fans with integral variable frequency drives (VFDs);
 - Air flow sensors;

- Control dampers;
- Heating Coils and related control valves;
- Humidifiers and related control valves;
- Cooling Coils and related control valves;
- Duct Monitoring Stations (“DMS”);
- Integral temperature, humidity, dewpoint, enthalpy and pressure sensors associated with AHU control;
- .4 Central exhaust fan and/or ventilation fan systems including:
 - Exhaust and/or ventilation fan(s) with integral variable frequency drives (VFDs);
 - Air flow sensors;
 - Control damper(s);
 - Duct Monitoring Stations (“DMS”);
 - Integral temperature and pressure sensors associated with fan system control;
- .5 Hydronic heating and cooling systems including:
 - Pump(s) with integral variable frequency drives (VFDs);
 - Heat exchanger(s) and related control valves;
 - Integral temperature and pressure sensors associated with hydronic system control;
- .6 Plumbing service water heating, circulation and drainage pumping systems including:
 - Pump(s) with integral variable frequency drives (VFDs);
 - Heat exchanger(s) and related control valves;
 - Integral temperature and pressure sensors associated with plumbing system control;
 - Level controllers;
 - Packaged control panels.
- .7 All major fire protection equipment and systems
- .8 Fuel oil levels and system status
- .9 A Facilities Maintenance (“FM”) program for scheduled Preventative Maintenance (“PM”) work based upon run time
- .13 The BAS shall include control of the following terminal devices, equipment, and systems:
 - .1 Terminal re-heat coils;
 - .2 Terminal Fan Coil Units (FCUs) with integral ECM motors;
 - .3 Terminal VAV and/or CAV boxes;
 - .4 Terminal Fan Powered (FP) boxes;
 - .5 Unit heaters;
 - .6 Cabinet heaters;
 - .7 Perimeter wallfin radiation elements;
 - .8 Radiant heating panels;
 - .9 AV/IT Systems;
- .2 Network Architecture:

- .1 The BAS shall be a web-enabled, direct digital control (“DDC”) distributed open protocol, non-proprietary system. Acceptable open protocols are:
 - .1 BACNet/IP, BACNet MS/TP
- .2 The BAS shall integrate existing equipment in accordance with the following protocols:
 - .1 BACNet/IP for monitoring and control of Central Plant equipment such as chillers, and boilers;
 - .2 BACNet MS/TP for monitoring and control of Field Equipment Controllers (FECs) and Zone Level Controller (ZLCs) for mechanical equipment such as Air Handling Units (AHU’s), standalone terminal units, and Variable Frequency Drives (VFDs);
 - .3 BACNet MS/TP, or Modbus RTU for integration of metering devices, specialty HVAC equipment or process equipment;
 - .4 Other industrial protocols with the use of appropriate integration Gateways, for process equipment and electrical load management systems shall be allowed only following review and acceptance by the Owner.
- .3 The use of battery powered (meaning without external power) and/or wireless-communication controllers is prohibited unless agreed to by the Owner in writing.
- .4 Each Management Level Processor (MLP), Building Control Unit (BCU), and Field Equipment Controller (FEC) shall have integral battery backup power supply for a minimum of two (2) hours.
- .5 Each Building Control Unit (BCU) and Field Equipment Controller (FEC), and the overall Building Automation System (BAS) shall have 20% spare points for future use.
- .3 Equipment and System Integration:
 - .1 The BAS shall be integrated with other Third Party Systems and Devices including:
 - .1 Fire alarm (common first stage alarm, common second stage alarm and other alarms as noted in the Documents),
 - .2 Security,
 - .3 Lighting,
 - .4 AV/IT Systems,
 - .5 Electrical Power Transformation,
 - .6 Automatic Transfer Switch(es) (“ATS”),
 - .7 Emergency Generator Control,
 - .8 Fuel Oil Storage and Distribution Systems,
 - .9 Elevator Control Panel(s).
 - .2 The BAS shall be capable to integrate with other systems such that all monitoring information from the BAS is available to and usable (send and receive commands) by the Owner.
 - .3 The intent of the integration is to display information at the workstation in the same format for both the BAS and the existing stand-alone control systems, and to allow a building operator the same method of access to view information for the BAS and the existing stand-alone control system.
 - .4 Regardless of the method used, integration of the existing BAS includes at a minimum replication of the existing graphical displays including all setpoints, current values and alarm conditions.
- .4 Operator Workstation (OWS) Locations:
 - .1 Provide hierarchy password protected Operator Workstations (OWS) to access the BAS, including graphical displays, trend log information, tabular data, and alarm management in the following locations:

- .1 Main Maintenance/Facilities office;
 - .2 One additional location as directed by the Owner;
 - .3 Colour touchscreen devices with minimum 7-inch diagonal display in the existing main penthouse mechanical room; and
 - .4 By Mobile User Interface in the form of three (3) iPad mini tablets, or approved equal, shall supplied by the successful BAS Trade Contractor.
- .2 Proved high-level graphic visualization tool(s), or Dashboards, that displays a building's operating data, performance analytics and other useful information, at each Operator Workstation (OWS) as follows:
 - .1 easy for operators to quickly visualize and prioritize their work;
 - .2 Information presented to allow operators to respond to changing operational parameters with a focus on building occupant comfort, energy usage, costs, Key Performance Indicators (KPIs), trends, and alarm management, and comparisons with similar buildings or building uses;
 - .3 minimum three (3) Dashboards to be provided for each building stakeholder or stakeholder group with specific information for each dashboard to be decided by each stakeholder group.
- .5 WAN Access:
 - .1 Provide necessary interface and cabling to connect the BAS to the the Owner's WAN. Obtain the particular WAN system details from the Project Supervisor.
 - .2 The Owner shall supply the WAN IP address, Gateway and Subnet mask for the BBMD router in the network. The controls contractor will facilitate integration into the Owner's existing BAS BACNET network.
 - .3 On the network a BACnet IP device that is capable of BBMD will route information from other sites and the operator work station. In addition there shall be a CAT5 wire that is run to the Owner's IT switch with a 4' pigtail and connector.
- .6 Alarms:
 - .1 The BAS will be configured to provide for remote alarm capabilities.
 - .2 Alarms shall be capable of being routed to The Owner's IT server so that they can be sent to Operator's email addresses.
 - .3 The operator workstation shall provide audible, visual and printed means of alarm indication. The Alarm Dialog box shall always become the Top Dialog box regardless of the application(s) being run at the time (such as a word processor). A printout of all alarms shall be sent to the assigned terminal and port.
 - .4 Provide a log of alarm messages. The alarm log shall be archived to the hard drive of the operator workstation. Each entry shall include a point descriptor and address, time and date of alarm occurrence, point value at the time of alarm, time and date of point return to normal condition and time and date of alarm acknowledge.
 - .5 The BAS Trade Contractor shall work with the Owner to determine the alarms unless specified otherwise.
 - .6 Alarm messages shall be in plain English and shall be user definable on site or via remote communication.
- .7 DDC Controls for mechanical equipment and systems:
 - .1 Provide instrumentation and control devices as required to achieve full automatic control of all mechanical building services defined in the project Scope of Work.
 - .2 Sequences of operation shall be in accordance with the Mechanical Contract Documents.

- .3 Alarms and monitoring points shall provide the building operators with full knowledge of system operation including setpoint values, current measured values, equipment status, and equipment fault status.
- .4 Local adjustment of room temperature (where specified) shall be proved within a limited range (+/- 2.5°C);
- .5 CO2 monitoring shall be provided in all lobbies, open public areas, high occupant density areas, loading dock areas, and other areas specified to meet Demand Control Ventilation energy conservation strategies.
- .6 For Variable Frequency Drives (where specified), the following control functions shall be hard-wired in addition to any network integration provided:
 - .1 Remote start/stop;
 - .2 Summary alarm;
 - .3 Remote fault reset.
- .8 Instrumentation and Controlled Devices:
 - .1 The use of battery-powered (meaning without external power) and/or wireless-communication instruments, including but not limited to room temperature and humidity sensors/controllers, is prohibited except under the following conditions:
 - .1 In feature architectural finished areas such as main entrances where, due to the architectural and structural design, it is not possible to run conduit and wiring in a concealed location; or
 - .2 In other areas which are expressly approved in writing by the Owner for each instance of requested use.
 - .2 Provide the following metering which shall be monitored on the BAS:
 - .1 Air flow stations for each AHU and associated return/exhaust air fans;
 - .2 Domestic water flow meters;
 - .3 Natural gas flow meters;
 - .4 Bulk thermal energy meter;
 - .5 Thermal energy meters for secondary pumping systems for heating;
 - .6 Bulk thermal energy meters for primary chilled water system;
 - .7 Thermal energy meters for 24/7 cooling system.
- .9 BAS monitoring of equipment operating status:
 - .1 The BAS shall monitor the status of the following equipment types:
 - .1 Control valve position by end-switch or positioners for major equipment located in the Service Spaces and Service Rooms as follows:
 - AHU heating control valves;
 - AHU cooling control valves;
 - AHU humidification control valves;
 - AHU control dampers;
 - Exhaust fan control dampers;
 - Make-up air dampers;
 - Ventilation fan control dampers;
 - Relief dampers;
 - Energy Recovery Ventilator (ERV) dampers

- .2 Motorized air damper position by end-switch or positioner, as applicable to the type of damper control function. For fans with two-position dampers, the damper power shall be provided or controlled by the fan starter or VFD, and a damper proved-open end-switch shall be hard-wire interlocked to prevent the fan from operating unless the damper is proven open.
- .3 For two-position valves and dampers, provide end-switches to prove the valve or damper is open and closed.
- .4 For modulating valves and dampers, provide a feedback positioner to indicate the current position of the valve or damper.
- .5 Combination smoke and fire dampers, in both open and closed position;
- .6 Motor run status through current switches or transmitters on constant speed or two speed motors, or by VFD operating status;
- .7 Chillers and boilers by network communications status;
- .8 Air filters, by differential pressure switch or transmitter across each bank of filters (where specified).
- .2 Control valves on terminal equipment such as unit heaters, cabinet heaters, room reheat coils, or perimeter heating room control valves are not required to have position feedback.
- .10 Energy Management System ("EMS"):
 - .1 An Integrated Energy Management System to monitor, record, analyze and report on Energy Consumption from metered sources.
 - .2 Provide purpose developed, web-based database software suite of analytical and reporting tools to develop mathematical models of building system energy consuming equipment. Energy Management System software functionalities shall include:
 - .1 Database for dashboard display with dashboard editing software;
 - .2 Multi-building dashboard displays;
 - .3 Collects metered data from building system meters
 - .3 Web-based graphical displays of conventional trend-logs, Key Performance Indicators, multiple energy source consumption and cost comparison, period-to-period energy consumption comparison, graphical drill-down for data detail, web-integrated weather data and forecasting functions.
 - .4 Energy reporting including standard and custom graphic outputs, narrative fields, year-to-year comparisons, and greenhouse emission estimates.
 - .5 Graphical touchscreen displays for configuration of display information.
 - .6 MS Word, Excel or similar programs do not meet these requirements and shall not be used for analysis, display or reporting of energy performance.

1.13 CONTROLLED INDOOR ENVIRONMENTAL CONDITIONS

- .1 Unless noted otherwise, the BAS shall be arranged to maintain the following indoor environmental conditions:

	Occupied Mode				Un-occupied Mode			
	Winter		Summer		Winter		Summer	
Area	DB ¹ (°C)	RH ² (%)	DB ¹ (°C)	RH ² (%)	DB ¹ (°C)	RH ² (%)	DB ¹ (°C)	RH ² (%)
General Office	22	>30	23.5	<60	15	---	29.5	---
Corridors	22	>30	23.5	<60	15	---	29.5	---

	Occupied Mode				Un-occupied Mode			
	Winter		Summer		Winter		Summer	
Area	DB ¹ (°C)	RH ² (%)	DB ¹ (°C)	RH ² (%)	DB ¹ (°C)	RH ² (%)	DB ¹ (°C)	RH ² (%)
Lobbies	22	>30	23.5	<60	15	---	29.5	---
Toilets	22	>30	23.5	<60	15	---	29.5	---
Locker Room	22	>30	25	<60	15	---	29.5	---
Conference/ Meeting Room	22	>30	23.5	<60	15	---	29.5	---
Computer Room	22	>30	23.5	<60	22	---	23.5	---
Print Room	22	>30	23.5	<60	22	>30	23.5	<60
Auditorium	22	>30	23.5	<60	15	---	29.5	---
Cafeteria	22	>30	23.5	<60	15	---	29.5	---
Courtroom	22	>30	23.5	<60	15	---	29.5	---
Kitchen	22	---	23.5	---	15	---	29.5	---
Exit Stairwells	18	---	None	---	15	---	None	---
Elevator Machine Rm.	18	---	25	---	18	---	25	---
Electrical closets	15	---	25	---	15	---	25	---
Mechanical Rooms	15	---	35 ³	---	15	---	35 ³	---
Electrical Switchgear	15	---	35 ^{3,4}	---	15	---	35 ^{3,4}	---
Emergency Power Generation Room	18	---	35 ³	---	18	---	35 ³	---
Storage Room	18	---	30	---	15	---	30	---
Bus Storage Garage	12	---	30	---	12	---	30	---
EMS Ambulance Bay	18	---	30	---	18	---	30	---
Vehicle Maintenance/ Repair	18	---	30	---	15	---	30	---

Notes:

1. Temperatures are degrees Celsius, to be maintained at +/- 1 °C.
2. Relative humidity to be maintained at +/- 5% RH. Maximum permissible humidity is 60% RH in conditioned areas.
3. Maximum temperature.
4. Electrical cables to be de-rated if required by Code.

- .2 Building heating shall be enabled when the outside air temperature is less than 10°C and shall be adjustable.
- .3 Overhead roll up doors (open/closed) shall be monitored by the BAS and interlocked with radiant tube or unit heaters so that heaters do not run when overhead doors are open. Space heating shall be disabled when the outdoor air temperature is above 10°C.

1.14 ENERGY AND RESOURCE METERING

- .1 Provide separate end-use metering for the following energy and/or resource services consumed:
 - .1 Natural Gas:
 - .1 Facility incoming bulk gas
 - .2 Space heating

- .3 Domestic water heating
- .4 Process gas
- .5 Commercial kitchen equipment
- .2 Potable (Domestic) Water:
 - .1 Facility incoming municipal water service
 - .2 Domestic hot water make-up
 - .3 Plumbing fixtures
 - .4 Heating plant water make-up
 - .5 Cooling plant water make-up
 - .6 Cooling tower and/or fluid cooler make-up
 - .7 Process water make-up (e.g. vehicle wash, humidification)
 - .8 Commercial kitchen water usage
 - .9 Landscape irrigation
- .3 Non-potable water:
 - .1 Greywater
 - .2 Harvested rainwater
 - .3 Landscape irrigation
- .4 Electrical metering for each separate end use type:
 - .1 Facility incoming electricity
 - .2 Interior Lighting
 - .3 Exterior Lighting
 - .4 Ventilation Fans
 - .5 Pumps
 - .6 Space Cooling
 - .7 Process electricity (e.g. compressors)
 - .8 Elevators
 - .9 Data Centres
 - .10 Plug loads
 - .11 Electric heating where it is the primary source of building heating
 - .12 Any other load 40 kW (50 HP for motors) or greater (submeter individually except where multiple similar pieces of equipment serve a similar load)
 - .13 Generation used as part of demand response systems
- .2 Metering shall include both instantaneous and cumulative consumption of energy and/or resource services.
- .3 Materials shall be compatible with the systems in which they are installed at all potential operating temperatures and pressures.
- .4 Meter accuracy shall be +/- 1.5% in expected operating range.

1.15 BAS ACCEPTANCE

- .1 Following satisfactory completion of testing and Commissioning of the BAS as described in the Specifications, and checklists and reports are submitted and reviewed, provide Certification in writing operation of the BAS including:

- .1 Control system checkout and testing
 - .2 Control system demonstration
 - .3 Owner Training
 - .4 As-built documentation, and Operating and Maintenance (O&M) manuals and instructions submitted and reviewed.
- .2 Certification document shall identify any testing that cannot be performed due to extenuating circumstances such as weather conditions. Append program to certification document for rectification and completing of these tests later during warranty period.
- .3 Submittals for Acceptance:
- .1 Provide system documentation at time of acceptance.
 - .2 As-Built Documentation:
 - .1 Within two weeks following Substantial Completion of the project, update the original submittal documents to reflect the "As Built" conditions of the project and submit four (4) copies to the Project Manager.
 - .2 Provide a separate laminated copy of the control drawings for mounting in the mechanical room or in the controls panels.
 - .3 Provide final point lists, shop drawings and all installed equipment data and operations sheets.
 - .4 Submit USB memory thumb drives containing up to date copies of the programs in each controller. Provide original program documentation proving registration for all software programs provided as a part of this contract including: the BAS operator interface software, and the BAS graphics (bitmap files). Provide one set of original thumb drives for every computer supplied under this contract or that the software has been loaded onto.
 - .5 Submit (4) printed copies of the final programs that include all point definitions, weekly and annual schedule setting, controller setpoints and tuning parameters, and documented programmed sequences of operation.
 - .3 Operation and Maintenance (O&M) Manuals:
 - .1 Provide two (2) paper copies of material and two (2) copies on USB memory storage stick in Adobe PDF format.
 - .2 O&M shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS and associated equipment. This documentation shall include specific part numbers and software versions and dates. A complete recommended spare part inventory list, and the lead time and expected frequency of use of each part clearly identified.
 - .3 Provide following information in separate sections, each with an index.
 - .1 Service and parts;
 - .1 Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - .2 List of recommended spare parts with part numbers and suppliers.
 - .2 System description;
 - .1 English language outline of BAS system and system architecture
 - .2 As-built versions of shop drawing product data.
 - .3 Reduced size (11 in x 17 in) copies of record drawings
 - .4 Graphic files, programs, and database on magnetic or optical media.

- .5 Licenses, guarantees, and warranty documents for equipment and systems.
- .3 Technical literature for equipment, including;
 - .1 catalogue sheets,
 - .2 calibration, adjustments and operation instructions,
 - .3 installation instructions,
 - .4 hardware and software manuals, with information supplied by original product developer, on application programs and on computers and controllers supplied
 - .5 Operator's manual with procedures for operating control systems; logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set-points and variables.
 - .6 Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - .7 Original-issue documentation with installation and maintenance information for third-party hardware including computer equipment and sensors.
 - .8 Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
 - .9 Programming manual or set of manuals with description of programming language and syntax, explanation of statements for algorithms and calculations used, procedures for point database creation and modification, documentation of techniques for program creation and modification, and instructions for use of editor.
 - .10 Documentation of programs created using custom programming language including set-points, tuning parameters, and object database. Electronic copies of programs to modify and create control logic, set-points, tuning parameters, and objects that can be viewed using programming tools.
- .4 Original Software:
 - .1 Furnish one original set of application and system software on original media. Disks to bear manufacturer's label. Field copies are not acceptable.
 - .2 Original-issue copies of software to include operating systems, custom programming language, application generation, graphic support, maintenance support, operator workstation or web server software, and other utilities provided in support of installed system.
- .5 On-line record documentation:
 - .1 After completion of testing and adjustment, install the following additional information on the server OWS.
 - .1 As-built record drawing files,
 - .2 detailed catalog data on all installed system components, with supplier contact information for purchasing and factory authorized repair service.
- .4 After start-up, testing, and BAS Commissioning has been completed demonstrating satisfactory and reliable operation of equipment and systems, and Owner Training has been complete, Preliminary

Acceptance shall be certified by the Consultant should the documented deficiencies remaining to be corrected have no adverse effect on the day-to-day operation of the building operation.

- .5 Final Acceptance of the BAS by the Consultant shall be certified when all of the above items have been satisfactorily completed and all identified deficiencies resolved.

1.16 CORRECTION AFTER ACCEPTANCE

- .1 Provide updates and patches to resolve software deficiencies in operator workstation or web server software, project-specific software, graphic software, database software, and firmware during warranty period.
- .2 Provide upgrades that improve routines and procedures of operator workstation software, web server software, project-specific software, graphic software, or database software, free of charge, during the warranty period .
- .3 Provide details of proposed changes and obtain written authorization before installation of updates, patches, or upgrades.
- .4 Include preventative maintenance, with allowance for spare parts, labour, and emergency (24 hour) service for system and equipment during the warranty period.
- .5 Equipment manufacturers to submit written undertakings to make circuit board repairs and provide spare parts, software support and patches, and technical assistance for at least five (5) years after Acceptance is certified.

1.17 LICENSES AND OWNERSHIP

- .1 Ownership of, and licenses for, hardware and software supplied or used for this project or for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.
- .2 This is applicable to System Software, Workstation Application Editors, and Controller Software.
 - .1 Licensing to permit an unlimited number of users to access system without additional fees.
 - .2 As of last day of warranty period, software is to be upgraded to current version or release.
 - .3 Project-developed software and resulting documentation to be treated as part of system and subject to these same requirements for ownership and licensing. This material includes;
 - .1 Project graphic images
 - .2 CAD generated record drawings
 - .3 Project database
 - .4 Project-specific application programming code and documentation.
- .3 Software Licenses:
 - .1 Supply licenses for all software required to monitor, configure system, edit graphics, trend storage, (data exchange including ODBC (if applicable)) without limitations to points.
 - .2 Reliable Controls shall include licensing for the following: RC Studio, RC Webview, RC Archive.
 - .3 Delta Controls shall include licensing for the following: ORCAweb-Large, Illustrator, ORCAweb, OWS, ODBC, DDE, Historian Large.
 - .4 Automated Logic shall include licensing for the following: WEB CTRL, Advanced reports.
 - .5 The operator workstation interface software shall be designed to operate on the Windows 7 Professional platform or later.

1.18 WARRANTY

- .1 At completion of Work, submit written guarantee undertaking to remedy defects in work for period of two (2) years from date of Acceptance, which includes:
 - .1 Rectification of control system failures attributable to defects in workmanship, materials, hardware, and software; controllers excepted.

- .2 Service Technician to arrive on site within 24 hours of warranty service request, to install and de-bug software patches, to replace defective parts, materials or equipment, and to provide incidental supplies, and labour for remedial work during this period without cost to the Owner.
- .3 Technician to remain in attendance until system is returned to proper operating condition in accordance with system operation expectations.
- .2 All Controllers shall have a minimum five (5) year manufacturer's warranty.
- .3 Submit similar warranty for any part of Work accepted by Owner, prior to certification of Substantial Performance.

PART 2 - PRODUCTS

2.01 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.01 COORDINATION

- .1 Owner Coordination:
 - .1 The work shall occur while the control system remains on-line in order to maintain a minimum level of comfort within the building. The Owner shall be notified about situations in which equipment will be off-line for extended periods of time during the project. The Contractor shall conduct all on-site work in conjunction with building operating staff to streamline the new system startup.
- .2 Mechanical and Electrical Trade Coordination:
 - .1 Control Trades shall turn over control devices for installation in Work performed by Mechanical and Electrical Trades.
 - .2 Mechanical and Electrical Trades shall coordinate installation details and operational requirements with Control Trades.
 - .3 Mechanical and Electrical Trades shall provide sufficient labour, materials and equipment to complete point-to-point verification, system performance verification, and other activities as part of the project commissioning requirements.

3.02 ENERGY AND RESOURCE METERING

- .1 Provide meters complete with bypass piping arrangement, or other suitable means, to remove or isolate service without interruption to flow.
- .2 Provide meter manufacturer's calibration certificate(s), installation, operations and maintenance manuals (for meter(s) and data logger) and recommended meter recalibration interval(s).

3.03 BAS TESTING, COMMISSIONING AND ACCEPTANCE

- .1 Comply with the requirements of Section 20 08 10 Mechanical Commissioning and the additional requirements outlined in this Article.
- .2 The BAS Trades shall conduct full end-to-end testing and commissioning of the BAS installations and the overall monitoring and control of the building systems, including test documentation and requirements for testing and demonstration.
- .3 BAS Trade testing shall include the monitoring and supervisory control and data communications with all systems operational and integration with Third Party Devices complete.
- .4 Perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning.
- .5 The BAS Subcontractor shall undertake joint testing of the BAS integration with the Project Stakeholder Group including:
 - .1 the Commissioning Authority,

- .2 the Owner,
- .3 the Owner's Project Manager,
- .4 the Consultant,
- .5 the Construction Manager/General Contractor, and
- .6 all affected Trades.
- .6 The BAS Contractor shall perform a complete and detailed operational check of each BAS component. Testing shall be documented on start-up forms.
- .7 Upon completion of the operational checks, repeat these tests, point-by-point in the presence of the Owner's representative, as required. Properly schedule these tests so that testing is completed by the time directed by the Owner's representative. The Project Stakeholder Group shall undertake such random testing as the Project Stakeholder Group considers necessary to verify the acceptability of the components.
- .8 Verify BACnet communications as specified and submit all point naming and identification values accordingly.
- .9 Provide a field checks for all controllers and front-end equipment (computers, printers, modems, and similar devices). The BAS Trades shall verify proper operation of both hardware and software of all system components. A checkout sheet shall be provided itemizing each device and a description of the associated tests shall be prepared and submitted to the Owner's Commissioning Authority at the completion of the project.
- .10 Point-to-Point (End-to-End) Testing:
 - .1 Provide schedule for point-to-point (end-to-end) checks and testing.
 - .2 Perform point-to-point (end-to-end) checks from an operator terminal to all sensors and actuators to the controller/outstation and from the controller to the presentation of the point on the graphic via LAN.
 - .3 Each analogue inputs (i.e. temperatures, pressure, etc.) shall be verified with an approved calibration device. All actual temperature readings should be with +/- 1°C of the readings observed at the workstation.
 - .4 Each analogue output shall be verified by manually commanding the output channel from the operator workstation to two or more positions within the 0-100% range and verifying the actual position of the actuator or device. All devices shall operate over their entire 0- 100% range from a minimum control range of 10-90%.
 - .5 Digital outputs shall be verified by witnessing the actual start/stop operation of the equipment under control.
 - .6 Digital inputs shall be verified by observing the status of the input point as the equipment is manually cycled on and off.
 - .7 Point-to-point (end-to-end) checks shall verify (at minimum) the following:
 - .1 Correct location of the field device for the application.
 - .2 Correct installation of the control device/interface with reference to the manufacturer's literature and check that sufficient access has been provided for maintenance.
 - .3 Verify and record in as built OEM drawings that control wiring is connected and free of shorts and ground faults. Verify that terminations are tight.
 - .4 That the control device has the correct range for the application, that the range is correctly entered in the controller and is correctly engineered on the operator's terminal.
 - .5 Correct operation of the controls device/interface, including any associated alarm and alarm text.

- .6 Verify and record that binary output devices operate and that normal positions are correct.
- .7 Verify and record that analog output devices are functional, that start and span are correct, and that direction and normal positions are correct.
- .8 Correct installation of each valve and damper actuator, and ensure that each valve and damper actuator is stroked correctly when checked against the BAS output; adjust valve stem and damper blade travel.
- .9 Calibration of the control device.
- .10 Labels provided on the control devices and mechanical equipment are correct.
- .8 Start-up testing shall commence once all component point-to-point (end-to-end) testing has been successfully completed and reviewed by the Consultant.
- .11 BAS Start-up Testing:
 - .1 Start-up testing to verify completion of control system before system demonstrations begins.
 - .1 Verify and record that system operates according to Sequences of Operation. Simulate changes in variables by overriding and varying inputs and schedules, and observe and record each operational mode response.
 - .2 Tune Control Mode loops and control routines.
 - .3 Check each alarm with an appropriate signal at value that will trip alarm.
 - .4 Trip interlocks using field contacts to check logic and to ensure that actuators fail in proper direction.
 - .5 Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.
 - .2 Prepare and submit log documenting Start-up testing of each input and output device and each control routine, with technician's initials certifying each device and each routine is functioning correctly and sensors have been calibrated. Include list of deficiencies, if any, and schedule setting out rectification program with time lines.
 - .3 Manually operate each output for every system with a Mobile User Interface supplied by the BAS Trades as part of the Commissioning activities.
 - .4 Submit site-specific trends that contain all I/O points recorded at an analog or digital time frequency that confirms the correct system operation.
- .12 BAS Trade System Testing:
 - .1 Document the following:
 - .1 each point on the BAS including calibration checks and the stroking of actuators.
 - .2 all dynamic graphics comply with the mechanical and control specifications.
 - .3 all system programs comply with the specification under the normal modes of operation, emergency power, building fire detected and firefighter's override operating modes.
 - .4 all system alarms comply with the operating sequences and the specifications.
 - .5 System stability.
 - .6 Dynamic tests to prove control stability and that environmental comfort conditions are maintained.
- .13 Confirm and demonstrate to the Consultant and the Owner's agent that all systems are programmed and operating correctly.
- .14 System Performance Verification Testing:

- .1 Prior to acceptance, perform System Performance Verification Testing to demonstrate system operation and compliance with specification after, and in addition to, tests specified above. Show field operation of:
 - .1 each Sequence of Operation,
 - .2 Operator Interface,
 - .3 DDC loop response with graphical trend data output showing:
 - .1 Each DDC loop response to set point change producing an actuator position change of at least 25% of full range,
 - .2 Trend sampling rate to be from 10 seconds to 3 minutes, depending on loop speed,
 - .3 Loop trend data to show set point, actuator position, and controlled variable values,
 - .4 Documentation of further tuning of any loop that displays significantly under- or over-damped control,
 - .4 Demand limiting routine with trend data documenting action sampled with output showing demand-limiting algorithm action for each minute over a minimum 30-minute period indicating building kW, demand-limiting set point, and status of set-points and other affected equipment parameters,
 - .5 Building fire alarm system interface,
 - .6 Trend logs for each system point with:
 - .1 trend data to indicate set-points, operating points, valve positions, and other data as specified in points list provided with each Sequence of Operation,
 - .2 each log to cover three 48-hour periods and to have sample frequency not less than 10 minutes,
 - .3 occupancy sensor trend logs shall show the occupancy patterns of the space,
 - .4 confirmation that setpoints are being maintained and excessive cycling of equipment is not occurring.
 - .5 show that Logs are accessible through operator interface and can be retrieved for use in other software programs.
 - .7 Control loop tuning parameters shall be verified by applying a change to the current setpoint and observing the resulting trend log with setpoint being reached within a "reasonable" period of time without excessive cycling or hunting of the controlled device,
 - .8 Substantiate calibration and response of any input and output points requested,
 - .9 Provide at least two technicians equipped with two-way communication,
 - .10 Provide and operate test equipment to establish calibration and prove system operation.
- .2 Obtain approval of Start-up Testing and Trade System Testing documentation, including any rectifications made, prior to scheduling System Performance Verification Testing.
- .3 Provide notification not less than ten (10) business days before System Performance Verification Testing begins.
- .4 The System Performance Verification Testing shall be performed by the BAS Trades and shall be witnessed by the Consultant who shall complete the Consultant's portion of the system performance verification test sheets as each test is successfully completed.

- .5 The BAS Trade Contractor shall remedy any deficiencies that are observed during the system performance verification tests and shall be re-tested as required to demonstrate satisfactory performance.
- .6 System Performance Verification Testing to follow previously submitted and approved procedures;
 - .1 submit checklists and report forms for each system as part of demonstration,
 - .2 lists and forms to have initials of technicians conducting demonstrations,
 - .3 date of each demonstration and signatures of Owner's representatives witnessing each demonstration section.
- .15 Third Party Device Integrated Systems Testing:
 - .1 Third Party Device Integrated System Testing shall include the following minimum requirements:
 - .1 Test all Third Party monitored and controlled field devices, Third Party data points and all Third Party input and output points. Monitored data point values shall be verified against actual field device values to ensure both Third Party and BAS reported values are the same.
 - .2 Third Party controller device status and data communications status are accurately monitored at the BAS. Alarms for failed controllers and failed data communications are annunciated.
 - .3 BAS override control via the Operator Workstation of all Third Party output points and control data points shall be verified.
 - .4 Third Party data values displayed on the BAS dynamic system graphics, or in tabular data format, are functional and accurate.
 - .5 BAS facilities for operator adjustment of Third Party alarm definition parameters and thresholds, setpoint adjustment, control parameter adjustments, point trend initiation and modification to trends, and similar control functions, are fully operational.
- .16 Security System Monitoring to BAS:
 - .1 Provide digital input from security system.
 - .2 When building security armed all outside lighting control shuts off 20 minutes after alarm system armed.
 - .3 When building security armed all AHU's, Exhaust Fans and heating systems shall be changed to unoccupied mode immediately when armed regardless of scheduled times.
 - .4 All critical alarms as determined by the Owner.
- .17 When project is complete the BAS Trade Contract shall allow sufficient programming time in order to customize the sequences to meet operational needs, fine tuning of the system and other duties as required. The Owner will determine the schedule.
- .18 Commissioning Record Documentation.
 - .1 Test results shall be documented using test sheets. The test sheets shall be prepared in an appropriate format for the various categories of component and system to be tested. It is the responsibility of the BAS Trades to provide test verification sheets for each component and system that accurately reflect the sequences of operation and appropriate data for the components and systems
 - .2 All test documentation shall be maintained in electronic format and in hard copy.
 - .3 Submit a four (4) copies of the system Commissioning Report to the Consultant for review and approval.
 - .4 Record all out-of-season or unverified points in the commissioning report as "uncommissioned".

- .5 Submit inspection certificates.
- .6 Certificate of Acceptance to be withheld until Submittals are reviewed.
- .19 Ensure the BAS has met requirements outlined in the Article entitled 'Completion' found in Section 20 01 10.

3.04 OWNER TRAINING

- .1 Owner Training sessions shall include classroom type instruction and "hands on" instruction and shall be delivered by the BAS Trades on site using the completed installations. Arrange for additional meeting room space with the Owner.
- .2 Provide training tailored to the various Owner operations personnel requirements.
- .3 Materials:
 - .1 Provide course outline and materials for each class at least six weeks before first class.
 - .2 Provide training through instructor-led sessions, with computer-based, or web-based techniques.
 - .3 Instructors to be factory-trained and experienced in presenting this material.
 - .4 Perform classroom training using network of working controllers representative of installed hardware
- .4 Once five (5) consecutive Days of alarm-free operation are complete and documented, operator training may begin.
- .5 Provide one (1) day of instruction to the Owner's designated personnel on the operation of the BAS and describe its intended use with respect to the programmed functions.
- .6 Operator orientation of the BAS shall include, but not be limited to:
 - .1 the overall operation program,
 - .2 equipment functions (both individually and as part of the total integrated system),
 - .3 commands,
 - .4 systems generation,
 - .5 advisories, and
 - .6 appropriate operator intervention required in responding to the system's operation.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with the requirements of Section 20 01 10 Mechanical General Requirements
- .3 Comply with the requirements of Section 20 10 50 Basic Materials and Methods
- .4 Comply with the requirements of Section 20 05 70 Motors, Motor Starters, and Wiring
- .5 Comply with the requirements of Section 20 05 75 Variable Frequency Drives
- .6 Comply with the requirements of Section 25 05 10 BAS General Requirements
- .7 Comply with the requirements of Section 25 30 10 BAS Instrumentation and Devices
- .8 Comply with the requirements of Section 25 56 26 Integrated Lighting System Controls

1.02 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM

- .1 The building automation system is to consist of a modular, BACnet protocol, open architecture system incorporating direct digital control and monitoring of equipment and systems and consisting of all hardware and software required for the complete system. The BAS is to be accessible through standard personal computers within the building through a wireless application protocol device, or remotely through the Internet by means of a standard web browser.
- .2 The BAS is to be field expandable, with an architectural design to eliminate dependence upon any single device for alarm reporting and control execution. Failure of any single component or network connection is not to interrupt the execution of control strategies at other operational devices. The BAS is to maintain all settings and overrides through a system re-boot, and is to incorporate, as a minimum, the following integrated features, functions and services:
 - .1 operator information, alarm management, and control features;
 - .2 enterprise-level information and control access;
 - .3 information management including monitoring, transmission, archiving, retrieval, and reporting functions;
 - .4 dashboard graphics package providing current high-level operational status of alarms, building comfort, and building energy usage;
 - .5 diagnostic monitoring and reporting of BAS functions;
 - .6 off-site monitoring and management access;
 - .7 energy management;
 - .8 integrated lighting system controls;
 - .9 standard applications for terminal HVAC systems.
- .3 The BAS is to include, but not be limited to, the following:
 - .1 a web based operator work station user interface with colour monitor for colour-graphic displays, and a colour printer;
 - .2 a portable operator's terminal;
 - .3 Management Level Processor (MLP)
 - .4 Building Control Units (BCUs);
 - .5 Field Equipment Controllers (FECs);
 - .6 Zone Level Controllers (ZLCs)
 - .7 input/output modules;
 - .8 local display devices;
 - .9 distributed user interfaces;

- .10 network processing, data storage and communication equipment;
- .11 all other components required for a complete and operating BAS.
- .12 Interfaces to system utilizing standard communications protocols such as BACnet, Modbus and LON.

1.03 OPERATOR INTERFACE

- .1 Operator interface allowing for efficient communication of operational data and abnormal conditions, providing a consistent framework for viewing of information, and following requirements:
 - .1 critical areas (such as alarm icons) visible at all times;
 - .2 predefined area on screen providing operator messaging visible at all times;
 - .3 set of standard displays for configuration, and navigation around BAS system provided with every system and not requiring any engineering;
 - .4 unlimited number of custom (facility specific) displays created to meet needs of specific facility.
 - .5 software capable of running in Windows Server environment of version recommended by manufacturer;
 - .6 interactive and totally graphics and/or icon based, capable of supporting at least 65,000 colours at a minimum 1280 x 1024 pixel resolution;
 - .7 employ standard Windowing conventions so as to reduce required operator training, in particular, standard, totally configurable tool bar icons and drop-down menus available on standard and custom displays to allow easy access to common functions, and such functions also available via a standard set of function-key based pushbuttons without requiring configuration;
 - .8 support ability to "full screen lock" window so users cannot access other applications, and if "full screen lock" is not enabled, support for copy and paste facilities are to be provided between operator window and other Microsoft applications;
 - .9 operator interface connection:
 - .1 flexible in its connection to BAS server;
 - .2 Ethernet LAN or Internet connection used between server and operator workstations and browser clients;
 - .3 provide standard remote access support using industry standard tools like VNC, RADMIN, and Windows Terminal Services;
 - .4 where used, remote connections are to use password protected user authentication and encrypted network/internet protocols.
 - .10 following functions performed through operator interface:
 - .1 display and control of field equipment;
 - .2 acknowledge alarms on a priority basis;
 - .3 initiate printing of reports;
 - .4 archive and retrieve event logs;
 - .5 view historical plant information on predefined trend windows;
 - .6 view intranet or information from the Internet in a secure environment;
 - .7 change own password;
 - .8 monitoring of data communications channels;
 - .9 configure system parameters.
- .2 Web Browser Operator Interface

- .1 Operator interface fully available and functional through internet via an Internet Explorer browser allowing an operator to operate facility and perform all functions on same standard and custom graphics as used in standard operator interface. Custom graphics, alarm graphics and standard graphics available without modification or reengineering through Internet in an Internet Explorer browser user interface.
- .2 Browser interface providing login and security authentication in same way as standard operator interface. Large number of casual users permitted without any additional licensing burden with licensing based on number of simultaneous operator connections on a "first come first served" basis. Users with casual access are to automatically disconnect from BAS server after an idle timeout period.
- .3 Operator Interface Characteristics
 - .1 Following minimum capabilities are standard and require no custom programming or scripting:
 - .1 window re-size, zoom in, zoom out with display resolutions continuously resized to fit available window size;
 - .2 dedicated icons and pull down menus to perform multiple operations.
 - .2 Operator Input Devices
 - .1 Operator interface capable of being mouse driven and simultaneously support keyboard data input. Both fixed menus and configurable function keys supported to aid novice and experienced operator respectively. Interface also capable of supporting a touch-screen for pointing and command input.
 - .2 Utilizing a Tool Bar for common operator commands, and able to request display of commonly used displays and activate system functions via drop-down menus.
 - .3 Operator interface input is possible using only pointing device and QWERTY section of keyboard.

1.04 OPERATOR SECURITY

- .1 BAS shall have the capability to provide each operator with an assigned user profile that defines following:
 - .1 security and/or control level;
 - .2 operator identifier;
 - .3 unique encrypted password;
 - .4 operator scope of responsibility assignment;
 - .5 start graphic for that operator;
 - .6 timeout value for that operator.
- .2 Log actions initiated by operator in event database by operator identifier. In addition, any control actions to a given point are only allowed if control level configured in operator's profile exceeds level assigned to controlled point.
- .3 System to support at least 6 levels of operator security.
- .4 Sign-On/Sign-Off:
 - .1 Operator is permitted to sign on to system if correct operator identity and password have been entered. It is possible to have system authentication integrated directly into Windows, Windows Group Accounts, or an LDAP Server such that operator uses pre-existing account details to sign on to BAS system ensuring operators only need to remember 1 set of credentials for both their workstation and BAS.
 - .2 Each operator is to be assigned a password and a defined scope of responsibility which defines locations in facility that may be managed and controlled by individual operator.
 - .3 Operator may sign-off at any time by issuing a sign-off command.

- .5 Location Assignment / Scope of Responsibility Profile:
 - .1 Each operator is to be assigned one or more specific areas of building with appropriate monitoring and control responsibility (no view, view only, alarm acknowledge only or full control). Location is defined in this context as a logical entity comprising of a set of points in system. This in turn may represent a physical space in building. Locations are used to partition BAS database in such a way as to assign operators control over certain areas and prevent unauthorized access to other areas.
- .6 Duress:
 - .1 System to support operator duress function, so operator may discretely indicate they are signing in to BAS system under duress. System is to recognize operator is signing on under duress and be able to issue a control to alert appropriate assistance.
- .7 Command Partitioning:
 - .1 Possible to assign each operator a set of allowed commands for each assigned location. Commands can be mapped against output state of any given digital point in respective area to determine whether a control command is allowed for particular operator.
 - .2 With this feature, it will, for example, be possible to configure an operator to set a digital point to "ON", but to disallow same operator from setting same digital point to "OFF".

1.05 DISTRIBUTED BUILDING CONTROL UNITS

- .1 Provide a method for monitoring and control of points on remote BAS Building Control Units (BCUs), specifically real-time and history values. Features to be supported include:
 - .1 Global access to data, such that users at operator workstations on one Building Control Unit (BCU) can access data, history, point detail displays, and other information on any other Building Control Unit (BCU). It shall not be necessary to configure system wide, more than one point for each data value or signal, regardless of number of Building Control Units (BCUs) accessing data.
 - .2 Ability to nominate sets of points to be accessed on a BCU-by-BCU and user-by-user basis. Mechanism is to be same as mechanism to control individual operator and workstation access to data for single server systems.
 - .3 Operators and workstations at any server are to see alarms from any other BCU, and not necessary to configure alarms more than once, regardless of number of servers accessing data.
 - .4 Ability to configure real time and historical trends that combine data from any connected server on a single trend, and not necessary to configure more than one point for each data value or signal, regardless of number of BCUs accessing data.
 - .5 Graphics, reports, and applications at a server have same distributed access to data on other BCUs as described above for operators and workstations, and not necessary to configure more than one point for each data value or signal, regardless of number of BCUs accessing data.
 - .6 Important service-oriented architecture (SoA) web services enabling extension of BAS system providing seamless access to points, alarms and history from any distributed system BCU, without needing to directly address each individual BCU. Data across distributed system BCUs is to be seamlessly integrated into Web services.
- .2 Connections between Building Control Units (BCUs) can be made through local Ethernet connections, or Local Area Network (LAN).

1.06 REMOTE ACCESS VIA MOBILE USER INTERFACE

- .1 Available with an operator interface designed for use on various Smart Phone Devices and Tablets with network connectivity.
- .2 Mobile User Interface shall include full operator workstation functionality.

- .3 Mobile User Interface is to support standard operator workstation features including full operator scope of responsibility, and operable using commercial off-the-shelf technology.
- .4 Network Agnostic:
 - .1 Mobile user interface operating over standard TCP network connection, performing well down to mobile 3G speeds, and optimized to ensure very high performance across different network topologies.
- .5 Browser Agnostic
 - .1 Solution written with HTML5 web standards and browser agnostic, not deploying or using ActiveX controls, nor requiring installation of Java Runtime engine.
- .6 BAS Features Integrated into Mobile User Interface:
 - .1 Mobile solution incorporating full scope of responsibilities of BAS operators for remote mobile users, allowing them to view or control points within their assigned facility locations.
- .7 Operable Within Normal PC Desktop and Laptop Browsers
 - .1 Without alternation, Mobile User Interface operable within any standard internet browser from a normal personal computer.

1.07 SHOP DRAWINGS

- .1 Submit four (4) copies of following information to the consultant and/or the project manager for review and approval:
 - .1 Control Schematics.
 - .2 Detailed sequence of operation for each control schematic or controlled system.
 - .3 System Architecture indicating the proposed interconnection and location of all BAS panels, network connections and key peripheral devices (workstations, modems, printers, repeaters, and similar devices).
 - .4 BAS Points List indicating the panel ID, panel location, hardware address, point acronym, point description, field device type, point type (i.e, AO/DO/AI/DI), end device fail position, end device manufacture and model number, and wire tag ID). Terminal identification for all control wiring shall be shown on the shop drawings.
 - .5 Wiring diagrams including complete power system, interlocks, control and data communications.
 - .6 Hard copy graphical depiction of the application control programs.
 - .7 Manufacturers' data / specification sheets for all material supplied.
- .2 Submit shop drawings schedules for;
 - .1 control damper; spreadsheet type, to include separate line for each damper and columns for damper attributes.
 - .2 control valve; spreadsheet type, to include separate line for each valve and separate columns for valve attributes.
- .3 Submit catalogue cut-sheets for;
 - .1 manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for equipment and hardware items as follows;
 - .1 Management Level Processors (MLPs)
 - .2 Controllers (BCU's, FEC's, ZLC's)
 - .3 Transducers/Transmitters and Sensors with
 - .1 accuracy data, range and scale information,

- .2 one sheet for each device marked with applicable options. (Where several devices of same type are to be used, submit one sheet for each device, individually marked.)
- .4 Actuators
- .5 Valves
- .6 Dampers
- .7 Relays/Switches
- .8 Panels
- .9 Power Supplies
- .10 Batteries
- .11 Operator Interface
- .12 Wiring and wiring accessories
- .13 All other Instrumentation and Devices Specified in Section 25 30 10
- .2 hardware data sheets for Operator Interfaces, local panels, and portable operator terminals.
- .4 Submit supporting documentation:
 - .1 examples of graphics for Operator Interface.
 - .2 Software manuals for applications programs for Operator Interface, portable operator terminals, and programming devices.
 - .3 Protocol Implementation Conformance (PIC) statement for BACnet devices.
 - .4 Where interfaces occur with control or wiring diagrams of other sections, obtain reproducible copies of these diagrams and revise to show terminal numbers at interface and include diagrams as part of interconnection schematic shop drawings.

1.08 BAS INTEGRATION WITH THIRD PARTY DEVICES

- .1 BAS Trades shall review Shop Drawings and other Submittals from Trades providing equipment and systems that are required to Integrate with the BAS.
- .2 BAS Trades shall ensure the BAS network architecture is compatible with Third Party Devices provided by multiple vendors to the Project, and that these Third Party Devices are provided with the required Integration capabilities.
- .3 Where Third Party Devices cannot communicate to the BAS through an open protocol, BAS Trades shall ensure appropriate Gateways are provided, including all relevant hardware and software, to allow bi-directional communication of all relevant data.
- .4 Gateway shall be required to pass Owner's Information Technology (IT) security audit prior to implementation if gateway is BACnet IP; if gateway is BACnet MSTP it shall be BTL certified.
- .5 Vendor should provide Protocol Implementation Conformance Statement (PICS) for Owner's review to confirm compatibility with existing supervisory controller.
- .6 There shall be one (1) vendor gateway per loop if using BACnet MSTP.
- .7 If using BACnet MSTP, Vendor shall provide wiring scheme regarding reference, shield, termination, and wiring specifications. Owner shall confirm compatibility with existing Base Building Control Vendor.
- .8 Any configuration or programming software/tool(s) used for this gateway shall be provided to Owner.
- .9 Vendor warranty shall include parts and service (labour) during warranty period.
- .10 No scheduling, no event and no trends shall be provided by the Gateway, these functions shall be provided through a separate dedicated controller by the BAS Vendor.

- .11 Any safety interlock, where possible, shall be hard wired and accomplished through the gateway or through BAS programming.
- .12 Vendor shall provide one (1) gateway for base building controller compatibility test.

PART 2 - PRODUCTS

2.01 GENERAL PERFORMANCE REQUIREMENTS

- .1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges:
 - .1 Temperature - 0°C to 32.2°C (32°F to 90°F)
 - .2 Relative Humidity 10% to 90% non-condensing
 - .3 Electrical power service of single phase, 120 VAC +/- 10%, 60 Hz nominal.
- .2 Control system:
 - .1 high-speed, peer-to-peer network of microprocessor based Direct Digital Control (DDC) controllers with web-based operator interface,
 - .2 each mechanical system, building floor plan, and control device to be displayed through point-and-click graphics,
 - .3 Web server with network interface card to gather data from this system and generate web pages that can be accessed through conventional web browser on any PC connected to network,
 - .4 Operators to access this system through web browser, and browser interface to perform normal operator functions.
- .3 Open protocol:
 - .1 Provide an integrated, open protocol building automation system, either/ or in combination:
 - .1 BACnet to ANSI/ASHRAE Standard 135,
- .4 General functional requirements:
 - .1 Control mechanical and electrical equipment as specified in Control Sequences, shown on Control Schematics, and described in Equipment Schedules.
 - .2 System architecture to be modular, permitting stepped expansion of application software, system peripherals, and field hardware.
 - .3 Each controller;
 - .1 operates with local closed loop programming, independent from server, if peer-to-peer communication is interrupted;
 - .2 performs resident control routines;
 - .1 receiving information from field mounted sensors and switches and
 - .2 transmitting instructions to actuators to perform control sequences.
 - .3 manages local hardware and software alarms;
 - .1 to collect historical data,
 - .2 to facilitate operator input and output and
 - .3 to communicate with Central BAS web server and operator interface.
 - .4 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.
- .5 Performance:
 - .1 General:
 - .1 information transmission and display times are based upon network, rather than modem, connections.

- .2 test systems using manufacturer's recommended hardware and software for operator interface.
- .6 Performance criteria:
 - .1 Graphic Display;
 - .1 display graphic with 20 dynamic points with current data within 10 seconds.
 - .2 Graphic Refresh;
 - .1 update graphic with 20 dynamic points with current data within 10 seconds and
 - .2 automatically refresh every 15 seconds.
 - .3 Configuration and Tuning Screens;
 - .1 special screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic to refresh every 5 seconds.
 - .4 Refresh Rate;
 - .1 The Refresh Rate is defined as the time it takes the controller central processing unit (CPU) to sample all inputs, calculate all variables, update all timers and proportional integral derivative (PID) controllers, check all schedules, update all trend logs and runtime logs, execute all programs and assign values to all outputs.
 - .2 The maximum permissible refresh rate is one (1) second.
 - .5 Reporting Accuracy;
 - .1 system to report values with an end-to-end accuracy equal to or better than those listed below.
 - .2 control loops to maintain measured variable at set point value within tolerances equal to or better than those listed below.
- .7 Provide Owner's Training on the operation of the BAS.
- .8 Provide BAS As-built documentation, and Operating and Maintenance (O&M) manuals and instructions.

2.02 EQUIPMENT STANDARD

- .1 Products and software: manufacturer/developer/supplier's catalogued current stock.
- .2 This installation is not to be used as test site for newly developed product or software, without explicit written approval.
- .3 Equipment and systems installed under this Contract to meet;
 - .1 performance specifications when subjected to VHF, UHF, FM, AM or background RF interference as generated by commercial or private, portable or fixed transmitters that meet regulatory codes.
 - .2 Federal Communication Commission (FCC) Rules and Regulations, Part 15, Subpart J for computing devices.

2.03 BAS ARCHITECTURE

- .1 Automation Network: The BAS is to be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards are to be standard "off-the-shelf" products available through normal PC vendor channels. The BAS is to be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication. The BAS is to be compatible with other enterprise-wide networks, and where indicated, the BAS is to be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
- .2 Control Network: Management Level Processors (MLPs), Building Control Units (BCUs), are to provide supervisory control over the control network and are to support the BACnet Standard MS/TP, or approved equal, bus communication protocol (ASHRAE SSPC-135, Clause 9). The control networks are to provide either a "peer-to-peer", master-slave, or supervised token passing

communications and are to operate at a minimum communication speed of 9600 baud. DDC controllers are to reside on the control network.

.3 Integration:

- .1 The BAS is to include appropriate hardware and software to allow BACnet bi-directional data communications between the BAS and building equipment/system control panels. The BAS is to receive, react to, and return information from the equipment and systems. All data required by the application is to be mapped into the automation engine's data base and is to be transparent to the operator. Point inputs and outputs from building equipment/system control panels is to have real-time inter-operability with BAS software features such as control software, energy management, custom process programming, alarm management, historical data and trend analysis, totalization, and local area network communications.
- .2 The BAS is to include appropriate hardware and software to allow BACnet bi-directional data communications between the BAS and the existing facility's building automation system. Each system shall be capable of read access to a defined set the other systems data points.
- .4 Air Handling Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be interfaced to the BAS. The contractor supplying the equipment shall use BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.
- .5 Variable Frequency Drive Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be interfaced to the BAS. The contractor supplying the equipment may use Modbus or BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.
- .6 Lighting Control System Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be interfaced to the BAS. The contractor supplying the equipment may use Modbus or BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.
- .7 Refrigerators and Freezers Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be interfaced to the BAS. The contractor supplying the equipment may use Modbus or BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.
- .8 Generator Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be interfaced to the BAS. The contractor supplying the equipment may use Modbus or BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.
- .9 Fuel Oil Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be

interfaced to the BAS. The contractor supplying the equipment may use Modbus or BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.

- .10 Water Treatment Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be interfaced to the BAS. The contractor supplying the equipment may use Modbus or BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.
- .11 In Floor Heating Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be interfaced to the BAS. The contractor supplying the equipment may use LonTalk, Modbus or BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.
- .12 Miscellaneous Equipment: The equipment will be provided by its manufacturer with an interface to monitoring and control points specified in the input/output point schedules of the BAS. Points specified in the input/output point schedules shall be the minimum acceptable list of points to be interfaced to the BAS. The contractor supplying the equipment may use Modbus or BACnet interface for the points listed as AI, DI, AO or DO in the input/output points schedule. The supplier of the equipment shall ensure they have supplied and installed all of the software and hardware so that the equipment will be able to provide the points listed on the BAS.

2.04 CENTRAL BAS OPERATOR WORKSTATION (OWS)

- .1 General requirements:
 - .1 Operator Workstation shall be dedicated web based by means of a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions including scheduling, history collection, and alarming is to be resident in the BAS network control panels to facilitate greater fault tolerance and reliability.
 - .2 Operator Workstation shall perform global application programs and data collection and consolidation as follows:
 - .1 communicating with controllers;
 - .2 obtaining data from field devices for central monitoring of building systems, and;
 - .3 transmitting instructions to controllers.
 - .3 Operator Workstation shall have software routines for;
 - .1 BAS Server operation,
 - .2 database creation and data storage,
 - .3 web based Graphical User Interface (GUI) with graphics generation and display,
 - .4 report formulation, printing, and presentation,
 - .5 alarm detection and reporting and
 - .6 event initiated programming.
 - .4 Audit Trail;
 - .1 The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing

- a graphic display, running a report, modifying a schedule, and similar type of activity.
- .2 The system is to employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the Operator. Additional features to be provided are as follows:
- .1 all inputs, outputs, set-points, and other parameters shown on the drawings, or required as part of the system software are to be displayed for operator viewing and modification from the operator interface software;
 - .2 the user interface software is to provide help menus and instructions for each operation and/or application;
 - .3 the system is to support customization of the user interface configuration and a home page for each operator;
 - .4 the system is to support user preferences in alarm, trend, display, and applications screen presentations;
 - .5 all controller software operating parameters are to be displayed for the operator to view/modify from the user interface, and these parameters are to include set-points, alarm limits, time delays, PID tuning constants, run times, point statistics, schedules, etc.;
 - .6 the operator interface is to incorporate comprehensive support for functions including but not limited to the following:
 - .1 user access for selective information retrieval and control command execution;
 - .2 monitoring and reporting;
 - .3 alarm, non-normal, and return to normal condition annunciation;
 - .4 selective operator override and other control actions;
 - .5 information archiving, manipulation, formatting, display and reporting;
 - .6 BAS internal performance supervision and diagnostics;
 - .7 on-line access to HELP menus;
 - .8 on-line access to current BAS as-built records and documentation;
 - .9 means for controlling, re-programming, and re-configuration of the BAS operation and for the manipulation of the BAS database information in compliance with applicable Codes and Regulations for individual BAS applications.
 - .7 the system is to support a list of application programs configured by the users that are called up by the Tools Menu, hyperlinks within the graphic displays, and key sequences;
 - .8 the operation of the control system is to be independent of the Operator Workstation, which is to be used for operator communication only.
- .3 Navigation Trees: The system is to have a minimum of five levels of nesting, and the capability of displaying multiple navigation trees to aid the operator in navigating throughout all systems and points connected, adding custom trees, defining any logical grouping of points and arranging them on a tree in any order, and nesting groups within other groups. The navigation trees are to be "dockable" to other displays such as graphics, meaning that the trees will appear as part of the display but can be detached and then minimized to the Windows task bar or closed altogether, however, a simple keystroke will reattach the navigation to the primary display of the user interface.
- .4 Alarms: Alarms are to be routed directly from network automation engines to PC's and servers, and it is to be possible for specific alarms from specific points to be routed to specific PC's and servers. The BAS is to annunciate diagnostic alarms indicating system failures and non-normal operating conditions, annunciate application alarms as required by points lists and sequences, and as a minimum, permit four categories of alarm sounds customizable through user defined wav. files. The alarm management segment of the user interface is to provide, as a minimum, the following alarm functions:
- .1 log, date, and time of alarm occurrence;

- .2 generate a "pop-up" window with audible alarm to inform a user that an alarm has been received;
 - .3 permit a user with the appropriate security level to acknowledge, temporarily silence, or discard an alarm;
 - .4 provide an audit trail on the PC hard drive for alarms by recording user acknowledgement, deletion or disabling of an alarm, the name of the user, the alarm, the action taken, and the time/date of the alarm;
 - .5 facilitate the ability to direct alarms to an email address or alphanumeric pager, in addition to the pop-up window described above;
 - .6 any attribute of any object in the system may be designated to report an alarm.
- .5 Reports and Summaries: Reports and summaries are to be generated and directed to the user interface displays with subsequent assignment to printers or discs. Summaries and reports are to be accessible via standard user interface functions, and selection of a single menu item, tool bar item, or tool bar button is to print any displayed report or summary. The system is to permit the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports. As a minimum the BAS is to provide the following reports and summaries:
- .1 all points in the BAS;
 - .2 all points in each BAS application;
 - .3 all points in a specific controller;
 - .4 all points in a user-defined group of points;
 - .5 all points currently in alarm;
 - .6 all points locked out;
 - .7 all BAS schedules;
 - .8 all user defined and adjustable variables, schedules, interlocks, etc.
- .6 Schedules: A graphical display for time-of-day scheduling and override scheduling of building operations is to be provided, with weekly schedules for each group of equipment with a specific time use schedule, and it is to be possible to define one or more exception schedules for each schedule including reference to calendars, with monthly calendars provided to permit simplified scheduling of holidays and special days for a minimum of five years in advance, user selected with the pointing device or keyboard. Changes to schedules made from the user interface are to directly modify the network automation engine schedule database. Selection of a single menu item or tool bar button is to print any displayed schedule. As a minimum the following functions are to be provided:
- .1 weekly schedules;
 - .2 exception schedules;
 - .3 monthly calendars.
- .7 Passwords: The BAS is to be complete with multiple-level password access protection to permit the user/manager to user interface control and display, database manipulation capabilities deemed appropriate for each user, based on an assigned password. Password access protection features are to include:
- .1 each user is to have a user name (24 characters maximum), a password (12 characters maximum), and access levels;
 - .2 each user may change his or her password at any time;
 - .3 when editing or entering passwords the system is not to echo the actual characters for display on the monitor;
 - .4 a minimum of one hundred unique password is to be supported;

- .5 operators are to be able to perform only those commands available for their respective passwords, and display of menu selections is to be limited to only those items defined for the access level assigned to the password of each user;
- .6 the BAS is to automatically generate a report of log-on/log-off and system activity for each user, and any action that results in a change in the operation or configuration of the control system is to be recorded, including the acknowledgement and deletion of alarms;
- .7 a minimum of five levels of access is to be supported individually or in any combination of the following:
 - .1 Level 1 – view data;
 - .2 Level 2 – command;
 - .3 Level 3 – operator overrides;
 - .4 Level 4 – database modification;
 - .5 Level 5 – database configuration;
 - .6 Level 6 – all privileges including password add/modify.
- .8 Screen Manager: The user interface is to be equipped with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of four active display windows plus a network of user defined navigation trees.
- .9 Dynamic Colour Graphics: The Graphic User Interface application program is to be an integral part of the user interface and is to include a create/edit function and a runtime function, and the system architecture is to support an unlimited number of graphic documents (graphic definition files) to be generated and executed. The graphics are to be capable of displaying and providing animation based on real-time data that is acquired, derived, or entered. Additional features include the following:
 - .1 graphics runtime functions: a maximum of sixteen graphic applications are to be able to be executed at any one time on a user interface or workstation with four visible to the user, and each graphic application is to capable of the following functions:
 - .1 all graphics are to be fully scalable;
 - .2 graphics are to support a maintained aspect ratio;
 - .3 multiple fonts are to be supported;
 - .4 a unique background is to be assigned on a per graphic basis;
 - .5 the colour of all animations and values on displays is to indicate the status of the object attribute.
 - .2 operation from graphics: it is to be possible to change values (set-points) and states in the system controlled equipment by using drop-down windows accessible via the pointing device;
 - .3 graphic editing tool: a graphic editing tool is to be provided to permit the creation and editing of graphic files, and the graphic editor is to be capable of performing/defining all animations, defining all runtime binding, and:
 - .1 in general, facilitate the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required;
 - .2 be capable of adding additional content to any graphic by importing backgrounds in the SVG, BMP, or JPG file formats.
 - .4 aliasing: many graphic displays representing part of the building and various building components are exact duplicates, with the exception that the various variables are bound to different field values, consequently, it is to be possible to bind the value of a graphic display to aliases, as opposed to physical field tags.
- .10 Historical Trending and Data Collection: Trend and change of value data is to be stored within the BAS server and uploaded to a dedicated trend database or exported in a selectable data format via

a data export utility. Uploads to a dedicated database are to occur based on one of user-defined interval, manual command, or when the trend buffers are full. Exports are to be as requested by the user or on a time scheduled basis. The system is to be equipped with a configurable data storage sub-system for the collection of historical data which can be stored in either Microsoft Access or SQL database format. The Server is to store, trend, and point history data for all analog and digital inputs and outputs as follows:

- .1 any point, physical or calculated, may be designated for trending, and methods of collection are to be defined time interval or a change of value;
 - .2 the server is to be capable of storing multiple samples for each physical point and software variable based on available memory, including an individual sample time/date stamp, and points may be assigned to multiple history trends with different collection parameters.
- .11 Trend Data Viewing and Analysis: A trend viewing utility with access to all data points and the capability of defining trend study displays to include multiple trends is to be provided, and is to include:
- .1 the capability of retrieving any historical database point for use in displays and reports by specifying the point name and associated trend name;
 - .2 displays which are able to be single or stacked graphs with on-line selectable display characteristics such as ranging, colour, and plot style;
 - .3 display magnitude (zoom capability) and units selectable by the operator at any time without reconfiguration the processing or collection of data;
 - .4 display magnitude is to be automatically scaled to show full graphic resolution of the data being displayed;
 - .5 trend studies are to be capable of calculating and displaying calculated variables including highest value, lowest value, and time based;
 - .6 the display is to support the user's ability to change colours, sample sizes, and types of markers.
- .12 Database Management: The BAS is to be equipped with a database manager that separates the database monitoring and management functions by supporting two separate windows. Database secure access is to be accomplished using standard SQL authentication including the ability to access data for use outside of the BAS application. Additional features are as follows:
- .1 the database management function is to include summarized information on trend, alarm, event, and audit for backup, purge, and restore database management functions;
 - .2 the database manager is to support four tabs as follows:
 - .1 statistics, which is to display database server information and trend, alarm (event), and audit information on the BAS database;
 - .2 maintenance, which is to be an easy method of purging records from the BAS server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data;
 - .3 backup, which is to provide the means to create a database backup file and select a storage location;
 - .4 restore, which is to provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.
 - .3 the status bar is to appear at the bottom of the BAS database manager tabs and is to indicate information on the current display activity with icons as follows:
 - .1 Ready;
 - .2 Purging Record From Database;
 - .3 Action Failed

- .4 Refreshing Statistics;
- .5 Restoring Database;
- .6 Shrinking A Database;
- .7 Backing-Up A Database;
- .8 Resetting Internet Information Services;
- .9 Shutting Down The BAS Deice Manager;
- .10 Action Successful.
- .4 the database manager monitoring functions are to be accessed through the Monitoring Settings window and are to continuously read database information once after the user has logged in;
- .5 the system is to advise the user via task bar icons and email messages when a database value has exceeded a warning or alarm limit;
- .6 the Monitoring Settings window is to have the following sections:
 - .1 General, to allow the user to set and review scan intervals and start times;
 - .2 Email, to allow the user to create and review email and telephone text messages to be delivered when a Warning or Alarm is generated;
 - .3 Warning, to allow the user to define the warning limit parameters, set the Reminder Frequency, and link the email message;
 - .4 Alarm, to allow the user to define the alarm limit parameters, set the Reminder Frequency, and link the email message;
 - .5 Database Login, to protect the system from unauthorized database manipulation by creating a Read Access and Write Access for each of the trend, alarm (event), and audit databases as well as an Expert Mode required to restore a database.
- .7 the Monitoring Settings taskbars to display the following informational icons:
 - .1 Normal, which indicates by colour and size that all databases are within their limits;
 - .2 Warning, which indicates by colour and size that one or more databases have exceeded their warning limit;
 - .3 Alarm, which indicates by colour and size that one or more databases have exceeded their alarm limit.
- .8 the BAS is to indicate via taskbar icons and email messages when a database value has exceeded a warning or alarm limit;
- .13 Demand Limiting and Load Rolling: The BAS is to be equipped with a demand limiting and load rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption. The program is to support both Sliding Window and Fixed Window methods of predicting demand. Additional features are as follows:
 - .1 the system is to support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system, as follows:
 - .1 Low Setting, which sheds loads later and over the shortest period of time and maximizes the period of time the equipment is on;
 - .2 Medium Setting, which sheds loads earlier over a period of time greater than the Low Setting, and increases the time the equipment is on and decreases the probability of exceeding the "Tariff Target";
 - .3 High Setting, which sheds loads earlier and over a longer period of time than the Medium Setting to minimize the probability of exceeding the "Tariff Target".
 - .2 the system is to have both a Shed Mode and a Monitor Only Mode of operation, as follows:

- .1 when the Shed Mode is engaged the system is to actively control the demand;
- .2 when the Monitor Mode is engaged the system is to simulate the shedding action but will not take any action.
- .3 the Demand Limiting Program is to monitor the energy consumption rate and compare it to a user defined "tariff Target", and maintain the consumption below the target by selectively shedding loads based on a user defined strategy;
- .4 the Demand Limiting Program is to be capable of supporting a minimum of ten separate load priorities, with each load user assigned, and a minimum of twelve separate "Tariff Targets" defining the maximum allowed average power usage during the current interval;
- .5 the system is to support a maximum shed time for each load as determined by the user, and the system is to restore the load before the maximum shed time has expired;
- .6 the system is to support a minimum shed time for each load as determined by the user, and the system is not to restore the load before the minimum shed time has expired;
- .7 the system is to support a minimum release time for each load as determined by the user, and the system is not to shed the load until it has been off for the minimum release time;
- .8 the system is to support three user defined options if the meter does not function properly, as follows:
 - .1 shedding – the currently shed loads will be released as their maximum shed time expires;
 - .2 maintain the current shed rate – the system will use the demand limiting shed rate that was present when the meter began to function improperly;
 - .3 use unreliable meter shed rate – the system is to control to a user defined unreliable shed rate target.
- .9 the Load Rolling Program is to sum the loads currently shed and compare the sum to a user defined load rolling target, and the system is to maintain consumption below the target by selectively shedding loads based on a user defined load priority;
- .10 the Load Rolling Program is to be capable of supporting a minimum of ten separate load priorities with each load user defined to a load priority;
- .11 the Load Rolling Program is to be capable of supporting a minimum of twelve separate "Tariff Targets" defining the amount of energy by which the demand must be reduced;
- .12 the system is to equip the user with a Load Tab that displays all the demand limiting and load rolling parameters for any selected load;
- .13 the system is to be complete with a Load Summary that displays all of the loads associated with the demand limiting and load rolling program, and status icons for each load are to indicate:
 - .1 Load Is Offline;
 - .2 Load Is Disabled;
 - .3 Load Is Shed;
 - .4 Load Is Locked;
 - .5 Load Is In Comfort Override.
- .14 the Load Summary is to include a load summary runtime view listing the following load conditions:
 - .1 Load Priority;
 - .2 Shed Strategy;
 - .3 Load Rating;
 - .4 Present Value;

- .5 Ineligible Status;
- .6 Active Timer;
- .7 Time Remaining;
- .8 Last Shed time.

2.05 MANAGEMENT LEVEL PROCESSOR (MLP)

- .1 Management Level Processor (MLP) shall reside at the top of the BAS system hierarchy, exercising control and management over the connected sub-systems.
- .2 A Management Level Processor (MLP) shall be a server connected to a desktop computer for use by management personnel to collect, store, and process data for reports on energy use, operating costs, and alarm activity.
- .3 The Management Level Processor (MLP) shall be capable of accessing points or data in all the lower level Processors and Controllers.
- .4 Many of the functions of the Management Level Processor (MLP) may be combined into a Building Control Unit (BCU).

2.06 BUILDING CONTROL UNIT (BCU)

- .1 Building Control Units (BCUs) are to be UL listed and labelled, BACnet Testing Labs certified and labelled, fully user programmable supervisory controllers to monitor a network of up to a minimum of ninety distributed Field Equipment Controllers (FECs) and Zone Level Controllers (ZLCs) over the BAS Local Area Network (LAN) for a global strategy and direction and to communicate on a peer-to-peer basis with other Building Control Units (BCUs)
- .2 User Interface: Each Building Control Units (BCUs) is to have the ability to deliver a web based user interface as specified above, and all computers connected physically or virtually to the automation network are to have access to the web based user interface. Additional characteristics/requirements are as follows:
 - .1 the web based user interface software is to be imbedded in each BCU;
 - .2 each BCU is to support a minimum of four concurrent users;
 - .3 the user is to be capable of accessing all system data through one BCU;
 - .4 remote users connected to the network through an internet service provider or by telephone dial-up are also to have total system access through one BCU;
 - .5 each BCU is to be capable of generating web based user interface graphics, and this capability is to be imbedded in the BCU;
 - .6 the user interface is to support the following functions using a standard version of Microsoft Internet Explorer:
 - .1 configuration;
 - .2 commissioning;
 - .3 data archiving;
 - .4 monitoring;
 - .5 commanding;
 - .6 system diagnostics.
 - .7 each BCU is to permit temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- .3 Processor: Each Building Control Unit (BCU) is to be a multi-tasking, multi-user, microprocessor based real time digital control processor sized to meet requirements of the system with a minimum word size of 32 bits, and standard operating systems.
- .4 Memory: Each Building Control Unit (BCU) is to have sufficient memory to support its own operating system, databases, and control programs to provide supervisory control for all control level devices.

- .5 Real Time Clock: Each Building Control Unit (BCU) is to include an integrated, hardware based real time clock.
- .6 LED Indicators: Building Control Unit (BCU) is to be equipped with LED indicators to identify the following conditions:
 - .1 Power, On/Off;
 - .2 Ethernet Traffic, Ethernet Traffic/No Ethernet Traffic;
 - .3 Ethernet Connection Speed, 10 Mbps/100 Mbps;
 - .4 FC Bus A, Normal Communications/No Field Communications;
 - .5 FC Bus B, Normal Communications/No Field Communications;
 - .6 Peer Communication, data traffic between Building Control Units (BCUs);
 - .7 Run, BUC Running/BCU in Start-up/BCU Shutting Down/Software Not Running;
 - .8 Battery Fault, Battery Defective/Data Protection Battery Not Installed;
 - .9 24 VAC, 24 VAC Present/Loss of 24 VAC;
 - .10 Fault, General Fault;
 - .11 Modem RX, BCU Modem Receiving Data;
 - .12 Modem TX, BCU Modem Transmitting Data.
- .7 Communications Ports: Each Building Control Unit (BCU) is to be equipped with ports for operation of operator input/output devices such as industry standard computers, modems, and portable operator's terminals. Ports are to be as follows:
 - .1 two USB ports;
 - .2 two URS-232 serial data communication ports;
 - .3 two RS-485 ports;
 - .4 one Ethernet port.
- .8 Diagnostics: Each Building Control Unit (BCU) is to continually perform self-diagnostics, communications diagnostics, and diagnostics of all pane components, and transmit both local and remote annunciation of any detected component failure, low battery condition, and repeated failures to establish communication.
- .9 Power Failure: In the event of loss of normal power each Building Control Unit (BCU) is to continue to operate for a user adjustable period of up to two hours after which there is to be an orderly shut-down of all programs to prevent the loss of database or operating system software, and:
 - .1 during a loss of normal power the control sequences are to go to the normal system shutdown conditions, and all critical configuration data is to be saved into Flash memory;
 - .2 upon restoration of normal power and after a minimum off-time delay the controller is to automatically resume full operation through a normal soft-start sequence without manual intervention.

2.07 FIELD EQUIPMENT CONTROLLER (FEC)

- .1 Field Equipment Controller (FEC) shall be incorporate microprocessor-based controller that control centrally located HVAC equipment such as central air handling units, central chiller plants, and central boiler plants and other similar complex arrangements involving multiple equipment.
- .2 Field Equipment Controllers (FECs) shall communicate with Building Control Units (BCUs) over the BAS Local Area Network (LAN).
- .3 Field Equipment Controllers (FECs) may interface with controlled equipment directly through sensors and actuators, or indirectly through communications links with Zone Level Controllers (ZLC).

- .4 Field Equipment Controllers will incorporate input/output (I/O) device capability, a library of control programs, may control more than one mechanical system from a single controller, and must include a terminal communication port for an Operating Terminal plug-in.
- .5 Each Field Equipment Controller (FEC) is to be a fully user programmable BACnet Testing Labs certified and labelled digital controller that communicates via BACnet MS/TP protocol. Each controller is to be housed in a plenum rated plastic housing with removable base to permit pre-wiring of analog and binary input/output field points without the controller in place.
- .6 Each Field Equipment Controller (FEC) is to employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences, and are to be factory programmed with a continuous adaptive tuning algorithm that sense changes in the physical environment and continually adjusts loop tuning parameters appropriately.
- .7 Each field equipment controller is to:
 - .1 include troubleshooting LED's to identify the following conditions:
 - .1 Power On;
 - .2 Power Off;
 - .3 Download or Start-Up In Progress-Not Ready For Normal Operation;
 - .4 No Faults;
 - .5 Device Fault;
 - .6 Field Controller Bus-Normal Data Transmission;
 - .7 Field Controller Bus-No Data Transmission;
 - .8 Field Controller Bus-No Communication;
 - .9 Sensor Actuator Bus-Normal Data Transmission;
 - .10 Sensor Actuator Bus-No Data Transmission;
 - .11 Sensor Actuator Bus-No Communication.
 - .2 support universal inputs, configured to monitor any of the following:
 - .1 analog input, voltage mode;
 - .2 analog output, current mode;
 - .3 analog input, resistive mode;
 - .4 binary input, dry contact maintained mode;
 - .5 binary input, pulse counter mode.
 - .3 support binary inputs configured to monitor either of the following:
 - .1 dry contact maintained mode;
 - .2 pulse counter mode.
 - .4 support analog outputs configured to output either of the following:
 - .1 analog output, voltage mode;
 - .2 analog output, current mode.
 - .5 support binary outputs, 24 VAC Triac;
 - .6 support configurable outputs capable of the following:
 - .1 analog output, voltage mode;
 - .2 binary output mode.
 - .7 have the ability to reside on a master-slave/token-passing field controller bus supporting BACnet standard protocol as follows:

- .1 support communications, including input/output communications between the field controllers and the network automation engines;
- .2 support a minimum of one hundred input/output modules and field equipment controllers in any combination;
- .3 operate at a maximum distance of 4560 m (15,000') between the field controller and the furthest connected device.
- .8 have the ability to monitor and control a network of sensors and actuators over a master-slave/token-passing sensor-actuator bus supporting BACnet standard protocol as follows:
 - .1 the bus is to support a minimum of ten devices per trunk;
 - .2 the bus is to operate at a maximum distance of 365 m (1200') between the field controller and the furthest connected device.
- .9 the capability of executing complex control sequences involving direct wired input/output points as well as input and output devices communicating over the field controller bus or sensor-actuator bus;
- .10 support, but not limited to, the following:
 - .1 hot water, chilled water/central plant applications;
 - .2 custom air handling units for special applications;
 - .3 terminal units;
 - .4 special programs as required for systems control.
- .11 support a password protected local controller LCD back-lit display with six key keypad as an integral part of the field controller or as a remote device communicating over the sensor-actuator bus to permit the user to view monitored points without logging into the system, and to view and change set-points, modes of operation, and parameters;

2.08 INPUT/OUTPUT MODULES

- .1 Input/output modules to facilitate additional inputs and outputs for use with the Field Equipment Controller (FEC), are to similar to the FEC, but less the display and with a minimum of four and a maximum of seventeen points.
- .2 Input/Output Modules that are integral to a building Smoke Control System shall be listed to UL 864, UUKL category.

2.09 ZONE LEVEL CONTROLLER (ZLC)

- .1 Zone Level Controllers (ZLCs) shall be microprocessor-based controllers that control distributed or terminal equipment including:
 - .1 VAV Boxes;
 - .2 Fan Coil Units;
 - .3 Heat Pumps;
 - .4 Unit Ventilators;
 - .5 Cabinet Unit Heaters;
 - .6 Unit Heaters;
 - .7 Perimeter Heating Elements (Walfin, Radiant Panels, and similar);
 - .8 Other similar terminal devices.
- .2 At the Zone Level Controller (ZLC), sensors and actuators shall interface directly with the controlled equipment. These controllers are expected to have relatively few connected I/O devices, incorporate standard control sequences, and be dedicated to specific types of application control.

- .3 Within the BAS architecture, Zone Level Controllers (ZLCs) shall provide processing of point data for higher level processors such as Field Equipment Controllers (FECs), and Building Control Units (BCUs).

2.10 LOCAL CONTROL PANELS

- .1 NEMA/EEMAC 12 (NEMA/EEMAC 3R in sprinklered areas) wall mounting, enamelled steel barriered enclosures sized to suit the application with 20% spare capacity, a perforated sub-panel, numbered terminal strips for all low and line voltage wiring, hinged door, and slotted flush latch.
- .2 Local Control Panels may be used to house Zone Level Controllers (ZLCs) and other local BAS instrumentation.

2.11 ELECTRIC WIRING, CONDUIT AND JUNCTION BOXES

- .1 Refer to Division 26 for wiring, conduit and junction box requirements.

2.12 SYSTEM CONFIGURATION TOOLS

- .1 System Configuration Tool: The system configuration tool is a software package supplied with the BAS to enable a computer platform to be used as a stand-alone engineering configuration tool for a BCU and to permit programming of FECs and ZLCs. The configuration tool is to provide an archive database for the configuration and application data and is to have the same look and feel at the user interface regardless of whether the configuration is being done online or offline. Additional features and characteristics are as follows:
 - .1 the tool is to include:
 - .1 basic system navigation tree for connected networks;
 - .2 integration of system enabled devices;
 - .3 customized user navigation tress;
 - .4 point naming operator parameter setting;
 - .5 graphic diagram configuration;
 - .6 alarm and event message routing;
 - .7 graphical logic connector tool for custom programming;
 - .8 downloading, uploading, and archiving databases.
 - .2 the tool is to have the capability to automatically discover field devices on connected buses and networks;
 - .3 the tool is to be capable of configuring from a library of standard applications, simulating to verify applications, and commissioning FECs and field devices;
 - .4 the tool is to be complete with a Bluetooth Wireless Technology wireless access point to enable a wireless enabled portable computer to make a temporary Ethernet connection to the automation network.
- .2 Wireless MS/TP Converter: The Bluetooth Wireless Technology converter is to provide temporary wireless connection between field-controller bus and a wireless enabled portable computer. The converter is to be powered through a connection to either field-controller bus and is to support downloading and troubleshooting ECUs and field devices from the portable computer over the wireless connection. The converter is to be complete with LED indicators for the following conditions:
 - .1 Power: On/Off;
 - .2 Fault: Fault/No Fault;
 - .3 SA/FC Bus: Bus Activity/No Bus Activity;
 - .4 Bluetooth: Bluetooth Communication Established/Bluetooth Communication Not Established.

2.13 NAMEPLATES

- .1 All control equipment is to be labelled with new lamacoid plates with a designation corresponding to the specific system point description/label. All lamacoids shall be mechanically fastened (screwed or pop-riveted) to surfaces. Submit samples to Owner for approval.
- .2 All manual switches, unless they come with standard nameplates, are to be labelled. All thermostats, thermometers and switches installed on all local panels shall be similarly labelled. Permanent painted stencil labels may be used on controllers and relays mounted inside local panels, if so desired. Tape labels are not acceptable.
- .3 All duct and pipe mounted sensors, ASC's, and similar devices are to be similarly labelled.
- .4 Provide, on all equipment operated by BAS, red lamacoid tags with white lettering reading: "Warning: This equipment may start at any time. Do not service without disconnecting power."

PART 3 - EXECUTION

3.01 GENERAL

- .1 Examination:
 - .1 Inspect site and thoroughly examine documents to establish locations for control devices and equipment and report discrepancies, conflicts, or omissions for resolution before starting rough-in work.
 - .2 Be responsible for correction of defects caused through neglect of inspections and examinations or failure to report and resolve discrepancies.
- .2 Protection:
 - .1 Protect work and material against damage during construction and be responsible for work and equipment until inspected, tested, and accepted.
 - .2 Protect material not immediately installed and close open ends with temporary covers or plugs during storage and construction to prevent entry of foreign objects.
 - .3 Protect electronic equipment from elements during construction.
- .3 Coordination:
 - .1 Coordinate and schedule control work with other work in same area to ensure orderly progress.
 - .2 Testing and balancing:
 - .1 Supply set of tools for Testing and Balancing Technicians to interface to control system, train these technicians in use of tools and provide qualified Control Technician to assist with testing and balancing first 10 terminal units.
 - .2 Tools to be turned over to Owners on completion and sign-off of testing and balancing.
- .4 Controls work by others:
 - .1 Integrate and coordinate this control work with controls and control devices provided or installed by Others.
 - .2 Each supplier of control product to configure, program, start up, and test that product to satisfy requirements of Sequence of Operation regardless of where within contract documents product is specified or described.
 - .3 Resolve compatibility issues between control products provided by Control Trades and those provided by other Mechanical and Electrical Trades.
- .5 General Workmanship:
 - .1 Installation to be performed by skilled and certified technicians.
 - .2 All equipment shall be located for ease of maintenance and service access.
 - .3 Install equipment, piping, and wiring or raceways horizontally, vertically, and parallel to building lines.

- .4 Provide sufficient slack and flexibility in connections to allow for vibration isolation between conduit, raceways, piping and equipment.
- .5 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- .6 Install instrumentation and devices in locations providing adequate ambient conditions.
- .7 Protect components placed in areas of potentially high humidity.
- .6 Cleaning:
 - .1 Clean up debris, remove packaging material, collect waste and place in designated location, on a daily basis.
 - .2 Keep work areas free from dust, dirt, and debris.
 - .3 On completion of work, check finish of equipment provided under this section for damage and repair damaged factory-finished paint, replace deformed cabinets and enclosures with new material, and repaint to match original.
- .7 Field Quality Control:
 - .1 Ensure work, materials, and equipment comply with this specification and approved shop drawings.
 - .2 Monitor field installation for code compliance and workmanship quality.
 - .3 Arrange and pay for inspections required by Authorities Having Jurisdiction (AHJs).

3.02 EQUIPMENT LOCATION

- .1 Distributed Equipment:
 - .1 All distributed equipment such as VAV boxes, Rooftop units, unit ventilators, fan coil units, and similar terminal equipment that utilize dedicated BAS controllers, shall have locally mounted controllers in accessible locations within the building envelope.
 - .2 All locally mounted controllers shall be installed in enclosures suitable for that location. BAS controllers for mechanical equipment other than those listed above shall be mounted in mechanical rooms as noted below, unless specifically approved by the Consultant.
 - .3 All other BAS controllers, and interface devices that require regular inspection or that serve multiple HVAC systems shall be located in mechanical rooms, or in pre-approved storage rooms, or janitor closets.
 - .4 No BAS panel shall be located inside the rooftop fan enclosure under any circumstances. All BAS panels shall be located within the building envelope, and shall be enclosed in a metal locking enclosure.
- .2 All equipment located in mechanical rooms, storage rooms or janitor closets shall be installed in metal cabinets with hinged, lockable covers.
- .3 Transformers or power supplies for terminal control valves, actuators or zone controllers shall not be located in ceiling spaces unless approved by the Consultant. When transformers are installed above ceilings, transformers shall be installed in metal enclosures, and the location shall be clearly labeled on the ceiling to indicate power transformer location.
- .4 A 120 VAC duplex receptacle for laptop power shall be provided if the cabinet is located further than 5'-0" (1500mm) laterally from the nearest outlet.

3.03 ELECTRIC WIRING, CONDUIT AND JUNCTION BOXES

- .1 All wiring line and low voltage shall be installed in EMT conduit unless specifically specified otherwise.
- .2 All wiring shall be in accordance with the Ontario Electrical Code and any applicable local codes. All BAS wiring shall be installed in conduit unless otherwise allowed by the Ontario Electrical Code or applicable local codes. Where BAS plenum-rated cable wiring is allowed, it shall be run parallel to, or at right angles to, the structure, properly supported and installed in a neat and workmanlike

- manner. BAS wiring that runs in exposed ceiling spaces (eg garages, mechanical rooms) shall be installed in conduit.
- .3 In accessible ceilings, wiring from BAS controllers to sensors and actuators, control system network and low voltage wiring only may be installed with yellow jacket LVT cable. Where the ceiling is used as a return air plenum install plenum rated yellow jacket cable instead of LVT.
 - .4 BX or flex conduit may only be used for the final (approximately one meter) run to controls devices, where the controls equipment is mounted on vibrating machinery.
 - .5 Install EMT and cable at right angles to building lines, securely fastened, and in accordance with the standards set out in Division 26.
 - .6 No wire smaller than 18 gauge is to be used on the project except for: wiring between terminal computer devices, wire in standard communication cables, such as printers and short haul modems, wire used in communication networks, i.e. any cable transferring digital data, using twisted shielded pairs.
 - .7 All field wiring including sensor wiring and wiring from panels to devices shall be continuous. The use of wire connectors, wire nuts or splicing is not allowed.
 - .8 Provide wells for all specified temperature sensors in hydronic piping system. Strap-on sensors may be only be used where a well installation is not possible. Obtain approval of Engineer for the use of strap-on sensors.
 - .9 Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently be switched off.
 - .10 Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line side breakers/fuses for all transformers.
 - .11 All 120 VAC power for any controls equipment shall be from dedicated circuits. Provide a breaker lock for each breaker used to supply the control system. Update the panel circuit directory.
 - .12 The controller may be powered from the equipment that it is directly controlling (i.e. heat pump, roof-top unit) only if the controller controls no other equipment and the power supply to the controller remains energized independently of unit operation or status.
 - .13 All BAS control wiring shall be yellow jacket for identification purpose.
 - .14 The breaker or power isolation location shall be clearly marked on the inside door of each BAS panel enclosure.
 - .15 Wiring in ceiling spaces to be installed clear of ceiling tiles and lights to allow access and removal of tiles and lights.
 - .16 Contractor shall prepare a wiring mock-up of a typical system/device/main panel to demonstrate quality and workmanship for approval by the Region. This approved mock- up quality shall be maintained throughout the entire installation. System requiring mock- up to be discussed with the Region's Project Manager.
 - .17 All wiring shall be routed orthogonally and drops shall have additional wiring coiled in ceilings to facilitate future sensor relocation.
 - .18 Wiring in ceiling spaces to be secured/tied every 48" minimum.
 - .19 Surge suppression shall comply, as a minimum, with the manufacturer's requirements.
 - .20 All equipment including controllers shall be grounded.
 - .21 All end-of-wire connectors shall be certified.
 - .22 All components shall be labelled and detailed in manuals.
 - .23 All wiring systems shall be colour coded to simplify maintenance.
 - .24 The 120VAC power wiring to each Management Level Panel (MLP), Building Control Unit (BCU), and Field Equipment Controller (FEC) shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.

- .25 Wiring is to be kept a minimum of six (6) inches from hot water, steam, or condensate piping. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.

3.04 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

- .1 All panels must have a lamacoid tag (min. 3"x1") affixed to the front face indicating panel designation and function (i.e. "BAS Panel 1" or "Relay Panel 3").
- .2 All field sensors or devices must have a lamacoid tag (min. 3"x1") attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. AHU1_MAT, 2.IP4).
- .3 Room sensors and other sensors in finished areas will require a device tag.
- .4 All devices within a field enclosure will be identified via a label or tag.
- .5 All BAS panel power sources must be identified by an adhesive label indicating the source power panel designation and circuit number on the outside of the enclosure door (i.e. "120vac fed from LP-2A cct #1).
- .6 All field equipment panels fed from more than one power source must have a warning label on the front cover.
- .7 All wires will be identified with self-adhesive wire labels or clip-on plastic wire markers at both ends.
- .8 All rotating equipment controlled by the BAS will have a tag or label affixed indicating that the equipment may start without warning.
- .9 All BAS panels will have a points list sheet (within a plastic sleeve) attached to the inside door. The points list will identify the following for each point: Panel number, panel location, hardware address, software name, point description, field device type, point type (i.e. AI or DO), device fail position, device manufacturer and model number or reference and wire tag reference.
- .10 Where required, field panels will have wiring diagrams attached to the inside door.
- .11 Provide new or modify existing equipment wiring diagrams (i.e. boilers, chillers, etc.) wherever the BAS interfaces to other equipment.

3.05 CONTROL SYSTEMS

- .1 Install the entire Control system under supervision of factory trained engineers and technicians fully capable of providing instruction, routine maintenance, programming and emergency maintenance service on all system components.
- .2 During the Operator Training period and at no extra cost, make any required program changes to enable optimum system operation as directed by the Consultant.
- .3 Provide "status" confirmation by using auxiliary starter contacts load side activated relays or current transformer switches rated for design load operation for pumps. Use load side activated relays or auxiliary relay contacts for single phase motors. Use pressure differential switches for fans.
- .4 For stop/start operation wire only to starter "Auto" circuit. Failure to stop and start to register as an alarm.
- .5 In the event of a control system failure from any cause, provide for normally "ON" sequence for equipment such as boilers, boiler pumps, heating pumps and coil circulation pumps and normally open to heating for scheduling valves and other 3-port valves to prevent coil and equipment freeze-up.
- .6 Provide a minimum of two spare input and two spare output points on each controller.
- .7 Where motor operation is specified to provide enable/disable, permissive or sequential operation, use programming software wherever possible or provide hard wire interlocks.

3.06 BAS DATABASE NAMING CONVENTIONS & PROGRAMS

- .1 All BAS programs shall be created in each panel in logical order as determined by the equipment being controlled by each panel on the network.

- .2 All programs and program code is to follow proper coding practices including internal comments to describe the function of the statements and also ensure the source code is formatted in a consistent and logical manner. Programming coding should be kept as simple as possible.
- .3 System Schedules shall be submitted for Owner's approval and will include global and local scheduling.
- .4 The Outdoor Air Temperature Program shall be in its own program named OAT PG.
- .5 Network Status Panel Naming Conventions should indicate the building, panel location and panel number. The building name can be abbreviated as necessary to fit in the space.

3.07 CONTROL PROGRAMMING

- .1 General:
 - .1 The control programs shall be modular and structured in order to provide specific control operation of HVAC components.
 - .2 All control programs shall provide a minimum of 20% spare memory for expansion.
 - .3 Each control program shall contain "REM" statements which explain this program operation.
 - .4 Each control program shall open with a list of the I/O points used and controlled in the program.
- .2 Sensors and Devices - are listed in this specification. Provide 5% spare I/O capacity.
- .3 Implement all control program concepts in full, or partial as required, to provide complete HVAC equipment control. The programs shall perform all control strategies on the basis of protecting equipment operation, saving operational energy costs, and indicating alarm conditions.
- .4 Programs which increase the system energy consumption or cause equipment failures will be refused and resolved by the contractor at no additional cost to the Owner.

3.08 CONTROL SYSTEM GRAPHICS

- .1 BAS graphics shall incorporate, as a minimum, the following information for each system type as noted:
 - .1 Architecture Panel Layout (Locations on Floor Plans)
 - .1 Locations of each panel on each floor plan level
 - .2 Panel types indicated by different icon
 - .3 Controls transformers locations
 - .4 Main network wiring and sub-network wiring layout
 - .2 Floor Plans graphics
 - .1 Room numbers accurate as per room signage
 - .2 Mechanical rooms locations & signage tags
 - .3 Space temperatures for every temperature on each floor in appropriate room
 - .4 Space focus pick area for individual room control where applicable shall be yellow text
 - .5 Air Handler symbols indicating areas of the floor plan serviced by each air handler by a corresponding colour
 - .6 Status of Air Handler by colour change Red for off status, or text indication
 - .7 Supply air temperature for each air handler
 - .3 Air Handler (AHU) graphic
 - .1 Accurate representation of the AHU design
 - .2 All associated control points to be displayed

- .3 All points to be monitored for automatic mode and shall be displayed when in Manual mode
- .4 A calculated percentage of fresh air shall be indicated on the AHU graphic
- .5 Operator offset adjustment of the supply air setpoint, adjustable directly from the graphic
- .6 AHU physical location shall be indicated on the graphic
- .7 Weekly occupied time of day schedule for the associated AHU shall be accessible directly from the graphic by selecting an icon
- .8 Weekly student time of day schedule for the associated AHU shall be accessible directly from the graphic by selecting an icon
- .9 Trend logs shall be accessible directly from the graphic by selecting an icon
- .4 Boiler graphic
 - .1 Boiler graphic piping layout shall be accurate as per piping layout
 - .2 All associated control points for the boiler system to be displayed
 - .3 Operator offset adjustment of the scheduled water setpoint, adjustable directly from the graphic
 - .4 Lead boiler and boiler stages shall be indicated
 - .5 Lead pump shall be indicated
 - .6 Boiler status shall be indicated graphically
 - .7 Pump status shall be indicated graphically
 - .8 Calculated scheduled water setpoints to be displayed
 - .9 Operator offset editable directly from the graphic screen
 - .10 Weekly time of day schedule for the building occupied schedule shall be accessible directly from the graphic by selecting an icon
 - .11 Trend logs shall be accessible directly from the graphic by selecting an icon
- .5 Exhaust fans graphic
 - .1 Exhaust fans control shall be editable directly from the graphic
 - .2 Exhaust fan status shall be indicated in text and a change in the exhaust fan icon
 - .3 Exhaust fan physical location shall be indicated on the graphic
 - .4 Area of the building being exhausted shall be indicated on the graphic

3.09 BAS TESTING, COMMISSIONING AND ACCEPTANCE

- .1 Comply with requirements of Article entitled "BAS Testing, Commissioning and Acceptance" in Section 25 05 10 BAS General Requirements.
- .2 Ensure the Work has met requirements outlined in the Article entitled 'Completion' found in Section 20 01 10.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.
- .2 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .3 Comply with requirements of Section 20 10 50 Basic Materials and Methods.
- .4 Comply with the requirements of Section 20 05 70 Motors, Motor Starters and Wiring
- .5 Comply with the requirements of Section 20 05 75 Variable Frequency Drives.
- .6 Comply with the requirements of Section 25 05 10 BAS General Requirements.
- .7 Comply with the requirements of Section 25 10 10 BAS Control Network.
- .8 Comply with the requirements of Section 25 56 26 Integrated Lighting System Controls

1.02 SCOPE OF WORK

- .1 Provide all controls, instrumentation and wiring as specified and as may be required for the control of building systems as intended by the design.
- .2 System shall be designed to provide robust activation and control of mechanical systems and equipment to maintain equipment operating sequences, schedules and setpoints.
- .3 Provide all detailed design, labour, materials, products and Instrumentation necessary for Building Automation System (BAS) to function as intended by the Sequence of Operations indicated in the Documents.
- .4 Ensure that the equipment and system operation is fully coordinated within the construction documents, verify quantities and types of dampers, operators, alarms, and other control devices to be provided. Any discrepancies between contract documents, the greater quantity and better quality shall take precedence.
- .5 Electromagnetic starters with required number of ancillary contactors will be provided by Mechanical Trades unless supplied as an integral part of equipment. Where integral starters are supplied with equipment provide all additional wiring and ancillary devices to achieve specified control sequences.
- .6 Provide Owner's Training on the operation of the BAS.
- .7 Provide BAS As-built documentation, and Operating and Maintenance (O&M) manuals and instructions.
- .8 Arrange for all the necessary inspections and approvals of built-up and modified control systems and relay panels by the Authorities Having Jurisdiction ("AHJ's"). All electrical equipment, material and its installation shall conform to the current requirements of the AHJ's including:
 - .1 Ontario Electrical Safety Code ("OESC")
 - .2 Ontario Building Code ("OBC")
 - .3 Ontario Fire Code ("OFC")
 - .4 Canadian Standards Association ("CSA")
- .9 Generally control systems, algorithms and sequence programming shall follow requirements outline is ASHRAE Guideline 35 - High-Performance Sequences of Operation for HVAC Systems. Any proposed deviations from the Standard shall be reviewed with the Consultant prior to implementation on site.

1.03 SUBMITTALS

- .1 Submit shop drawings for all instrumentation and devices provided.
- .2 Submit shop drawing of schematics with operational descriptions for all control system sequences provided.

- .3 Automatic Control Valve shop drawings shall clearly show the following for each valve:
 - .1 Associated system.
 - .2 Manufacturer and model number with the indication of the medium
 - .3 Valve size and line size.
 - .4 Flow-rate, flow coefficient (Cv) and pressure drop at design conditions, and pressure drop across the associated mechanical equipment, (i.e. coil, heat exchanger, or similar heat transfer device) at design conditions.
 - .5 Valve configuration (e.g. two-way, three-way, butterfly).
 - .6 Leakage rate.
 - .7 Maximum pressure shut-off capability.
 - .8 Actuator manufacturer and model number.
 - .9 Valve body pressure and temperature rating,
 - .10 Normally Open or Normally Closed (failure) positions.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- .1 A general guideline requires all new devices to be provided as specified. Sensors must provide responses that deliver accurate, reliable control of mechanical equipment.
- .2 Sensors and control devices are to be industry standard products that can be purchased by the Owner from the manufacturer.
- .3 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.
- .4 NEMA 1 (NEMA 3R in sprinklered areas) sheet metal cubicles with vertically hinged lockable doors, panel(s) mounted outdoors shall meet NEMA 4 rating.
- .5 sensors, transducers, BAS controllers, and relays mounted on backing board and/or DIN rails within inner section,
- .6 enclosures to house controllers, power supplies for sensors and associated transformers, control relays, contractors, safety circuits wiring, conduits and other auxiliary equipment; enclosure shall be sized for twenty percent spare mounting space.
- .7 engraved lamaroid labels with white lettering indicating function of each sensor, transducer, controller, gauge and instrument.
- .8 wiring terminations shall be labelled
- .9 EMT conduit openings and adapters in sufficient quantities and sizes to accommodate wiring terminating within enclosure
- .10 wiring within enclosure installed in neat and protected manner, enclosed in wireways or plastic conduit.
- .11 inside each panel, one set of as built, plasticized control Shop Drawings for equipment served by that panel permanently affixed to cabinet frame.

2.02 TEMPERATURE SENSORS

- .1 General Requirements:
 - .1 Acceptable temperature sensing technologies:
 - .1 Resistance Temperature Device (RTD) of precision platinum element with:
 - .1 linear characteristics over sensor range,
 - .2 1000 Ω Platinum, IEC 751, 385 Alpha, thin film sensor,
 - .3 temperature coefficient of resistance $0.00385\Omega/\Omega/^{\circ}\text{C}$,

- .4 +/-0.3°C (+/-0.54°F) @ 0°C (32°F) sensor accuracy,
- .5 transducing circuit for 0-10,000 Ω linear output in 0.5°C (0.9°F) increments at 16-26°C (60-80°F) temperature range compatible with equipment controller
- .2 Resistance Temperature Device (RTD) of precision thin film nickel element with:
 - .1 linear characteristics over sensor range,
 - .2 1000 Ω Nickel, Class B, DIN 43760 sensor
 - .3 temperature coefficient of resistance 0.006178Ω/Ω/°C,
 - .4 +/-0.4°C (+/-0.72°F) @ 0°C (32°F) sensor accuracy,
 - .5 transducing circuit for 0-10,000 Ω linear output in 0.5°C (0.9°F) increments at 16-26°C (60-80°F) temperature range compatible with equipment controller
- .3 Thermistor element type with:
 - .1 non-linear, curve matched over sensor range,
 - .2 10,000 Ω at 25°C (77°F), NTC Type III, +/-0.2°C (+/-0.36°F) sensor
 - .3 +/-0.2°C (+/-0.36°F) sensor accuracy over 0°C to 70°C (32°F to 158°F),
 - .4 long term stability of 0.025°C (0.045°F) drift per year
 - .5 transducing circuit for 0-10,000 Ω linear output in 0.5°C (0.9°F) increments at 16-26°C (60-80°F) temperature range compatible with equipment controller
- .2 Provide temperature sensors, with accuracy as noted, in the following applications:
 - .1 chilled water, chilled glycol solution, outdoor air temperature: +/-0.2°C (+/-0.45°F);
 - .2 heating water, heating glycol solution, condenser water, duct dry-bulb temperature points: +/-0.3°C (+/-0.9°F);
 - .3 room dry-bulb temperature: +/-0.4°C (+/-1.35°F);
 - .4 algorithm(s) for measuring dewpoint temperature, wet-bulb temperature, and enthalpy: +/-0.2°C (+/-0.45°F);
 - .5 algorithm(s) used as part of metering applications: +/-0.2°C (+/-0.45°F);
- .3 Each temperature sensor shall be as follows:
 - .1 Complete with a custom label that references the model, manufacturer, specifications, and BAS point I.D.
 - .2 Complete with two (2) integral anchored lead wires
 - .3 Complete with a waterproof sensor to sheath seal
 - .4 strain minimizing construction
 - .5 Capable of being secured to standard junction box termination with cover
 - .6 Complete with pig-tail wire leads with wire nuts or screwed terminal connector block
 - .7 Factory calibrated and capable of end to end (sensing element to BAS), accuracy noted above, over full operating range of measured variable.
 - .8 Complete with a serial communications port for portable PC or hand held commissioning equipment.
- .2 Adjustable room/ space dry-bulb temperature sensors with display, Type 1:
 - .1 For measurement and adjustment of space dry-bulb temperatures in rooms at designated location and where ever called for on the Drawings or Sequences of Operation.
 - .2 Field configure for either °C or °F display;

- .3 sensor ambient operating temperature range from 0 to 50°C (32 to 122°F), 5 to 95 %RH non-condensing,
- .4 three digit LED digital temperature display with 0.5° display resolution
- .5 Up / Down keypad for ten (10) step temperature setpoint adjustment between 20°C to 25°C (68°F to 78°F);
- .6 Dry contact occupancy override feature;
- .7 minimum / maximum limit set point values adjustable from BAS operator interface and Controller
- .8 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors; guard secured to mounting plate by screws.
- .9 When used with multi-speed terminal device such as a fan coil unit or cabinet heater, provide five (5) position fan speed switch - Off, Auto, Low, Medium, High – using resistive signal reference 0, 2, 4, 6, 8 KΩ respectively.
- .3 Room/ space dry-bulb temperature sensors (no adjustment, no display), Type 2:
 - .1 for measurement of space dry-bulb temperatures throughout facility
 - .2 sensor ambient operating temperature range from 0 to 70°C (32 to 158°F), non-condensing 5 to 95% RH
 - .3 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors.
 - .4 guard secured to mounting plate by screws.
- .4 Secure area room/ space dry-bulb temperature sensors (no adjustment, no display), Type 3:
 - .1 for measurement of space dry-bulb temperatures at locations subject to vandalism, including spaces designated for Mental Health care, and where ever called for on the Drawings or Sequences of Operation.
 - .2 sensor ambient operating temperature range from -20 to 60°C (-4 to 140°F), non-condensing 5 to 95% RH
 - .3 stainless steel flat plate surface type with sensor epoxy-bonded to back of cover plate.
 - .4 tamperproof / secure concealed fasteners.
- .5 Concealed (Button) type room/ space dry-bulb temperature sensors (no adjustment, no display), Type 4:
 - .1 for measurement of space dry-bulb temperatures at locations where sensor is intended to be inconspicuous and where ever called for on the Drawings or Sequences of Operation.
 - .2 sensor ambient operating temperature range from -40 to 60°C (-40 to 140°F), non-condensing 5 to 95% RH
 - .3 White plastic button, paintable, for interior use only, IP30 (NEMA 1)
- .6 Duct mount probe type dry-bulb temperature sensors:
 - .1 for measurement of a single point dry-bulb temperature within a ducts of cross section less than 0.4 sq.m (4 sq.ft.), including toilet exhaust branch ducts and/or return ductwork serving areas subject to excessive vandalism such as prisoner holding cells and where ever called for on the Drawings or Sequences of Operation.
 - .2 sensor ambient operating temperature range from -40°C to 60°C (-40°F to 140°F), non-condensing 5 to 95% RH
 - .3 6.35mm (0.25") diameter, 304 series stainless steel probe
 - .4 metal mounting plate
 - .5 provide multiple sensors where single element cannot be located to provide proper duct or plenum temperature sampling.

- .7 Duct mounted probe type dry-bulb temperature sensors:
 - .1 for measurement of a single point dry-bulb temperature within a ducts of **cross section larger than 0.4 sq.m (4 sq ft)**, including toilet exhaust branch ducts and/or return ductwork serving areas subject to excessive vandalism such as prisoner holding cells and where ever called for on the Drawings or Sequences of Operation;
 - .2 insertion elements for single point temperature measurement inside duct;
 - .3 6 mm (0.236") diameter, 304 series stainless steel probe;
 - .4 -40 to 50°C (-40 to 122°F), 5 to 95% RH non-condensing;
 - .5 Standard lengths: 50 mm (2"), 100 mm (4"), 150 mm (6"), 200 mm (8"), 300 mm (12"), and 450 mm (18");
- .8 Duct averaging element type dry-bulb temperature sensors:
 - .1 for measurement of average dry-bulb temperature in ducts of **cross section greater than 0.4 sq.m (4 sq ft)**.
 - .2 sensor ambient operating temperature range from -40°C to 60°C (-40°F to 140°F), non-condensing 5 to 95% RH
 - .3 flexible multi-point duct averaging temperature sensor utilizes several precision sensors spaced at equal distances along probe length;
 - .4 7.94mm (0.315") diameter probe, soft copper construction;
 - .5 probe minimum length of 4m (13 ft.);
 - .6 probe field formable to minimum radius of 100 mm (4 in) at any point along probe length (within 200 mm (8 in) of connector box excepted), without degradation of performance;
 - .7 provided as multiple sensors where single averaging element cannot be located to provide proper duct or plenum temperature sampling.
- .9 Outside air dry-bulb temperature sensors:
 - .1 aluminum probe for measurement of a single point dry-bulb outdoor air temperature
 - .2 insertion type for through-the-wall installation with a 0.85" diameter hole for conduit connection or cable gland fitting;
 - .3 waterproof seal at wall;
 - .4 complete with non-corroding polycarbonate enclosure with a hinged and gasketed cover minimizing solar heating effect;
 - .5 sensor ambient operating temperature range from -40°C to 60°C (-40°F to 140°F), non-condensing 5 to 95% RH;
- .10 Temperature limit switches:
 - .1 minimum 4.5 m (15') sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest or warmest 450 mm (18") section of element;
 - .2 where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required;
 - .3 complete with manual reset type SPDT snap acting contacts rated for 16 amperes at 120 VAC
 - .4 Acceptable manufacturers:
 - .1 Johnson Controls Inc. Model A70,
 - .2 or approved equal.
- .11 Thermowell immersion temperature sensors:
 - .1 insertion elements for single point temperature measurement of fluid

- .2 6 mm (0.236") diameter, 304 series stainless steel probe
- .3 -40 to 50°C (-40 to 122°F), 5 to 95 %RH non-condensing
- .4 316 stainless steel thermowells, complete with thermal conductive compound added inside the thermowell for optimum thermal transfer.
- .5 Probe and thermowell length minimum 30% of pipe size;
- .6 Spring loaded construction with compression fitting for 20mm (NPS ¾") well mounting
- .12 Standalone Temperature Sensors:
 - .1 Standalone temperature sensors are not considered a component of the BAS but are required to be provided by the BAS Trades in accordance with the following.
 - .2 Standalone Low-voltage Thermostat:
 - .1 Low-voltage thermostats shall be single or multi-stage heating and/or type as required by application.
 - .2 Include modulating heating or cooling stage where used in conjunction with control valves; step controllers; SCR's; or similar equipment requiring modulation, and switches where ON - OFF - AUTO control is required.
 - .3 Combination heating/cooling thermostats shall have independent adjustments for heating and cooling set points and shall not allow set point crossover.
 - .4 Provide individual heat or cooling anticipator for each control stage. Anticipator shall be matched to connected load, or shall be adjustable.
 - .5 Suitable switch sub-bases shall be provided when required by application, with switch functions clearly identified by permanent labels. Field-applied "stick-on" labels are not acceptable.
 - .6 Microprocessor-based programmable type thermostats, when used, shall not lose time or program upon power failures of twelve (12) hours or less and must have password protection capability.
 - .7 All space thermostats in non-common areas shall have exposed temperature setpoint adjustment. The temperature setpoint is limited to between 18° C and 23°C.
 - .8 Insulated mounting bases shall be installed when thermostats are located on exterior walls and at locations noted in the Documents.
 - .3 Electric Line Voltage Thermostat:
 - .1 Provide heating/cooling type thermostat with dead-band where sequencing of heating and cooling/ventilation is required.
 - .2 Line-voltage thermostats shall be ULC or cUL-listed, SPDT, with contact rating suitable for application, maximum 1.5°C differential.
 - .3 Provide heavy duty type. Include back plate and bracket for mounting on standard size outlet box where required.
 - .4 Provide isolation switch for line thermostat power source and label at thermostat.

2.03 HUMIDITY SENSORS

- .1 Each humidity sensor general requirements shall be as follows:
 - .1 Thermoset polymer-based capacitive sensors technology directly detecting changes in sensor capacitance according to changes in ambient relative saturation (relative humidity),
 - .2 suitable for operating range of 0 to 100%RH,
 - .3 sensor operating temperature range from -40 to 60°C (-40 to 140°F)
 - .4 accuracy of +/-2% RH over 5 to 95%RH,

- .5 long term stability <0.25% RH drift per year,
- .6 +/-0.8 %RH @ 25°C (77°F) hysteresis,
- .7 field selectable 0-100% linear proportional output signal indicating relative humidity 4-20mA, 0-5Vdc or - 0-10Vdc,
- .8 complete with a custom label that references the model, manufacturer, specifications, and BAS point I.D.
- .9 strain minimizing construction
- .10 capable of being secured to standard junction box termination with cover,
- .11 complete with pig-tail wire leads with wire nuts or screwed terminal connector block,
- .12 factory calibrated and capable of end to end (sensing element to BAS), accuracy noted above, over full operating range of measured variable.
- .13 complete with a serial communications port for portable PC or hand held commissioning equipment.
- .2 Room/ space humidity sensors general requirements per above with:
 - .1 analogue LCD humidity display,
 - .2 surface mounted plastic guard with surface mounting plate and wall anchors
 - .3 guard secured to mounting plate by screws,
 - .4 an occupancy override button.
- .3 Duct mount probe type humidity sensors general requirements per above with:
 - .1 metal mounting plate, hinged and gasketed plastic guard, and thread adapter and cable gland fitting,
 - .2 field replaceable 230 mm (9") long by 12.7 mm (0.5") diameter 304 stainless steel probe,
 - .3 60 micron HDPE filter,
- .4 Outdoor air type humidity sensors general requirements per above with:
 - .1 weatherproof enclosure with cover with hinged and gasketed cover, and cable gland fitting,
 - .2 waterproof seal.

2.04 COMBINATION TEMPERATURE AND HUMIDITY SENSORS

- .1 Where both temperature and humidity are shown to be measured at the same location or in the same airstream, use of single measuring unit is permitted provided that features and performance of both temperature sensor and humidity sensor are in accordance with requirements of this Specification, and as follows:
 - .1 Provide LCD display and occupancy override for Room/space combination temperature and humidity sensors.
- .2 Provide a combination dry-bulb temperature sensor (thermistor type sensor) and humidity sensor, complete with appropriate algorithm, where the operating sequence requires one, or more, of the following measured variables:
 - .1 Dewpoint temperature,
 - .2 Wet-bulb temperature,
 - .3 Enthalpy,
 - .4 Humidity Ratio,
 - .5 Air specific volume, (cu.ft/lb) or (cu.m/kg).

2.05 PRESSURE SENSORS (AIR SIDE)

- .1 General

- .1 Pressure sensors monitoring fan operation to have set point adjustable from 0 to 3600 Pa (0 to 10 in wg.) and adjustable differential between 10 to 300 Pa (0.03 to 1 in wg).
- .2 Static Pressure and Differential Pressure Sensors (Air Service):
 - .1 Applications include:
 - .1 Duct static pressure measurement
 - .2 Space differential pressure measurement
 - .3 Filter bank differential pressure measurement
 - .2 diaphragm driven, capacitance change type, 0-100% linear proportional output signal indicating input static pressure or differential pressure at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc
 - .3 field adjustable zero and span
 - .4 selected with span of not greater than twice maximum static pressure and not less than twice differential pressure at shut-off.
 - .5 minimum over pressure input protection of five (5) times rated input.
 - .6 accuracy, including non-linearity, hysteresis and non-repeatability; $\pm 1\%$ full scale
 - .7 operating temperature range; -18°C to 80°C (0°F to 175°F)
 - .8 operating humidity range; 10 to 90% non-condensing
 - .9 high and low pressure ports, brass hose barbed pressure fittings suitable for 8 mm ($\frac{1}{4}$ ") tubing
 - .10 mounting bracket, suitable for duct mounting
 - .11 exterior static pressure references shall be monitored via a static pressure sensor complete with surge dampener device capable of absorbing rapid pressure fluctuations to provide steady pressure outputs equal to Dwyer Model SD-01.
 - .12 dust proof enclosure, and
 - .13 screw terminal connector block.
- .3 Differential Pressure Switch (Air Service):
 - .1 Applications include:
 - .1 Air flow proving
 - .2 Duct Static Pressure - High Limit
 - .3 Filter Bank Pressure - High Limit
 - .2 UL, cUL, CSA listed and approved.
 - .3 SPDT switches rated for 10 amps minimum at 120 VAC for use as digital input to BAS
 - .4 Adjustable setpoint with a setpoint range to suit the application.
 - .5 $\frac{1}{4}$ " compression fittings suitable for copper sensing tubing.
 - .6 Temperature range of -18°C to 71°C (0°F to 160°F).
 - .7 operating humidity; 10 to 90% RH non-condensing.
 - .8 automatically reset when condition returns to normal.
 - .9 high and low pressure ports, brass hose barbed pressure fittings suitable for 8 mm ($\frac{1}{4}$ in) tubing with signal dampening facilities to prevent nuisance tripping where required.
 - .10 mounting bracket suitable for duct mounting,
 - .11 dust proof enclosure,
 - .12 screw terminal block,

- .13 Acceptable manufacturers:
 - .1 Kele Model AFS-460,
 - .2 Johnson Controls Inc.
 - .3 Cleveland Controls Inc. (Model AFS-222),
 - .4 Dwyer,
 - .5 or approved equal.
- .4 Differential Pressure Transmitters for Terminal Units:
 - .1 suitable for use in air with pressure independent terminal units (constant volume, variable volume, fan powered boxes and similar)
 - .2 capacitive sensor technology
 - .3 pressure range 0 Pa to 373 Pa (0 to 15 in.w.g.)
 - .4 linear output proportional to velocity pressure of unit inlet air stream, and suitable as analogue input to terminal unit controller
 - .5 accuracy including non-linearity, hysteresis, and non-repeatability; +/-1% full scale
 - .6 operating temperature range; 0°C to 50°C (32°F to 122°F)
 - .7 operating humidity range; 10 to 90% non-condensing
 - .8 high and low pressure ports, barbed pressure fittings suitable for 1/4" (6mm) tubing for connection to air flow pick up device provided with terminal box
 - .9 mounting kit, suitable for installation within terminal unit controller enclosure
 - .10 screw terminal connector block.

2.06 PRESSURE SENSORS (HYDRONIC SIDE):

- .1 General requirements:
 - .1 Pressure transmitters shall be suitable for pressure rating, temperature rating and hydronic medium being measured, and are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - .2 Pressure transmitters are to be complete with transducer to transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - .3 Differential pressure transmitters used for liquid flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the high and low sensing pick-up lines to allow permanent ease of use connection for system testing, balancing, and commissioning.
 - .4 Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 3R in sprinklered area) enclosure for indoor installations by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Provide NEMA 4 vapour tight enclosure for outdoor installations.
- .2 Single Point Pressure Sensor (Liquid Service):
 - .1 Applications include:
 - .1 Water;
 - .2 Propylene glycol solution;
 - .3 Ethylene glycol solution;
 - .2 Input range of 0 to 200 psi
 - .3 Complete with transducer with 4-20 mA output signal proportional to liquid pressure

- .4 0.5% accuracy over entire sensing range
- .5 Temperature range: -40°C to 100°C (-40°F to 212°F)
- .6 Operating humidity range: 10 to 90% non-condensing
- .7 Stainless Steel wetted parts suitable for continuous contact with the sensed medium.
- .8 Transducer with easily accessible, integral non-interacting zero and span adjustment
- .9 Over pressure input protection of two (2) times rated input
- .10 Burst pressure of five (5) times rated input
- .11 Long-term stability of 0.25% of full scale
- .12 NEMA 4 rated fittings
- .13 ANSI 300 rated
- .14 suitable for direct mounting to pressure port
- .15 dust proof enclosure, and
- .16 screw terminal connector block.
- .17 Acceptable Manufacturers:
 - .1 Dwyer
 - .2 Precise Sensor,
 - .3 Fisher/Rosemount,
 - .4 or approved equal.
- .3 Differential Pressure Sensor (Liquid Service):
 - .1 Complete with transducer with output of 4-20 mA proportional to the pressure sensed.
 - .2 Over pressure protection of five (5) times the rated input.
 - .3 Easily accessible, integral non-interacting zero and span adjustment.
 - .4 Operating range to suit application.
 - .5 Accuracy of +/- 2% of full scale reading.
 - .6 Valve taps shall be installed by the Mechanical Trades.
 - .7 Basis of design, Setra, or Greystone.
 - .8 Acceptable Manufacturers:
 - .1 Setra, Model 228-1,
 - .2 Veris Industries
 - .3 Alta Labs PW series,
 - .4 Mamac series PR-282,
 - .5 or approved equal.
- .4 Differential Pressure Switch (Liquid Service):
 - .1 Applications include:
 - .1 Liquid flow proving
 - .2 Over pressure protection (pump dead-head condition)
 - .2 UL, cUL, CSA listed and approved.
 - .3 SPDT switch rated for 10 amps minimum at 120 VAC.
 - .4 Adjustable setpoint with a setpoint range to suit the application.
 - .5 ¼" (6mm) compression fittings suitable for copper sensing tubing.

- .6 General purpose dust proof enclosure for use indoors with fluids at temperature greater than 0°C (32°F)
- .7 NEMA 4 vapour tight enclosure for use indoors or outdoors with fluids at temperatures below 0°C (32°F).
- .8 Provide sensing inputs complete with signal dampening facilities to prevent nuisance tripping where required.
- .9 Suitable for continuous contact with the sensed fluid (water, ethylene or propylene glycol, chlorinated or treated water).
- .10 Operating ambient temperature range; 0°C to 82°C (32°F to 180°F)
- .11 Operating liquid temperature range: 0°C to 121°C (32°F to 250°F)
- .12 Repeatability of +/- 1% of span.
- .13 Over pressure input protection to a minimum of five (5) times rated input.
- .14 Acceptable Manufacturers:
 - .1 Johnson Controls Inc Model P74
 - .2 Dwyer,
 - .3 Penn,
 - .4 Delta-Pro
 - .5 or approved equal.

2.07 OCCUPANCY SENSORS

- .1 Occupancy sensor shall sense the presence of human activity within the desired space and fully control the on/off function of the loads automatically. Sensors shall turn on the load within 0.6m (2 ft.) of entrance.
- .2 Passive Infrared (PIR) with temperature compensated pyro-electric dual active element sensing technologies shall be completely passive in nature, in that the occupancy sensor system shall not emit or interfere with any other electronic device, or human characteristic.
- .3 Upon detection of human activity by the detector, a Time Delay shall be initiated to maintain the "ON" state as specified and be field adjustable from 30 seconds to 20 minutes.
- .4 Provide red LED for occupancy indication
- .5 All sensors shall have non-adjustable factory calibrated sensitivity.
- .6 Sensors shall be capable of operating indoors between 0° C and 40° C.
- .7 BAS Trades shall be responsible for a complete and functional system. Proper coverage of the area for all types of human activity, and any necessary relays or miscellaneous devices is the responsibility of the BAS Trades
- .8 Occupancy sensors may be connected to the BAS or stand alone and direct to load (i.e., lighting). Application and control functionality to be defined in the sequences of operation.
- .9 Owner shall be able to completely configure the system and access all the data without requiring third party service teams. All firmware upgrades shall be possible remotely via IP.
- .10 Acceptable Manufacturers:
 - .1 InfraRed Integrated Systems, IRC 3000 series,
 - .2 Watt Stopper Model CX-100,
 - .3 or approved equal.

2.08 CARBON DIOXIDE (CO2) AIR QUALITY SENSOR (ROOM, DUCT AND OUTDOOR MOUNTED SENSORS)

- .1 Dual element, non-dispersive, thermally compensated lithium tantalate infrared detector

- .2 Complete with transducer with selectable 4-20 mA or 0-10VDC output signal proportional to carbon dioxide concentration.
- .3 Sensor measurement range: 0 - 2000 ppm adjustable from 1000 - 10,000ppm
- .4 Temperature dependency: +/-2.5ppm/°C
- .5 Sensor accuracy: +/- (30 ppm +3% of reading)
 - .1 In accordance with ASHRAE 62.1 requirements, manufacturer shall ensure CO2 sensors are certified to be accurate to within +/-75 ppm at concentrations of both 600 and 1000 ppm measured at sea level at 77°F (25°C).
- .6 Transmitter accuracy: +/-0.25% of span (including linearity, hysteresis and repeatability)
- .7 Annual Drift not to exceed +/-2% of full scale
- .8 Repeatability; ±1.0% of full scale
- .9 Operating temperature range - heated: -40 to 50°C (-40 to 122°F), unheated: 0 to 50°C (32 to 122°F)
- .10 Operating humidity range: 5 to 90 %RH non-condensing
- .11 warm up time: 60 seconds
- .12 response time: 20 seconds
- .13 Complete with auxiliary SPDT relay contacts for alarm indication.
- .14 Mounting and enclosure:
 - .1 Indoor: provide blank, white enclosure with no manufacturer Logo or LED indication.
 - .2 Duct mounted: provide sensor complete with aspiration box and air stream sensor.
 - .3 Outdoor: NEMA 4 Polycarbonate, with thread adapter and cable gland fitting
- .15 Acceptable Manufacturers:
 - .1 Greystone
 - .2 or approved equal.

2.09 VOLATILE ORGANIC COMPOUND (VOC) AIR QUALITY SENSORS (ROOM AND DUCT MOUNTED SENSORS)

- .1 MEMS metal oxide semiconductor VOC sensor technology, sensing, as a minimum, the following:
 - .1 Methane;
 - .2 Ethylene;
 - .3 Hydrogen;
 - .4 Carbon Monoxide;
 - .5 Carbon Dioxide;
 - .6 Ammonia.
- .2 Measurement range: 450-2000 ppm CO2 equivalent or 0-100%.
- .3 Drift compensation: Automatic baseline correction
- .4 Linear output signal: 0-5 / 0-10 Vdc (menu selectable) = 0-2000 ppm CO2 equivalent
- .5 Mounting and enclosure:
 - .1 Room sensors complete with NEMA 1 (NEMA 3R in sprinklered areas) wall mount plastic enclosure.
 - .2 Duct mounted sensors complete with weatherproof polycarbonate enclosure with duct mounting tabs and sampling tube inserted into the return air stream.
- .6 Operating temperature range: 0°C to 50°C (32°F to 122°F).

- .7 Operating humidity range: 5 to 90 %RH non-condensing
- .8 Acceptable Manufacturers:
 - .1 Greystone
 - .2 or approved equal.

2.10 CARBON MONOXIDE (CO) SENSORS

- .1 Provide electronic gas sensor suitable for either CO gasses in air as follows:
 - .1 Sensor shall produce an output signal to BAS proportional to concentration of gas sensed;
 - .2 Minimum Indicated Concentration: 15 ppm
 - .3 Repeatability: +/-5% of reading
 - .4 Accuracy: +/-10% of reading
 - .5 Span Drift: < 12% change per 6 months
 - .6 Response Time (Rise): T50 < 10 seconds, T90 < 30 seconds, successive exposures
 - .7 Recovery Time (Fall): T10 < 60 seconds
 - .8 Temperature Range: -20° to 50°C (-4° to 122°F)
 - .9 Humidity Range: 15–90 %RH, non-condensing
 - .10 Pressure Range: Ambient atmospheric, +/-1 psi

2.11 NITROGEN DIOXIDE (NO2) SENSORS

- .1 Provide electronic gas sensor suitable for NO2 gasses in air as follows.
 - .1 Sensor shall produce an output signal to BAS proportional to concentration of gas sensed;
 - .2 Minimum Indicated Concentration: 0.3 ppm
 - .3 Repeatability: +/- 2% of Reading
 - .4 Accuracy: +/- 10% of Reading
 - .5 Span Drift: < 12% change per 6 months
 - .6 Response Time (Rise): T50 < 10 seconds, T90 < 40 seconds, successive exposures
 - .7 Recovery Time (Fall): T10 < 120 seconds
 - .8 Temperature Range: -20° to 50°C (-4° to 122°F)
 - .9 Humidity Range: 15–90 %RH, non-condensing
 - .10 Pressure Range: Ambient atmospheric, +/-1 psi

2.12 MAINTENANCE GARAGE GAS DETECTION SYSTEM

- .1 Wall mounted with a NEMA 4 enclosure, 120/24 VAC step down transformer at each sensor, a protective cover-plate which will not restrict CO and NO2 Sensor operation, capability make-up and exhaust air fans, communicating with the BAS to monitor fan status (primary or secondary), zone concentration and alarms through required protocol, and complete with:
 - .1 continuous monitoring electro-chemical sensors, one for carbon monoxide, one for nitrogen dioxide each in accordance with the Specifications.
 - .2 password protected, factory programmed software to enable required sequence of operation;
 - .3 microprocessor-based, factory calibrated, ambient humidity and temperature compensated sensing element(s) capable of producing a RS-485 digital serial loop output signal to control panel;
 - .4 alphanumeric LCD display indicating system status and exact concentration level and type of gas detected, and two (2) alarm levels for each sensing point, Power (green), and Alarm Levels A and B (amber);

- .5 audible alarm rated at minimum 65 dBA at 1 m (3') that will fully activate at programmable levels.
- .6 three (3) levels of continuous diagnostics to verify reading of each sensor/transmitter for abnormal sensing behaviour, loss of communication between control panel and sensor/transmitter, and program corruption analysis;
- .7 capability of long term data logging to determine trends;
- .8 capability of output communication through BACnet/IP to BAS to monitor system status and to view logged historical data.
- .2 CO and/or NO2 monitoring shall be provided that adjusts the ventilation system by bringing in more outdoor air to maintain concentrations as follows:
 - .1 CO concentrations below 25ppm (adjustable) in a one hour period and 35ppm in an eight hour period and/or,
 - .2 NO2 below 0.25ppm (adjustable) in a one hour period.
- .3 Acceptable manufacturer:
 - .1 Honeywell model E³Point.
 - .2 Or approved equal.

2.13 REFRIGERANT LEAK MONITORING AND ALARM SYSTEM

- .1 Main Panel Located inside Chiller Mechanical Room:
 - .1 Main Refrigerant Leak Monitoring and Alarm System must provide all the functionalities necessary to comply with current ASHRAE 15 guidelines and CSA B-52 Mechanical Refrigeration Code, and all additional requirements of the Authorities Having Jurisdiction (AHJs).
 - .2 Provide compound specific refrigerant monitoring sensors in chiller rooms;
 - .3 Provide additional refrigerant monitoring sensors in the vent pipe on each chiller.
 - .4 Sensors will be monitored at the Main Refrigerant Leak Monitoring and Alarm System panel.
 - .5 Main Refrigerant Leak Monitoring and Alarm System panel shall be Password protected, and as follows:
 - .1 Use: Centralized Stand Alone refrigerant gas detection monitoring main controller with real-time gas reading, selective alarm activation
 - .2 Power Requirement: 22-27 Vac, 29-38 Vdc, 2A max @ 29Vdc
 - .3 Up to 20 gas transmitters provide digital communication via Modbus RTU, Modbus TCP/IP, BACNET/IP, Up to 61 m (200 ft.) from the controller.
 - .4 Alarm Levels: 3 fully programmable alarm levels
 - .5 Outputs: 4 DPDT form C relays (alarms and/or fault) at 5 A, 30 Vdc or 250 Vac (resistive load); 65dBA buzzer, 3 Outputs at 24 Vdc @ 250 mA each
 - .6 Integral Strobe/Horn: STAS flashing LED/105dBA, 4-28V, 2800Hz (RFSA)
 - .7 Display: 122 x 32 dot matrix backlit LCD display
 - .8 Visual Indicators: - Green LED - Normal Operation
 - .9 Red LED Gas Alarm A, B, and C
 - .10 Yellow LED: Fault/Service
 - .11 Manual Fan Start/Stop operation
 - .12 Audible Alarm with a silence key to acknowledge
 - .13 Visible Alarm

- .14 Operating Humidity Range: 0-95% RH, non-condensing
- .15 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)
- .16 Enclosure rating: NEMA 4X, ABS - Polycarbonate - indoor
- .17 Certifications: CAN/CSA C22.2 No 61010-1
- .18 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
- .6 Up to ten (10) Remote Refrigerant Leak Monitoring and Alarm System panels can be connected to the Main Refrigerant Leak Monitoring and Alarm System panel; Digital Communication Modbus RS- 485 up to 304m (1000ft)
- .7 Acceptable manufacturers:
 - .1 Honeywell Vulcain,
 - .2 Arjay Engineering Ltd Refrigerant Gas Monitor,
 - .3 Or approved equal.
- .2 Slave Panel Located outside Chiller Mechanical Room:
 - .1 Use: Remote Annunciator / Slave display panel located outside each entrance to Chiller Mechanical room
 - .2 Power Requirement: 22-27 Vac, 50 or 60 Hz, 29-38Vdc, 2.0 A max @ 24 Vdc
 - .3 The remote annunciator panel must provide all the functionalities necessary to comply with Current ASHRAE 15 and CSA B-52 Mechanical Codes. This includes a key for manual "fan start" only operation, strobe/horn audible visual alarm on top of the unit
 - .4 Display 122 x 32 dot matrix backlit LCD display
 - .5 Visual Indicators: - Green LED - Normal Operation
 - .6 Red LED Gas Alarm A, B, and C
 - .7 Yellow LED: Fault/Service
 - .8 Remote Refrigerant Leak Monitoring and Alarm System panel will display the concentration of refrigerant gas as displayed on the Main Refrigerant Leak Monitoring and Alarm System panel, and the refrigerant gas detected. The LCD display screen will indicate multiple alarm levels for each sensing point
 - .9 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)
 - .10 Enclosure rating: NEMA 4X, ABS - Polycarbonate - indoor
 - .11 Certifications: CAN/CSA C22.2 No 61010-1
 - .12 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
 - .13 Acceptable manufacturers:
 - .1 Honeywell Vulcain,
 - .2 Arjay Engineering Ltd Refrigerant Gas Monitor,
 - .3 Or approved equal.
- .3 Wired Refrigerant Gas Transmitter:
 - .1 Use: Wall mounted, wired refrigerant gas detector transmitter used in conjunction with Refrigeration Leak Monitoring and Alarm System controller, Diffusion Type with no internal sample pump or filter maintenance required.
 - .2 Power Requirement: 8.5 - 12.5 Vdc, 1A@10 Vdc Maximum
 - .3 Network: Modbus RS-485
 - .4 Sensing Technology: NDIR (Non Dispersive Infrared)

- .5 Accuracy: $\pm 10\text{ppm @ } 50\text{ ppm}$ / $\pm 40\text{ppm @ } 500\text{ ppm}$
- .6 Detection Range: Refrigerants 0-1000 ppm
- .7 Refrigerants: **specific to refrigerant compounds supplied to the project.**
- .8 Resolution: 1 ppm
- .9 Response Time (T90) 60 seconds
- .10 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)
- .11 0 to 95% RH (non-condensing)
- .12 Enclosure NEMA 4X ABS/Polycarbonate - Indoor
- .13 Certified to: CAN/CSA C22.2 No. 61010-1
- .14 Conforms to: ANSI/UL 61010-1
- .15 Acceptable manufacturers:
 - .1 Honeywell Vulcain,
 - .2 Arjay Engineering Ltd Refrigerant Gas Monitor,
 - .3 Or approved equal.

2.14 DIGITAL TO ANALOG OUTPUT CONVERTOR

- .1 Receives up to eight (8) 4-20mA analog input signals and converts to one digital signal to the BAS or Variable Frequency Drive (VFD)
- .2 Transmitters may be located a maximum of 600 m (2000') from Digital to Analog Output Convertor control panel.
- .3 Unit shall include internal logic to provide either minimum/ maximum/average value signal for an unlimited number of input signals, or a single dedicated 4-20mA output signal.
- .4 Acceptable manufacturers:
 - .1 Honeywell Analytics/Vulcain Inc Model 4201.;
 - .2 Mine Safety Appliance Co. (MSA);
 - .3 Armstrong Monitoring Co.;
 - .4 Quatrosense Environmental Ltd. (QEL).

2.15 LIQUID LEVEL CONTROLLERS

- .1 Ultrasonic Liquid Level Controller:
 - .1 Provide ultrasonic liquid level sensor, suitable for sensing water/ fluid levels in atmospheric sumps, tanks, cisterns, and similar storage vessels.
 - .2 Ultrasonic level sensors shall employ high-frequency sound waves technology to detect changes in the wave reflection as they return to the sensor.
 - .3 Sensors shall be capable of reporting both real time point levels, and shall be capable of providing continuous sensing suitable for trend analysis (liquid levels increasing, liquid levels steady, liquid levels decreasing).
 - .4 Sensors shall be as follows:
 - .1 Material: Nylon
 - .2 Mounting: 1/2" [12.7 mm] NPT
 - .3 Sensor Input: 5-12 VDC (<30 mA)
 - .4 Enclosure: NEMA 4X vapour tight.
 - .5 Output Signal: Max 2A relay at 30 VDC, or: 0.3 A at 125 VDC digital output compatible with BAS to suit application

- .6 Cable Length: minimum 12" (305 mm), or custom length to suit application
- .7 Response Time: < 1ms (typical)
- .8 Temperature: 45 to 160°F (7 to 70°C)
- .9 Maximum Pressure: 150 psi
- .5 Where high level alarm or low level alarm is required by the control sequences, provide an independent Liquid Level Switch.
- .2 Continuous Liquid Level Sensor (Float Type):
 - .1 Corrosion resistant, 316 stainless steel.
 - .2 Solid state float actuated sensor.
 - .3 Complete with transducer with 4 to 20 mA signal output proportional to sensed level.
 - .4 Temperature range of 32°F to 125°F.
 - .5 Pressure range of 0 to 500 psia.
 - .6 Acceptable manufacturers:
 - .1 MagneTek, 7025 Series
 - .2 or approved equal.
- .3 Liquid Level Switch:
 - .1 Polypropylene float, PVC cable, hermetically sealed mercury switch.
 - .2 13 amp running current @ 120 VAC, 11 amp current @ 240 VAC.
 - .3 SPDT switch contacts. Switch contacts shall be selected to suit required sensing/control action.
 - .4 Operating temperature of 32°F to 160°F (0°C to 71°C).
 - .5 Operating pressure of 26 psi.
 - .6 Acceptable manufacturers:
 - .1 MagneTek, 7010 Series
 - .2 Scientific Technologies
 - .3 W.E. Anderson
 - .4 or approved equal.
- .4 Leak Detector
 - .1 Provide sensing cable to detect the presence of water.
 - .2 Provide sensing and relay module to monitor leak detection cable.
 - .3 Provide separate contacts for leak detection and cable break.
 - .4 Acceptable manufacturers:
 - .1 Raychem tracetek TT1000 type with TTC sensing and relay module
 - .2 Or approved equal.

2.16 TIME DELAY RELAYS

- .1 Time Delay Relays shall be solid-state plug-in type, UL listed, with adjustable time delay adjustable +/-100% from set point shown;
- .2 Provide Time Delay Relays contact rating, configuration, and coil voltage suitable for application;
- .3 Provide Field Equipment Panel enclosure for relays not installed in control panels.

2.17 LATCHING TYPE CONTROL RELAYS

- .1 Pickup rating, time and hold rating as required for individual applications

- .2 Rated for a minimum of ten (10) million mechanical operations and a minimum of 500,000 electrical operations.
- .3 Provide complete isolation between the control circuit and the BAS digital output.
- .4 NEMA 1 (NEMA 3R in sprinklered areas) enclosure for relays not installed in local control panels, otherwise locate relays in the BCU, FEC, ZLC or Field Equipment Panels;
- .5 Malfunction of a BAS component shall cause the controlled output to fail to the positions identified in the failure procedure.
- .6 10 amp contact rating at 240 volts;
- .7 Pin type terminals complete with mounting bases;
- .8 Acceptable Manufacturers:
 - .1 IDEC, RR Series;
 - .2 Potter Bromfield;
 - .3 Cutler Hammer;
 - .4 or approved equal.

2.18 MOMENTARY TYPE CONTROL RELAY

- .1 Coil ratings of 120 VAC, 50 mA or 10-30 VAC/VDC, 40 mA as suitable for the application;
- .2 Provide complete isolation between the control circuit and the BAS digital output;
- .3 Field Equipment Panel enclosure for relays not installed in local control panels
- .4 10 amp contact rating;
- .5 LED status indication;
- .6 Acceptable Manufacturers:
 - .1 Core Components, Model CVR;
 - .2 or approved equal.

2.19 POWER MONITORING (AMPS)

- .1 Power monitoring achieved through a combination of current transformer and current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 ampere current draw signal.
- .2 Current draw signal shall be converted to a 4 to 20 mA DDC compatible circuit for use by BAS.
- .3 Current transformer as follows:
 - .1 split core current transformer with an operating frequency of from 50 to 400 Hz, 0.6 Kv class, 10 Kv BIL insulation, and 5 ampere secondary;
 - .2 equal to Veris Industries
- .4 Current transducer as follows:
 - .1 current to voltage or current to mA transducer with an accuracy of +/-5%, a minimum load resistance of 30 kOhm, an input of 0 to 20 amperes and an output of 4 to 20 mA, and a 24 VDC regulated power supply.
 - .2 equal to Veris Industries

2.20 CURRENT SENSING SWITCHES

- .1 self-powered dry contact output switches for sensing run status of motor loads,
- .2 each calibrated to indicate a positive run status only when motor is operating under load,
- .3 each consisting of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and a LED to indicate on or off status;
- .4 Acceptable manufacturer:

- .5 Veris Industries,
- .6 or approved equal.

2.21 AC VOLTAGE TRANSMITTERS

- .1 self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
- .2 adjustable full-scale unit ranges; 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac.
- .3 +/-1% full-scale accuracy at 500 ohm maximum burden.
- .4 UL/CSA listed, 600 Vac rated and conforming to ANSI/ISSA 50.1.

2.22 MOTOR STARTER TERMINAL STRIP

- .1 Provide a terminal strip within the starter enclosure or within a separate enclosure, mounted alongside the starter, to facilitate monitoring and control of the motor by the BAS, and to facilitate overriding control by the Fire Alarm System.
- .2 BAS Trades shall wire the motor starter to the terminal strip to enable the BAS to perform the required control and monitoring functions:
 - .1 ON/OFF control and status
 - .2 Speed Control
 - .3 High/Low Speed, plus status
 - .4 Damper Interlock
 - .5 Damper Control
- .3 The motor side load shall not exceed 10 amps at 120 volts for any signal to the BAS.

2.23 ELECTRONIC SIGNAL ISOLATION TRANSDUCERS

- .1 Provide Electronic Signal Isolation Transducers to establish a ground plane isolation between BAS and external control systems as follows:
 - .1 whenever an analog output signal from the BAS is to be connected to an external control system as an input (i.e. equipment control panel), or
 - .2 the BAS is to receive an input signal as an output from an external control system.
- .2 Acceptable manufacturers:
 - .1 Advanced Control Technologies
 - .2 Or approved equal

2.24 PRESSURE TO CURRENT TRANSMITTERS

- .1 Internal materials of the transducer suitable for continuous contact with industrial standard instrument air.
- .2 Input pressure range as required by application.
- .3 Output signal of 4-20 mA proportional to input pressure.
- .4 Output variation of less than 0.2% full scale for supply voltage variations of +/- 10%.
- .5 Combined non-linearity, repeatability and hysteresis effects not to exceed plus/minus 0.5% of full scale output over entire range.
- .6 Integral, accessible zero and span adjustments.
- .7 Operating temperature range of -10°C to 50°C with 5% to 90% RH non-condensing.
- .8 Temperature effect of 1.5% full scale 50°C or less.
- .9 Over pressure input protection to a minimum of twice maximum working input pressure.
- .10 Output short circuit and open circuit protection.
- .11 Dustproof housing.

- .12 Shock and vibration protection.

2.25 PRESSURE TO ELECTRIC SWITCHES

- .1 used to create electric switching from pneumatic control signals
- .2 diaphragm operated SPDT snap acting contacts with electrical rating suitable for application
- .3 designed to withstand up to 170 kPa (25 psi) input pneumatic control signal pressure,
- .4 adjustable cut-in and cut-out settings between 20 and 140 kPa (3 and 20 psi).

2.26 AUTOMATIC CONTROL DAMPERS (UNINSULATED)

- .1 Provide flanged, AMCA low leakage certified aluminium automatic dampers, custom fabricated to required size, opposed blade or parallel blade type as follows:
 - .1 two position dampers to be parallel;
 - .2 modulating dampers to be opposed blade type.
- .2 Blades to be of extruded aluminium profiles. Blade ends to be capped in order to seal hollow interior and reduce air leakage rate.
- .3 Blade and frame seals shall be of extruded silicon and be secured in an integral slot within the aluminium extrusions.
- .4 Bearings to be comprised of a Celcon inner bearing fixed to a 7/16" aluminium hexagon blade pin rotating within a polycarbonate outer bearing inserted in frame.
- .5 Linkage hardware shall be installed in frame side and be constructed of aluminium and corrosion resistant, zinc and nickel plated steel, complete with cup point trunnion screws for slip proof grip.
- .6 Dampers to be designed for operation in temperatures ranging between - 40°F and 212°F (- 40°C to 100°C).
- .7 Air leakage through a 48" x 48" (1220mm x 1220mm) damper in closed position shall not exceed 1.7 cfm/ft² against 1in.wg. differential static pressure at standard air.
- .8 Pressure drop of a fully open 48"x48" (1220mmx1220mm) damper shall not exceed 0.02 in.wg. at 1000 fpm.
- .9 Dampers shall be made to size and shall not be limited to standard sizes.
- .10 Acceptable manufacturer:
 - .1 Tamco Air Foil Series 1500,
 - .2 Ruskin CD50 Series,
 - .3 Arrow PBDAF 206,
 - .4 or approved equal.

2.27 AUTOMATIC CONTROL DAMPER (INSULATED)

- .1 Provide flanged, AMCA low leakage certified aluminium automatic dampers, custom fabricated to required size, opposed or parallel blade type as follows:
 - .1 two position dampers to be parallel;
 - .2 modulating dampers to be opposed blade type.
- .2 Damper frame shall be of extruded aluminium not less than 0.08" (2.03mm) in thickness. Damper frame to be 4" (101.6mm) deep and shall be insulated with Styrofoam on four sides. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts.
- .3 Blades to be of extruded aluminium, internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.
- .4 Blade and frame seals shall be of extruded silicon and be secured in an integral slot within the aluminium extrusions.

- .5 Bearings to be comprised of a Celcon inner bearing fixed to a 7/16" aluminium hexagon blade pin rotating within a polycarbonate outer bearing inserted in frame.
- .6 Linkage hardware shall be installed in frame side and be constructed of aluminium and corrosion resistant, zinc and nickel plated steel, complete with cup point trunnion screws for slip proof grip.
- .7 Dampers to be designed for operation in temperatures ranging between - 40°F and 212°F (- 40°C to 100°C).
- .8 Air leakage through a 48"x48" (1220mm x 1220mm) damper in closed position shall not exceed 4.12 cfm/ft² against 4 in.wg. differential static pressure at standard air.
- .9 Pressure drop of a fully open 48"x48" (1220mm x1220mm) damper shall not exceed 0.03 in.wg. at 1000 fpm.
- .10 Dampers shall be made to size and shall not be limited to standard sizes.
- .11 Acceptable manufacturers:
 - .1 Tamco Air Foil Series 9000 BF,
 - .2 Ruskin CDTI-50 BF Series,
 - .3 Arrow AFDTI-25LT insulated.
 - .4 or approved equal.

2.28 AUTOMATIC CONTROL DAMPER ACTUATORS

- .1 Electric/Electronic Sized to provide adequate power for opening, closing and modulating dampers in specified time.
- .2 Where indicated and/or specified, the normal position of the device, shall be the position that the damper returns to
- .3 All damper actuators to be provided with spring return to normal position when the control signal is lost as follows:
 - .1 normally open ("NO") or normally closed ("NC");
 - .2 either clockwise or counter clockwise rotation;
 - .3 sized to control the damper against maximum pressure or dynamic closing pressure, whichever is greater;
 - .4 sized to suit the sizes of dampers involved, and;
 - .5 provide sufficient force to maintain the damper rated leakage characteristics.
- .4 Actuators shall be equipped with a manual drive release mechanism and manual positioning mechanism in the absence of power.
- .5 Provide reversible gear type operators that can accept modulating control signals as follows:
 - .1 control signals:
 - .1 0 - 10VDC or 0 - 20ma for proportional control,
 - .2 power On-Off for two position service,
 - .2 Damper actuators shall have integral position potentiometer or 0 to 10 VDC feedback signals to indicate the drive shaft position of the damper at the BAS, all damper actuators shall include integral end position indicators,
- .6 Each is to be 1 phase AC, 120 or 24 volt as required or indicated, overload protected throughout the full range of rotation enabling the actuator to detect a blockage in the damper and withstand a continuous stall condition without premature failure in performance, and complete with an enclosure type as follows:
 - .1 general purpose, drip proof enclosure for indoor applications,
 - .2 NEMA 4 enclosure low temperature protected actuators for outdoor use, or exposed to the airstream inside an outdoor air intake plenum, suitable for operation down to -35°C.

- .7 Provide emergency power to each damper actuator.
- .8 Wherever possible, actuators to be provided to the original terminal device equipment manufacturer for factory installation (i.e. VAV terminal). Provide actuators meeting equipment Manufacturer's specifications.
- .9 Unless indicated otherwise in the Specifications, or on the drawings, actuators to be provided and set-up such that all recirculation air dampers are normally open, and outdoor air and exhaust dampers are normally closed.
 - .1 For air handling units intended to be used as part of a smoke control sequence, or remain operational during a fire alarm event, recirculation dampers shall be normally closed.
- .10 Each operator is to be complete with a damper position indicator, and external adjustable stops to limit the length of stroke in either direction, and is to be mounted on a corrosion resistant adjustable bracket.
- .11 Operating arms are to have double yoke linkages and double set screws for fastening to the damper shaft.
- .12 Actuators shall be quiet in operation such that noise from actuator operation is not detectable in any occupied spaces.
- .13 Operators for dampers to be connected to the building fire alarm system or to freeze protection devices are to be equipped with additional relays to permit the dampers to respond and return to the required position upon receipt of a signal.
- .14 Stroke dampers from fully closed to fully open in accordance with the following:

Service	Time Requirement
Two position normal service	75 seconds
Modulating normal service	120 seconds
Emergency service (stair pressurization, smoke control and similar)	<20 seconds

- .15 Acceptable manufacturers:
 - .1 Belimo,
 - .2 Siemens Building Technologies,
 - .3 Johnson Controls,
 - .4 Honeywell,
 - .5 or approved equal.

2.29 DAMPER POSITION SWITCHES

- .1 Provide damper end switch which indicates actual damper blade position; damper position switches which are actuated by damper crankshaft or actuator position will not be accepted for the following applications:
 - .1 Smoke control fans providing either 100% outdoor air, or 100% exhaust air;
 - .2 Dedicated make-up (100% outdoor) air fans;
 - .3 Dedicated exhaust fans.
- .2 Contacts shall be rated for the electrical load to be switched.
- .3 Provide auxiliary contacts as required by the Sequence of Operation.

2.30 ACTUATORS FOR TERMINAL UNIT DAMPERS

- .1 integrated DDC controller and damper actuator,
- .2 sized and selected in accordance with terminal box damper manufacturer's specifications,

- .3 gear drive, direct coupled type operators mounted to shaft with universal V-bolt clamp,
- .4 proportional type control,
- .5 selectable / reversible rotation direction,
- .6 input type and range as suitable for interfacing to output of terminal unit controller,
- .7 angle of rotation adjustable between 30 to 90° with mechanical limit stops,
- .8 damper position indication visible without cover removal,
- .9 manual override to set damper position without power applied to actuator,
- .10 electronic stall protection,
- .11 general purpose dust proof enclosure,
- .12 actuator running time of not more than 100 seconds,
- .13 delivered to terminal unit manufacturer's factory for installation.

2.31 CONTROL VALVES

- .1 General requirements:
 - .1 Provide control valves suitable for the operating pressures and temperatures of the systems. Ensure tight shut off against system operating differential pressures.
 - .2 Select valves with characteristics to suit the application.
 - .3 Body and trim materials selected in accordance with specification for globe valves, ball valves, or high performance butterfly valves, and in accordance with manufacturer's recommendations for design conditions and service.
 - .4 Size control valves for pressure drops and heating and cooling loads as scheduled with same pressure rating as globe valves under same service and pressure conditions.
 - .5 Size valves for two port and three port, two position service;
 - .1 line size,
 - .2 ball valves, sizes 2 ½" (65mm) and smaller,
 - .3 butterfly valves, sizes 3" (75mm) and larger.
- .2 For two port and three port modulating service;
 - .1 use globe valves for Cv rating 160 and smaller (4" [100mm] and smaller),
 - .2 use high performance butterfly valves for Cv rating above 160 based on 70° open position (6" [150mm] and larger)
- .3 Straight through two-way valves shall have equal percentage flow characteristics.
- .4 Three way valves shall have linear flow characteristics, to give constant total flow.
- .5 All valves shall have stainless steel stem and packing to suit application
- .6 For two-way and three-way valves ½" to 2" (12mm to 50mm) size in heating water, chilled water, condenser water, glycol solution (up to 50 percent), in modulating and two position (ON/ OFF) applications:
 - .1 General Requirements:
 - .1 ANSI Class 250 globe style valve body;
 - .2 single seat, metal to metal;
 - .3 Normally Closed (NC) or Normally Open (NO) action;
 - .2 Materials:
 - .1 bronze body
 - .2 stainless steel trim;

- .3 stainless steel stem to ASTM A582 Type 303
- .3 Packing:
 - .1 EPDM O-rings for liquid duty
- .4 Up to 50 psi (345 kPa) differential pressure for modulating service;
- .5 Minimum 100:1 rangeability;
- .6 Close-off rating per ANSI/FCI 70-2;
- .7 Class IV (0.01% of Cv) leakage rate;
- .8 Equal percentage flow characteristics.
- .7 For two-way and three-way valves 2 ½" to 6" (65mm to 150mm) size in heating water, chilled water, condenser water, glycol solution (up to 50 percent), in modulating and two position (ON/ OFF) applications:
 - .1 General Requirements:
 - .1 ANSI Class 250 globe style valve body;
 - .2 single seat, metal to metal;
 - .3 Normally Closed (NC) or Normally Open (NO) action;
 - .2 Materials:
 - .1 cast iron body ASTM A126 Class B;
 - .2 stainless steel trim;
 - .3 stainless steel stem to ASTM A582 Type 303
 - .3 Packing:
 - .1 EPDM O-rings for liquid duty
 - .2 PTFE V-rings and EPDM O-ring for steam applications
 - .4 Up to 50 psi (345 kPa) differential pressure for modulating service;
 - .5 Minimum 100:1 rangeability;
 - .6 Close-off rating per ANSI/FCI 70-2;
 - .7 Up to 200 psi close-off pressure in liquid applications;
 - .8 Class IV (0.01% of Cv) leakage rate;
 - .9 Equal percentage flow characteristics.
- .8 For two-way and three-way valves 6" (150mm) and larger size in heating water, chilled water, condenser water, glycol solution (up to 50 percent), in modulating and two position (ON/ OFF) applications:
 - .1 Provide Bray Series Series 31 lug (up to 125 psi), or Series 31H (high pressure service), or approved equal for use in 2-Way and 3-Way control valve arrangement suitable for a media temperature range based on water between -20°F to 250°F (-29°C to 120°C) in HVAC applications (chilled water, heating water, condenser water, glycol solution) in accordance with the following:
 - .2 Body:
 - .1 cast iron one piece lug design with extended neck to allow for 2" (50 mm) of piping insulation.
 - .2 Flange locating holes shall be provided on wafer bodies to allow for quick and precise alignment during valve installation.
 - .3 Flange hole drilling per international flange standard as specified.
 - .4 Provide a non-corrosive bushing and a self-adjusting stem seal

- .3 Disc:
 - .1 aluminum bronze disc material
 - .2 disc edge and hub on metal discs shall be spherically machined and hand polished for minimum torque and maximum sealing capability.
- .4 Stem:
 - .1 Shall be one piece design;
 - .2 .Disc-to-stem connection shall be and internal double "D" design with no leak paths in the disc-to-stem connection.
 - .3 Stem shall be mechanically retained in the body neck and no part of the stem shall be exposed to the line media.
- .5 Seat:
 - .1 Shall be tongue-and-groove bonded seat with a primary hub seal and a molded flange O-ring suitable for weld-neck and slip-on flanges.
 - .2 The seat shall totally encapsulate the body isolating it from the line media and no flange gaskets shall be required.
- .6 Testing:
 - .1 Valve shall be tested to 110% of the rated pressure.
- .7 Pressure Ratings:
 - .1 Valve shall be rated for bubble-tight shutoff at pressure rating as follows:
 - .1 2"-12" (50mm-300mm) 175 psi (12.0 Bar)
 - .2 14"-20" (350mm-500mm) 150 psi (10.3 Bar)
 - .3 For dead-end service:
 - .1 Provide larger retainer ring set screws to allow for the valve to be placed at the end of the line without a downstream flange in either flow direction while still holding full pressure (no downstream flanges and disc in closed position):
 - .2 2"-12" (50mm-300mm) 75 psi (5.2 Bar)
 - .3 14"-20" (350mm-500mm) 50 psi (3.4 Bar)
 - .4 For high pressure service:
 - .1 2" - 20" (50mm-500mm) 250 psi (17.2 Bar)
- .8 Approvals & Certifications:
 - .1 CE/PED Certification
 - .2 NSF/ANSI 61-2008 Certification (Potable Water)
 - .3 SIL Certification
 - .4 ABS Certification
 - .5 Bureau Veritas Certification
 - .6 DNV
- .9 Three-Way Valve Assembly:
 - .1 Three-way valve assemblies shall be furnished completely assembled with Tee, calibrated and tested, ready for installation;
 - .2 Tees fittings complying with ASME/ANSI B16.1 Class 125 Flanges; provide Class 250 fittings for high pressure service.
 - .3 Provide flange gaskets between control valve and Tee flanges;

- .4 Mount single actuator on primary control valve stem; provide suitable sized actuator linkage arm connected to secondary control valve stem to actuate secondary control valve disc at 90 degrees to primary control valve disc.
- .9 Valve sizing that is not noted in the Drawing Schedules or Control Sequences shall use the following sizing criteria:
 - .1 for two-position service; line size unless noted otherwise.
 - .2 for two-way modulating service unless otherwise shown; pressure drop at design flow **equal to greater of**:
 - .1 100% of pressure drop through heat transfer device (coil or heat exchanger) plus 2.0 psi (or 4.6 ft.wg),
 - .2 50% of pressure difference between supply and return mains, or
 - .3 35 kPa (5 psi).
 - .3 for three-way modulating service; pressure drop **equal to smaller of**:
 - .1 100% of pressure drop through heat transfer device (coil or heat exchanger) plus 2.0 psi (or 4.6 ft.wg),
 - .2 4.0 psi (9.2 ft.wg)
 - .4 for valves for radiation, terminal units and reheat coils;
 - .1 pressure drop of 1.5 psig (3.5 ft.wg)
- .10 Valve trim selected for close-off pressure ratings as follows;
 - .1 two-way modulating or two position service; 150% of pump shut off head.
 - .2 three-way modulating service; 300% of pressure differential between ports A and B at design flow or 100% of pump shut off head, whichever is greater.
 - .3 shut off head to be based on maximum rpm when pump is fitted with VFD
- .11 Pneumatic valve actuators used to sequence multiple valves shall be provided with pilot positioners to ensure proper sequence of each valve and to allow for an adjustable dead band between heating and cooling valves.
- .12 Control valves shall have the manufacturer's name and the pressure rating clearly marked on the outside of the body. Where this is not possible manufacturer's name and valve pressure rating shall be engraved on a minimum 50mm diameter stainless steel tag that shall be attached to the valve by a chain in such a manner that it cannot be unintentionally removed.
- .13 Control valves ½" to 2" (12mm to 50mm) shall have screwed ends with union fittings to allow easy removal for servicing.
- .14 Control valves 2 ½" (65mm) and larger shall have flanged ends.
- .15 All valves shall meet the appropriate ANSI requirements for service fluid, pressure and temperature.

2.32 POTABLE WATER SERVICE AUTOMATIC CONTROL VALVES

- .1 Valves for potable water service shall be as per above, and shall be NSF 61 certified for use in potable water applications.

2.33 CONTROL VALVE ACTUATORS

- .1 General Requirements:
 - .1 24 VAC electric/electronic motor driven type actuator coupled to control valves with linkage,
 - .2 Actuator construction shall be capable of withstanding high shock and vibration without operations failure, and be complete with:
 - .1 electronic interface control board;
 - .2 solid state drive;

- .3 reversible motor;
- .4 oil immersed gear train,
- .3 Actuator enclosure:
 - .1 general purpose, drip proof NEMA 3R die-cast housing with corrosion resistant hard-anodized aluminum or steel material cover for indoor applications;
 - .2 watertight NEMA 4 enclosure for outdoor use suitable for operation down to -35°C,
- .4 Actuator shall provide two position, or proportional control action as required by the intended application,
- .5 Actuator shall accept control signals compatible with the BAS analog or digital output of 0 to 10VDC, or 0 to 20mA as appropriate,
- .6 Actuator shall operate the valve from the fully closed to the fully open position and vice versa in less than two (2) minutes,
- .7 Actuator shall modulate the valve stem position in a linear relation to the control signal.
- .8 Control valve stem position shall be adjustable in increments of one (1%) percent or less of full stem travel,
- .9 Actuator shall have visual mechanical position indication, showing valve position,
- .10 Actuator shall have provision for manual positioning of valve when actuator is not powered,
- .11 Electronic overload or digital rotation sensing circuitry shall protect control valve actuator through entire range of rotation,
- .12 Provide span and zero travel adjustment,
- .13 Control valves larger than $\frac{3}{4}$ " (20mm) shall have integral position potentiometer or 0 to 10 VDC feedback signals to indicate the stem position of the valve at the BAS, all valve actuators shall include integral end position indicators,
- .14 Acceptable manufacturers:
 - .1 Belimo,
 - .2 Siemens Building Technologies,
 - .3 Johnson Controls Inc.,
 - .4 Honeywell
 - .5 Or approved equal.
- .2 Water and Glycol Solution Control Valve Actuators:
 - .1 Actuator selected for close-off pressure ratings as follows;
 - .1 two-way modulating or two position service; 150% of pump shut off head.
 - .2 three-way modulating service; 300% of pressure differential between ports A and B at design flow or 100% of pump shut off head, whichever is greater.
 - .3 shut off head to be based on maximum rpm when pump is fitted with VFD
 - .2 Actuator in include spring return mechanism to return valve to "normal" position on power failure or isolation from control signal as follows;
 - .1 Heating water and glycol zone valves; normally open.
 - .2 Heating coil valves in AHU; normally open.
 - .3 Chilled water control valves; normally closed.
 - .4 Chilled water differential pressure by-pass control valves; normally open.
 - .5 Hot water and glycol differential pressure by-pass control valves; normally closed.

2.34 AIR FLOW STATIONS (DUCT MOUNTED):

- .1 Air flow stations shall be multipoint flow cross or grid measuring arrangement, either rectangular or round as to suit the duct configuration. Provide a minimum of two flow sensing thermistors and temperature sensors per station.
- .2 Unit construction:
 - .1 14 gauge galvanized sheet steel casing, flanged for installation to duct or plenum as applicable,
 - .2 98% free area parallel cell 20 mm ($\frac{3}{4}$ ") aluminum honeycomb equalizer and air straightening grid,
 - .3 copper or stainless steel static pressure sensors and total pressure sensors, installed in a grid pattern to provide total coverage of the duct cross section.
- .3 Unit shall be capable of reading volumes within 1% for a velocity range of 0 to 5000 feet per minute (0 to 25 m/s).
- .4 Velocity pressure transmitter shall be selected to suit the system working pressures and shall meet the following performance requirements:
 - .1 Calibrated Accuracy: +/- 0.25% of span.
 - .2 Repeatability: 0.05% of output.
 - .3 Dead band & hysteresis: Not detectable.
- .5 Square root extractor and multiplier shall meet the following performance requirements:
 - .1 Calibrated Accuracy: +/- 0.5% of flow.
 - .2 Hysteresis: Not detectable.
 - .3 Repeatability: 0.05% of output.
 - .4 Response: 0.5 seconds.
 - .5 Multiplier: Adjustable 0.3 to 2.8.
- .6 Integral signal integrator to minimize primary signal noise from the output signal and shall be +/- 5% overall accuracy of measured flow.
- .7 Internal materials of the transducer suitable for continuous contact with air.
- .8 Transducer to be provided complete with easily accessible, integral non- interacting zero and span adjustment.
- .9 Temperature compensated linear analog output signal indicating average velocity at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc proportional to measured differential pressure.
- .10 Operating temperature range of -18°C to 71°C (0°F to 160°F)
- .11 Operating humidity range; 0 to 99% RH non-condensing
- .12 Dedicated electronic, solid state digital processing control panel, with general purpose dustproof enclosure, wall mounted and shall contain all control equipment.
- .13 Each panel shall have a hinged door, latch and lock.
- .14 Acceptable manufacturers:
 - .1 Air Monitor Corporation,
 - .2 Tek-Air Systems Inc.,
 - .3 Veltron II,
 - .4 Ebtron,
 - .5 Or approved equal.

2.35 AIR FLOW STATIONS (FAN BELL MOUTH):

- .1 Air flow stations shall consist of air flow traverse probes mounted on the fan bell mouth. Provide a minimum of two flow sensing thermistors and temperature sensors per station, two stations for each DWDI fan.
- .2 The probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds.
- .3 Sensors shall not protrude beyond the surface of the probe, and not be adversely affected by particle contamination normally present in system airflows.
- .4 The fan inlet air flow traverse probes (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings and shall be of aluminum construction with hard anodized finish, and suitable for continuous contact with air.
- .5 The fan inlet airflow traverse probes shall not induce a measurable pressure drop, nor shall the sound level with the system be amplified by its presence in the fan inlet bell.
- .6 The probes shall be capable of producing steady, non-pulsating signals of total and static pressure, without need for flow corrections or factors, with an accuracy of $\pm 3\%$ of actual flow over a fan operating range of 6:1 capacity turndown.
- .7 Velocity pressure transmitter shall be selected to suit the system working pressures and shall meet the following performance requirements:
 - .1 Calibrated accuracy within $\pm 0.25\%$ of span.
 - .2 Repeatability within 0.05% of output.
 - .3 Dead band & hysteresis not detectable or measurable.
- .8 Square root extractor and multiplier shall meet the following performance requirements:
 - .1 Calibrated Accuracy: $\pm 0.5\%$ of flow.
 - .2 Hysteresis: Not detectable.
 - .3 Repeatability: 0.05% of output.
 - .4 Response: 0.5 seconds.
 - .5 Multiplier: Adjustable 0.3 to 2.8.
- .9 Integral signal integrator to minimize primary signal noise from the output signal.
- .10 Combined sensor and transducer accuracy of $\pm 2.5\%$ of measured value.
- .11 Transducer to be provided complete with easily accessible, integral non-interacting zero and span adjustment.
- .12 Temperature compensated linear analog output signal indicating average velocity at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc proportional to measured differential pressure.
- .13 Operating temperature range of -18°C to 71°C (0°F to 160°F)
- .14 Operating humidity range; 0 to 99% RH non-condensing
- .15 Dedicated electronic, solid state digital processing control panel, with general purpose dustproof enclosure, wall mounted and shall contain all control equipment
- .16 Acceptable manufacturers:
 - .1 Air Monitor Corp.,
 - .2 Tek-Air Systems Inc.,
 - .3 Ebtron,
 - .4 Dietrich Standard,
 - .5 Or approved equal.

2.36 FLUID FLOW MEASURING DEVICES

- .1 General requirements:
 - .1 Flow meters for chilled water, heating water and steam condensate shall be ultrasonic or electromagnetic type; steam flow meter shall be vortex type.
 - .2 Flow meters shall be installed either in the supply or return pipe of the system, or branch pipe of the system to be measured.
- .2 Clamp-on Ultrasonic Type Liquid Flow Meter:
 - .1 Ultrasonic meter shall be capable of measuring bi-directional flow.
 - .2 Ultrasonic meter shall be complete with matched transducers, self-aligning installation hardware and coaxial transducer cables.
 - .3 Ultrasonic transducers provided shall be optimized for the specific pipe & process conditions for each application and the transducer frequency shall be automatically matched to the resonant frequency of the pipe at start-up.
 - .4 Provide an integral auto-zero function for zero precision and high accuracy at low flow velocities. Accuracy shall be within $\pm 1\%$ of rate from 1 to 40 ft/sec and ± 0.01 ft/sec for velocities below 1 ft/sec. Overall turndown shall exceed 400:1.
 - .5 Output signals shall be 4-20 mA and programmable pulse proportional to flow, with integral digital totalizer. Supply voltage 24 Vdc.
- .3 Inline (full bore) Electromagnetic Type Liquid Flow Meter:
 - .1 Electromagnetic type liquid flow meter shall be complete with integral electronics module. Electronics module shall include a backlit graphic display and keypad.
 - .2 The flow meter shall be capable of measuring bi-directional flow.
 - .3 Connections to the piping shall be ANSI class 150 flanges (ANSI class 300 available where required).
 - .4 The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316 stainless steel; the liner shall be polypropylene or ebonite for low temperature service, PTFE for hot water service.
 - .5 Each flow meter shall be individually wet-calibrated and accurate to within $\pm 0.2\%$ of reading from 1.6 to 33 feet per second velocity. A certificate of calibration shall be provided with each flow meter.
 - .6 Output signals shall be 4-20 mA and programmable pulse proportional to flow, with integral digital totalizer. Supply voltage 24 Vdc.
- .4 Turbine Type Liquid Flow Meter:
 - .1 Turbine type liquid flow meter shall be impedance based sensing device, with single or dual turbines, as required by application.
 - .2 Provide insertion type probe, bi directional, suitable for the system flow, temperature and pressure.
 - .3 Wetted material electroless nickel plated brass, or 316 stainless steel, as required by application.
 - .4 Pressure rating 2750 kPa, maximum / minimum continuous temperature rating -10°C to 93.3°C ,
 - .5 Sensing accuracy $\pm 2\%$ of reading with fluid velocity between 0.2 and 6.0 m/s.
 - .6 Pulse 0 -10 Vdc or 4-20mA output, proportional to flow, with integral digital totalizer. Supply voltage 24 Vdc.

2.37 FLUID FLOW ENERGY METERING

- .1 Where indicated in the documents provide fluid flow energy metering for the following services:

- .1 High Temperature Hot Water (supply and return),
- .2 Hot Water Heating (supply and return),
- .3 Chilled Water (supply and return),
- .4 Condenser water (supply and return),
- .5 Steam,
- .6 Condensate.
- .2 Flow metering installations shall be in compliance with the following:
 - .1 ISO Standard 5167 (latest version), Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full.
 - .2 AGA 3/ANSI 2530 (latest version), Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids,
 - .3 ASME MFC-3M (latest version) Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi.
 - .4 ASME Fluid Meters handbook (latest version),
- .3 Provide temperature and pressure compensation for mass flow density algorithms used for fluid flow energy metering as follows:
 - .1 Temperature sensors used in metering (eg. BTU) applications shall be in compliance with the following requirements:
 - .1 Tip-Sensitive thermistor sensors
 - .2 Provide compensation for resistance resulting from wire lead length.
 - .3 The sensors must be a matched pair.
 - .2 Provide 316 stainless steel thermowells for temperature sensors in compliance with the following requirements:
 - .1 Stainless steel probe length shall be at minimum 30% of the pipe width.
 - .2 Moisture/waterproof housing with conduit fitting.
 - .3 Provide complete with thermal transfer compound inside thermal well.
 - .3 Gauge Pressure Transmitter used in metering (eg. BTU) applications shall be in compliance with the following requirements:
 - .1 0.035% span accuracy, 150:1 range turndown, 15-yr stability
 - .2 Output 4-20 mA and HART protocol.
 - .3 Provide a two valve manifold (316SST) for instrument isolation and a drain/vent valve, drain/vent valve allows venting, draining, or calibration.
 - .4 Acceptable manufacturers:
 - .1 Rosemount MVP Series,
 - .2 Or approved equal
- .4 Water (Heating, Chilled, Condenser) Flow and Energy Metering
 - .1 The minimum turndown capability of 40:1.
 - .2 Communication shall be to the BAS via Modbus RTU, Modbus TCP/IP, BACNET MSTP, BACNET/IP.
 - .3 Capable of 4-20 mA analog, pulse and RS 485 output signal.
 - .4 A local LCD display & flow computer that may be configured for various energy and configuration displays.

- .5 Accuracy: +0.5%, -1.0% of flow for velocities greater than 0.3 m/s; +0.0015, -0.003 m/s for velocities less than 0.3 m/s
- .6 Acceptable manufacturer:
 - .1 Siemens Ultrasonic Flow meter
 - .2 Flexim Fluxus
 - .3 Or approved equal.

2.38 POTABLE WATER METER

- .1 Utility Meter
 - .1 Provide Neptune Tru/Flo, or equal, municipal type compound water meter of the sizes shown on the drawings and meeting the local requirements of the Authorities Having Jurisdiction for accuracy and repeatability.
 - .2 All meters shall meet or exceed the latest revision of AWWA C702.
 - .3 The BAS Trades shall provide connection from BAS to standard output of a water meter transducer provided by local authorities.
 - .4 Provide 4-20 mA or 0-10VDC output as appropriate for interfacing with BAS.
- .2 Sub-metering:
 - .1 Provide water meters complete with bypass piping arrangement or other means to remove or isolate for service without interruption to water flow.
 - .2 Materials shall be compatible with the systems in which they are installed at all potential operating temperatures and pressures.
 - .3 Meters shall provide a pulse output scaled to an appropriate volume. In general, provide a scaled pulse output of 0.001cu.m per pulse unless high consumption would result in pulses too frequent to be reliably captured by the pulse counting equipment.
 - .4 For the main incoming water supply, Utility company to provide pulse output meter where feasible.
 - .5 Meters requiring power shall be hard-wired to an independent emergency power circuit. Battery powered units are not acceptable.
 - .6 Provide meters with readout of totalized volume.
 - .7 Accuracy +/- 1.5% in expected operating flow range.
 - .8 Data logging Equipment:
 - .1 Internet Protocol (IP) based data logger complete with:
 - .1 Built-in web server.
 - .2 Capable of operating with a dedicated IP address (to be provided by the Owner).
 - .3 Communications Protocols:
 - .1 HTTP/Post capable of pushing data to 3rd party applications/databases.
 - .2 Modbus TCP.
 - .4 Built-in real-time and historic graphics accessible with any HTML 5 internet browser (computer, tablet, phone) on the Region's network. Data to be displayed in local time, adjusted for daylight savings time. All meter functions to be accessible via the browser.
 - .5 Real-time clock with battery backup and email alert for battery end of life.
 - .6 Time-Stamp:

- .1 Represent date and time
- .2 In UTC time or offset from a specified UTC time
- .3 Resolution: Minimum 1 second
- .7 Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets. Time-stamps to be exported as a single field with a numeric (non-text) value in local time.
- .8 Published application programming interface (API) allowing data to be retrieved from the pulse counter via non-proprietary means, such as JavaScript Object Notation (JSON).
- .9 Built-in trending and data storage:
 - .1 3 years of consumption data at 5 minute intervals for each input with time-stamp
 - .2 Stored in non-volatile memory.
- .10 Battery/power backup (for pulse counting):
 - .1 Lasting a minimum of 72 hours
 - .2 Rechargeable
 - .3 Email alert for battery end of life.
- .11 Security:
 - .1 Unrestricted access to data and graphics over the Owner's network.
 - .2 Password protection for access to setup, changing settings/parameters and deleting data.
- .12 Ability to measure, store and trend the following data complete with time-stamp:
 - .1 Totalized consumption (cu.m)
- .2 Acceptable product:
 - .1 z3 Controls Inc. NetMeter OMNI
 - .2 or equivalent.

2.39 NATURAL GAS METERING

- .1 Utility Connection:
 - .1 The BAS Trades shall provide connection from BAS to standard output of a gas meter transducer provided by local authorities.
 - .2 Provide 4-20 mA or 0-10VDC output as appropriate for interfacing with BAS.
- .2 Sub-metering:
 - .1 Provide gas meters complete with bypass piping arrangement or other means to remove or isolate for service without interruption to gas flow.
 - .2 Materials shall be compatible with the systems in which they are installed at all potential operating temperatures and pressures.
 - .3 Meters shall provide a pulse output scaled to an appropriate volume. In general, provide a scaled pulse output of 0.01 m3 per pulse unless high consumption would result in pulses too frequent to be reliably captured by the pulse counting equipment.
 - .4 Meters requiring power shall be hard-wired to an independent emergency power circuit. Battery powered units are not acceptable.
 - .5 Provide meters with readout of totalized volume.

- .6 Accuracy +/- 1.5% in expected operating flow range.
- .7 Data logging Equipment:
 - .1 Internet Protocol (IP) based data logger complete with:
 - .1 Built-in web server.
 - .2 Capable of operating with a dedicated IP address (to be provided by the Region).
 - .3 Communications Protocols:
 - .1 HTTP/Post capable of pushing data to 3rd party applications/databases.
 - .2 Modbus TCP
 - .4 Built-in real-time and historic graphics accessible with any HTML 5 internet browser (computer, tablet, phone) on the Region's network. Data to be displayed in local time, adjusted for daylight savings time. All meter functions to be accessible via the browser.
 - .5 Real-time clock with battery backup and email alert for battery end of life.
 - .6 Time-Stamp:
 - .1 Represent date and time
 - .2 In UTC time or offset from a specified UTC time
 - .3 Resolution: Minimum 1 second
 - .7 Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets. Time-stamps to be exported as a single field with a numeric (non-text) value in local time.
 - .8 Published application programming interface (API) allowing data to be retrieved from the pulse counter via non- proprietary means, such as JavaScript Object Notation (JSON).
 - .9 Built-in trending and data storage:
 - .1 3 years of consumption data (cu.m) at 5 minute intervals for each input with time-stamp.
 - .2 Stored in non-volatile memory
 - .10 Battery/power backup (for pulse counting):
 - .1 Lasting a minimum of 72 hours
 - .2 Rechargeable
 - .3 Email alert for battery end of life
 - .11 Security:
 - .1 Unrestricted access to data and graphics over the Owner's network.
 - .2 Password protection for access to setup, changing settings/parameters and deleting data.
 - .12 Ability to measure, store and trend the following data complete with timestamp:
 - .1 Totalized consumption (cu.m)
 - .2 Acceptable product:
 - .1 z3 Controls Inc. NetMeter OMNI
 - .2 or equivalent

2.40 ELECTRICAL METERING

- .1 Provide electrical sub-meters for loads identified in the Drawings and Specification; sub-metering refers to meters that are installed after the main utility meter and within the building.
- .2 Internet Protocol (IP) based electrical meters as follows:
 - .1 Built-in web server.
 - .2 Capable of operating with a dedicated IP address (to be provided by the Region).
 - .3 Communications Protocols:
 - .1 HTTP/Post capable of pushing data to 3rd party applications/databases.
 - .2 Modbus TCP
 - .4 Built-in real-time and historic graphics accessible with any HTML 5 internet browser (computer, tablet, phone) on the Region's network. Data to be displayed in local time, adjusted for daylight savings time. All meter functions to be accessible via the browser.
 - .5 Real-time clock with battery backup and email alert for battery end of life.
 - .6 Time-Stamp:
 - .1 Represent date and time
 - .2 In UTC time or offset from a specified UTC time
 - .3 Resolution: Minimum 1 second
 - .7 Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets. Time-stamps to be exported as a single field with a numeric (non-text) value in local time.
 - .8 Published application programming interface (API) allowing data to be retrieved from the meter via non-proprietary means, such as JavaScript Object Notation (JSON).
 - .9 Built-in trending and data storage:
 - .1 2 years of consumption data (kWh) at 1 minute intervals with time-stamp; and
 - .2 10 years of consumption data (kWh) at 1 hour intervals with time-stamp.
 - .3 Stored in non-volatile memory.
 - .10 Security:
 - .1 Unrestricted access to data and graphics over the Region's network.
 - .2 Password protection for access to setup, changing settings/parameters and deleting data.
 - .11 Ability to measure, store and trend the following data at 1 minute intervals complete with time-stamp:
 - .1 Accumulated energy per phase (kWh)
 - .2 Accumulated total energy (kWh)
 - .3 Active power per phase (kW)
 - .4 Active total power (kW)
 - .5 RMS voltage per phase
 - .6 RMS current per phase
 - .7 Power factor per phase
 - .8 Total power factor
 - .9 Line frequency
- .3 Acceptable manufacturers:

- .1 z3 Controls Inc. NetMeter
- .2 Or approved equal

PART 3 - EXECUTION

3.01 GENERAL

- .1 Provide all control devices as indicated in the Documents and as may be necessary to properly execute sequence of operation indicated.
- .2 Install all controllers, cabinets, control devices and power supplies in readily accessible locations providing adequate ambient conditions for its specified application and to the requirements of the Authorities having Jurisdiction (AHJs).
- .3 Instrumentation and devices shall be installed in accordance with manufacturer's placement guidelines and installation instructions; and any installation requirements specific to the intended functioning of the control requirements. Report any discrepancies to the Consultant if any discrepancies are observed. Coordinate device locations with the mechanical, electrical and architectural drawings.
- .4 Mount all controllers and relays within Field Equipment Panels.
- .5 Mount sensor assemblies and elements;
 - .1 in clean areas wherever possible,
 - .2 accessible to allow for replacement and servicing without interfering with access for adjacent equipment and personnel traffic in surrounding space,
 - .3 provide access doors where assemblies and elements are concealed;
- .6 Rigidly support field mounted transmitters, transducers, and sensors on pipe stands or channel brackets.
- .7 Orient sensing elements to correctly sense measured variable and to be isolated from vibrations and environmental conditions that could affect measurement or calibration.
- .8 Identify each cable and wire at every termination point.
- .9 Air seal wires attached to sensors at entry into junction box.
- .10 Actuators shall be firmly mounted to provide positive movement and linkage(s) shall be adjusted to provide smooth continuous movement throughout 100 percent of the stroke.
- .11 All panel wiring within enclosures shall be protected by typical wire trough.

3.02 EXISTING INSTRUMENTATION

- .1 Remove and dispose of existing instrumentation which becomes redundant as part of the Work.
- .2 Reuse existing thermowells where possible.

3.03 POINT NAMING CONVENTION

- .1 BAS Trades shall confirm proposed point naming convention with the Owner prior to naming all points and controllers.
- .2 Each point shall be clearly identifiable by viewing from its point name.
- .3 Room numbering that is shown on the design documents should be followed.

3.04 COMPONENT IDENTIFICATION

- .1 Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
- .2 All field enclosures, other than controllers, shall be identified with a backlit or engraved nameplate.
- .3 Junction box covers will be marked to indicate that they are a part of the BAS system.
- .4 All I/O field devices (except space sensors) that are not mounted within field panels shall be identified with name plates.

- .5 All I/O field devices inside panels shall be labeled.

3.05 SAFETY CONTROLS

- .1 Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches and controls to be hard-wired to de-energize equipment as described in Sequence of Operation unless otherwise shown.
- .2 Safety switches and controls to require Operator intervention to activate local manual reset.
- .3 Provide contacts that allow BAS software to monitor safety control status.

3.06 FIELD EQUIPMENT PANELS

- .1 For all I/O requiring field interface devices, including transmitters, transducers, controllers, solenoid air valves and relays, install in NEMA 3R field equipment panel(s) to protect the device(s) from dust, moisture, conceal integral wiring and moving parts;
- .2 Cut-out mount switches and timers on control panel fronts.
- .3 Wiring to and from the field equipment panel(s) will be to screw type terminals; the use of wire nuts is prohibited;
- .4 Analog or communications wiring may use the field equipment panel(s) as a raceway without terminating;
- .5 Install wiring and tubing within enclosures in trays or individually clipped to back of panel with identification tags and terminal numbers visible;
- .6 Field panel enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.07 TEMPERATURE AND HUMIDITY SENSORS

- .1 Space temperature and humidity sensors shall be mounted away from machinery generating heat, direct light and diffuser air streams.
- .2 Mount space temperature and humidity sensors 1200 mm (4 ft) above finished floor.
- .3 Install room temperature and humidity sensors on concealed junction boxes supported by wall framing.
- .4 Use duct averaging temperature sensors in mixing plenums and hot and cold decks. Install temperature averaging sensors in serpentine manner vertically across duct. Support each bend with capillary clip.
- .5 Install mixing plenum low-limit temperature sensors in serpentine manner horizontally across duct. Support each bend with capillary clip. Provide temperature sensor element length to coil area ratio of 3 m per 1 m² (1 ft per 1 sq ft).
- .6 High-limit and low-limit temperature sensors:
- .7 Relay outputs for low-limit and high-limit temperature sensors shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
- .8 Install hardwire interlocked to supply fan starter for respective system.
- .9 Low Limit Temperature Sensors:
 - .1 shall shut down the fan when duct temperature is equal to or less than 1.67°C (35 °F) (field adjustable).
 - .2 Shall be located to adequately cover potential areas of low level stratification;
 - .3 Shall be provided for each 2.8 sq.m (25 sq.ft.) of duct cross section;
 - .4 Shall be mounted on plastic clips.
- .10 High Limit Temperature Sensors:
 - .1 Shall shut down the fans when duct temperature is equal to or greater than 51.7°C (125°F).
 - .2 Shall be provided for each 3.7 sq.m (40 sq.ft.) of duct cross section.

- .11 Liquid Temperature Sensors:
 - .1 Install pipe-mounted liquid temperature sensors in wells with heat-conducting material. Pipe-mounted liquid temperature sensors shall be removable without shutting down the system in which they are installed.
 - .2 Where thermowell installation necessitates shutting down of pumps or draining of pumps, coordinate shut-down with Consultant and Owner.
 - .3 Cut and recover piping insulation to one foot either way for installation of strap-on temperature sensors. Provide removable insulation box over sensor and patch insulation to match existing.
- .12 Outdoor Air Temperature and Humidity Sensors:
 - .1 Outdoor air temperature and humidity sensors shall be mounted on the north building face directly in the outside air.
 - .2 Install outdoor sensors such that the effects of heat or cold from the building such as lamps and exhaust vents.
 - .3 Provide solar shield. Install shield to open downward.
 - .4 Locate minimum 1500 mm (5 ft) above horizontal surfaces.
 - .5 Where indicated or specified for installation in outside air intake, locate so as not to be affected by exhaust air flow or reverse flow.
 - .6 Seal interior of conduit at penetration through exterior wall.
- .13 Guards for Temperature and Humidity Sensors:
 - .1 For wall mount sensors where subject to damage or vandalism, and where indicated on the drawings provide guards.
 - .2 Guards shall be clear, ventilated polycarbonate covers with allen key locking hardware.

3.08 PRESSURE SENSORS

- .1 Piping to air pressure transducer pressure ports on all pressure transducers shall contain capped test port adjacent to transducer.
- .2 Locate air pressure transducers, except those controlling terminal unit boxes as follows:
 - .1 in control panels, not on monitored equipment or on ductwork,
 - .2 mount transducers in vibration-free location accessible for service without use of ladders or special equipment.
- .3 Duct Static Pressure Sensor Installations:
 - .1 Duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure pitot tube inserted into the duct;
 - .2 the low pressure port shall be left open to reference the open area where the transmitter is installed.
 - .3 make pressure tap connections according to manufacturer's recommendations.
- .4 Building Static Pressure Sensor Installations:
 - .1 pipe pressure sensor's low-pressure port to static pressure port located on outside of building and install with a shielded static air probe to reduce pressure fluctuations caused by wind,
 - .2 pipe pressure sensor's high-pressure port inserted into the space via a metal tube behind thermostat cover
- .5 Fluid pressure measuring stations:
 - .1 Mount gauge tees adjacent to water differential pressure taps. Install shut-off valves before tee for water gauges in the high and low sensing pick-up lines.

- .2 Isolation valve and snubber to be installed between pressure sensor and pressure source.
- .3 Sensors and switches on steam lines and high temperature water to be protected by pigtail siphon installed between sensor and fluid line.
- .4 Provide two pressure transducers with software calculation at controller for differential pressure measurements in fluid piping systems.

3.09 INSTALLATION OF CURRENT SENSING SWITCHES

- .1 Relay portion shall relay portion shall be installed in local Field Equipment Panel, in the Controller enclosure, or in the wiring channel between MCC tubs, relay shall not be installed within MCC tubs;
- .2 Provide device securely mounted with screw type wire terminations;
- .3 Device shall be mounted for easy access.

3.10 INSTALLATION OF FLOW SWITCHES

- .1 Fit correct length paddle for diameter of pipe.
- .2 Adjust switch for specified flow condition in accordance with manufacturer's instructions

3.11 INSTALLATION OF AIR QUALITY SENSORS

- .1 CO Sensors:
 - .1 Mount the sensor 1200 to 1800 mm (4 to 6 ft.) above finished floor.
 - .2 Provide sufficient number of sensors for full coverage of the monitored area.
- .2 NO2 Sensors:
 - .1 Use two sensors per zone, mount one of the sensors 300 mm (1 ft.) above finished floor and the other 300 mm (1 ft.) from the ceiling or underside of exposed slab.
 - .2 Provide sufficient number of sensors for full coverage of the monitored area.

3.12 INSTALLATION OF GAS DETECTION SYSTEM

- .1 For Parking Garage and Loading Dock Gas Detection System, Refrigerant Leak Monitoring and Alarm System, and other Gas Detection Systems provide gas detection system sensor/transmitter and control panel equipment for areas where indicated and/or specified on drawings.
- .2 Review exact locations of equipment with Consultant prior to installation.
- .3 Perform required 24 volt wiring in conduit to control panel(s) and from each panel to associated sensor/transmitter units as required and in accordance with system manufacturer's certified wiring schematics.
- .4 Provide 24 volt interlock wiring to exhaust fan starters in accordance with drawing control requirements.

3.13 CONTROL DAMPERS

- .1 Furnish control dampers for installation by Mechanical Trades. Provide supervision on site during installation.
- .2 Installation of automatic control dampers shall be in accordance with manufacturer's installation guidelines.
- .3 Install uninsulated control dampers in areas maintained above freezing, and/or where shown in the Documents.
- .4 Install insulated control dampers on all systems that connect with (or transfer air to or from) the outdoors and/or where shown in the Documents.

3.14 CONTROL DAMPER ACTUATORS

- .1 Mount actuators and adapters according to manufacturer's recommendations.
- .2 Mount damper actuators directly on damper shaft or jackshaft using a V bolt design

- .3 Mount valve actuator directly on shaft or with linkages according to manufacturer's recommendations.
- .4 For low-leakage dampers with seals, mount actuator with minimum 5° travel available for damper seal tightening.
- .5 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close damper, then tighten linkage.
- .6 Provide mounting hardware and linkages for actuator installation.
- .7 BAS Trades shall be responsible for connecting to existing pneumatic system, or supplying and installing pneumatic system, where required to operate pneumatically actuated dampers.

3.15 CONTROL VALVES

- .1 Furnish control valves for installation by Mechanical Trades. Provide supervision on site during installation.
- .2 Refer to Drawings for location of normally open/ normally closed and common ports. Where normally open or normally closed ports are defined, provide a valve that will fail to that position if power or control signal is lost.

3.16 CONTROL VALVE ACTUATORS

- .1 Mount actuators and adapters according to manufacturer's recommendations; actuator motor shall be fully accessible for ease of maintenance.
- .2 Connect actuators to control valves with adapters approved by actuator manufacturer.
- .3 BAS Trades shall be responsible for connecting to existing pneumatic system, or supplying and installing pneumatic system, where required to operate pneumatically actuated control valves.

3.17 AIRFLOW MEASURING STATIONS

- .1 Provide transducers, relays, and interconnection wiring to perform Sequences of Operations as detailed and Monitoring in accordance with Controls Schematics.
- .2 Provide mounting hardware for installation of airflow measuring stations by Sheet Metal Trades.
- .3 Provide supervision on site during installation.

3.18 AIR FLOW SENSORS, DUCT MOUNTED

- .1 Furnish duct mounted air flow sensors for installation in ductwork by Sheet Metal Trades.
- .2 Provide supervision on site during installation.

3.19 AIR FLOW SENSORS, FAN BELL MOUTH

- .1 Coordinate installation of air flow sensors at inlet of fans with fan manufacturer.
- .2 Provide supervision on site during installation.

3.20 FLUID FLOW METERS

- .1 BAS Trades shall verify all meter locations with the Consultant prior to installation.
- .2 Follow fluid flow meter manufacturer's installation instructions with particular attention paid to upstream and downstream straight pipe runs. Provide a flow straightener, if required to meet the manufacturer's minimum upstream straight pipe run requirement.
- .3 Provide lateral and horizontal supports as required to minimize vibration at each meter location.
- .4 Ultrasonic clamp-on type liquid flow meter shall be installed without making any openings in the pipe wall and shall utilize non-wetted ultrasonic transducers that may be located up to 300 ft from the meter.
- .5 Insertion type flow meters shall be provided with all installation hardware necessary to enable insertion and removal of the meter without system shutdown and shall be capable of being inserted and removed by hand up to 400 psi. Install sensor through a 1" (25 mm) full port ball valve for easy removal.

- .6 For installations in non-metallic pipe, install grounding rings or probes as required.
- .7 The installing Mechanical Trade contractor is responsible for providing suitable mating flanges and any required line reducer.
- .8 Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter (no special interface device or computer required).

3.21 FLUID FLOW ENERGY METERS

- .1 Provide all configuration software and licenses and all required interface cables to the Owner.
- .2 The Energy Meter display/flow computer supplier shall set up, commission and verify energy measurement and shall train Owner in all aspects of Energy Meter computer setup and operation.
- .3 Energy Meter installation shall be complete including sensor wiring, power wiring, coordination of flow meter installation in a pipeline, setup for operation, labeling, commissioning with commissioning reports.

3.22 POTABLE WATER METERS

- .1 Provide potable water meters for each separate end use as follows:
 - .1 Facility incoming domestic cold water
 - .2 Plumbing fixtures
 - .3 Process water:
 - .1 vehicle wash,
 - .2 humidification.

3.23 CONTROL PROGRAMS

- .1 General:
 - .1 The control programs shall be modular and structured in order to provide specific control operation of HVAC components.
 - .2 All control programs shall provide a minimum of 20% spare memory for expansion.
 - .3 Each control program shall contain "REM" statements which explain this program operation.
 - .4 Each control program shall open with a list of the I/O points used and controlled in the program.
- .2 Sensors and Devices - are listed in this specification. Provide 5% spare I/O capacity.
- .3 Implement all control program concepts in full, or partial as required, to provide complete HVAC equipment control. The programs shall perform all control strategies on the basis of protecting equipment operation, saving operational energy costs, and indicating alarm conditions.
- .4 Programs which increase the system energy consumption or cause equipment failures will be refused and resolved by the contractor at no additional cost to the Owner.

3.24 CONTROL SYSTEMS

- .1 Install the entire Control system under supervision of factory trained engineers and technicians fully capable of providing instruction, routine maintenance, programming and emergency maintenance service on all system components.
- .2 During the training period and at no extra cost, make any required program changes to enable optimum system operation as directed by the Consultant.
- .3 Provide "status" confirmation by using auxiliary starter contacts load side activated relays or current transformer switches rated for design load operation for pumps. Use load side activated relays or auxiliary relay contacts for single phase motors. Use pressure differential switches for fans.

- .4 For stop/start operation wire only to starter "Auto" circuit. Failure to stop and start to register as an alarm.
- .5 In the event of a control system failure from any cause, provide for normally "on" sequence for equipment such as boilers, boiler pumps, heating pumps and coil circulation pumps and normally open to heating for scheduling valves and other 3 port valves to prevent coil and equipment freeze-up.
- .6 Provide a minimum of two spare input and two spare output points on each controller.
- .7 Where motor operation is specified to provide enable/disable, permissive or sequential operation, use programming software wherever possible or provide hard wire interlocks.

3.25 BAS TESTING, COMMISSIONING AND ACCEPTANCE

- .1 Provide Commissioning in accordance with Section 20 08 10 and Section 25 05 10.
- .2 When the BAS system is fully installed and operational, the Mechanical Trades, in conjunction with the BAS Trades, shall review and verify the system functions with the Engineer of Record, the Construction Manager/ General Contractor, the Commissioning Authority the Owner's Representative in accordance with the Documents.
- .3 Provide additional Testing as follows:
 - .1 Check the installation of each sensor, actuator, and controlled device.
 - .2 Verify and record in as built OEM drawings the wiring of each I/O sensor and device as installed.
 - .3 Calibrate each sensor as required.
 - .4 Manually operate each output for every system with a portable Mobile User Interface supplied by the BAS Trades for commissioning.
 - .5 Tune each control loop and print the response of trends for hard copy record. Identify correct PIO parameters on all print outs.
 - .6 Verify all start/stop operations, e.g. "schedule control", "Optimized I control", "unoccupied mode" setback.
 - .7 Verify all custom control programs and alarm functions.
 - .8 Perform end-to-end checks from an operator terminal to all sensors and actuators to verify system communications and control via LAN.
 - .9 Verify BACnet communications as specified and submit all point naming and identification values accordingly.
 - .10 Submit site specific trends which contain all I/O points recorded at an analog or digital time frequency that confirms the correct system operation.
- .4 Ensure the Work has met requirements outlined in the Article entitled 'Completion' found in Section 20 01 10.

END OF SECTION

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PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Comply with requirements of the Owner's General Requirements and all documents referred to therein.

1.02 DESCRIPTION

- .1 Comply with requirements of Section 20 01 10 Mechanical General Requirements.
- .2 Comply with requirements of Section 20 01 50 Basic Materials and Methods.
- .3 Comply with the requirements of Section 25 05 10 BAS General Requirements
- .4 Comply with the requirements of Section 25 10 10 BAS Control Network
- .5 Comply with the requirements of Section 25 30 10 BAS Instrumentation and Devices
- .6 Comply with the requirements of Section 26 05 00 Electrical General Requirements

1.03 WORK PERFORMED BY THIS SECTION

- .1 This section includes general specification for the integrated lighting control system.
- .2 Provide all conduit, wire, connectors, hardware, and other incidental items necessary for the complete and properly functioning relay lighting control system as described herein and shown on the plans.

1.04 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 20 01 10 and Section 26 05 01.
- .2 Submittal package shall contain:
 - .1 A complete bill of materials
 - .2 Sets of catalog cuts for standard equipment
- .3 Sets of shop drawings detailing all mechanical and electrical equipment including one line diagrams, wire counts, internal wiring and physical dimensions of each item. Marked up catalog cuts are unacceptable.
- .4 Upon completion of all contractor's wiring, and after all fixtures are installed and lamped, the contractor shall request the services of a factory representative to completely check out the system prior to energizing the system. At the time of check out and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.
- .5 Two complete sets of as-built drawings shall ship with the equipment when it leaves the factory, along with operations and maintenance manuals for the relay system.
- .6 Be responsible to ensure that any fluorescent ballasts supplied are compatible with the equipment being furnished on this project.
- .7 Follow manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

- .1 Obtain lighting controls from a single source with total responsibility for compatibility of lighting control system components specified in this Section.
- .2 All equipment shall be 100% tested. Sample testing is not acceptable.
- .3 All standard system line voltage components shall be UL listed and so labelled when delivered to the job site.
- .4 Manufacturer Requirements
 - .1 Experience – the manufacturer shall have been continuously engaged in the manufacture of architectural lighting controls and relays for no less than ten (10) years.
 - .2 Testing – manufacturer shall perform functional testing of all components to confirm proper operation prior to shipment.

1.06 DELIVERY, STORAGE AND HANDLING

- .1 Materials must be delivered in a timely manner to other trades.
- .2 Store materials away from exposure to harmful construction and weather conditions and at temperature and humidity conditions recommended by the manufacturer.

1.07 WARRANTY

- .1 All equipment shall be warranted free of defects in materials and workmanship.
- .2 24 months from date of turn-over to the Owner. Relay modules shall be warranted for a period of ten (10) years.

1.08 ACCEPTABLE MANUFACTURER

- .1 The specification is based on Intelligent Lighting Controls LightLEEDer and shall serve to indicate the quality of equipment required.
- .2 Alternate manufacturers must comply with the specifications herein in every detail.

PART 2 - PRODUCTS

2.01 LIGHTLEEDER PROGRAMMABLE LIGHTING CONTROL PANELS

- .1 Hardware Features:
 - .1 Controller Back-Box: Each programmable lighting controller shall be provided with a factory furnished; UL listed NEMA 1 enclosure designed for wall mounting. The backbox must be capable of being shipped ahead of the controller chassis insert to allow for rough-in of all electrical connections prior to receipt of the controller chassis insert.
 - .2 Controller Chassis Insert: Each programmable lighting controller shall be provided with a factory or field-installable controller chassis insert. The Controller chassis insert shall contain all controller electronics, power supplies, relays, contactors, and other required components. Controller chassis inserts shall arrive at the project site completely pre-wired and require only the connection of lighting circuits and control devices.
 - .3 Line Voltage / Control Voltage Separation: Each programmable lighting controller shall be provided with a mechanical barrier that separates all line voltage components and wiring from all control voltage components and wiring. An additional barrier may be installed within the line voltage section that shall provide isolation between normal and emergency circuits where required.
 - .4 Controller Covers: Each programmable lighting controller shall be provided with a dead front screw-held or hinged locking cover that is designed for either surface or flush mounting. Flush mount doors shall be provided with a trim ring. If a hinge-locking door is provided, it shall be provided with a slam-latch with 2 keys and door hooks to assist in mounting.
 - .5 Controller Capacity/Configurations: Controllers shall be available in sizes to accommodate 4, 8, 16, 24, 32, 40, 48, 56, and 64 relay outputs. Controllers shall be available with the electronics in the center and voltage dividers with the lighting relays on the right and left sides.
- .2 Electrical:
 - .1 Controller Power Supply: Each programmable lighting controller shall be provided with a dual-rated, UL-listed Class 2 transformer capable of either 120/277 VAC or 120/347 VAC primary (50 to 60 Hz). It shall contain an internal self-resetting fuse.
 - .2 Connections: All connections shall be made to clearly and permanently labeled termination points.
- .3 Controller Electronics:
 - .1 Controller CPU: Each programmable controller shall be provided with a CPU (Central Processing Unit) that shall provide all the programming and control functions for the entire controller.

- .2 Real-Time Clock: Each controller shall be provided with a Real-Time Clock used to perform all time-controlled functions. It shall use a high-voltage line-sync circuit for timing and a crystal for backup. Clock accuracy shall be held +/- 2 minutes per year and displayed to the second with the line-sync setting. Real-Time Clock functions shall include the time of day, day of the week, date, and automatic daylight-saving time and leap year adjustments. The time clock shall be protected against loss of time during a power outage for a period of up to 45 days without power of any type. Daylight Saving Time shall be adjustable with an enable/disable feature. Systems relying on a single clock device shall not be acceptable.
- .3 Relay Driver Module: Relay output cards shall be provided to expand the controller capability from 8 to 64 relay outputs in increments of 8. Electronics shall feature surge protection and optic isolation. It shall also provide an interface for mounting input boards.
- .4 Relay Control Switches: Controller shall contain push-button switches to turn all relays ON or OFF without the presence of any programming.
- .5 Backup and Restore: The controller shall be equipped with an internal memory backup and restore capability. It shall have the ability to back up all internal programming into additional onboard memory, verify present programming with backup, and restore programming.
- .6 Runtime Logging: The controller shall be equipped with memory to log the runtime of each relay. It shall be capable of storing up to 30 days or 1092 hours of data and be able to be exported in a delimitative format.
- .7 Non-Volatile Memory: Controller shall contain a minimum of 4 Mb of nonvolatile EEPROM memory with data retention of >200 years and electrostatic discharge protection of >4000V.
- .8 Power Input Surge Suppression: The controller's 24VAC power input shall be equipped with double surge suppression to protect the electronics from transient over-voltages. Protection shall clamp over-voltages up to 123 volts.
- .9 Data Line Surge Suppression: The controller data line communications shall be equipped with transient voltage suppression protection that will protect the electronics from electrostatic discharge and other transient over-voltages. Protection shall clamp transients up to 8kv direct discharges and 15kv air discharges.
- .10 Data Line Communications: The controller shall be equipped with serial communications through RJ45 connectors for communicating on CAT-5 cable with other panels and LightSync devices. It shall also be equipped with a separate local port for communicating with LightSync devices. The communications shall consist of 2-RS485 data lines.
- .11 USB Serial Communications: A USB port shall be provided for programming and interfacing the system with the use of a personal computer.
- .12 TCP/IP Communications: A TCP/IP port shall be provided for programming and interfacing the system with a personal computer over a network (LAN) or the internet (WAN).
- .13 Optional Module Interface: The controller shall contain 4 ports for interfacing optional modules which include communications and power. Optional modules shall be able to be mixed on each controller.
- .4 Switching and Control Devices:
 - .1 Device Node Capacity: The lighting controller shall support switch input control of up to 64 data line LightSync devices locally per panel and 254 per network for up to 16,510 devices. The first 8 device nodes shall be powered by the lighting controller. The addition of a power supply or power supply/repeater shall be required for each additional 20-device node. Each LightSync device shall have a unique address and shall be capable of being programmed to the applicable functions described in the Switched Input Types heading in this specification.
 - .2 Data Line Media: The data line shall consist of RS485 communications protocol transmitted over CAT-5, CAT-5E, or CAT-6 Cable. The cable shall have male RJ45 connectors installed on each end for interfacing controllers and LightSync devices. Both daisy-chain and "T" (3-direction branching) of cable runs shall be permitted. "T" branching shall be accomplished

- by the addition of power supply/repeaters. It shall be able to be wired in a home-run configuration for LightSync devices by the addition of a LightSync Hub.
- .3 LightSync Switch Stations: LightSync data line switch stations shall be available in momentary push button (1-7 switches and pilots) and each switch shall have an associated pilot light. It shall be provided with optional dimming Raise and Lower buttons. Switches can be provided as Scene Multi-zone, Scene Stations, Multi-zone Stations, or Non-Dim Stations. Each button shall control any or all the relays in the lighting controllers or the dimmer outputs on the network. There shall be an option to program each pilot LED to indicate the state of any Relay, Group, Preset, Scene, and static ON or OFF. It shall also have the capability to reverse the status: LED is ON if the relay is OFF etc. It shall be available with an optional Bluetooth interface option for interfacing and programming LLEVO panels with an app. It shall have an optional 915 MHz radio with point-to-point capabilities. It shall communicate 100 feet of line-of-sight with the wireless devices.
 - .4 LightSync Photocell Controllers: The photo controller shall be provided with 256 light to dark levels (0-1800fc). It shall allow the selection of 8 individual setpoints for OFF and ON and includes a selectable range of dead-band. It shall be programmable for a 2- or 30-second delay. Each set point shall control any or all the relays in the lighting controllers or the dimmer outputs on the network.
 - .5 LightSync Input Modules: The input module shall provide 4 inputs that accept momentary, momentary PB, and maintained switch closures. Each input shall be optically isolated and can accept dry contact closures or 12-24VDC signals. Each input shall control any or all the relays in the lighting controllers or the dimmer outputs on the network. It shall provide four pilot outputs that provide the true status of relays, groups, and presets. It shall be installed in the control panel or remotely mounted.
 - .6 LightSync Disable Key Switch: The disable switch shall provide an RJ45 connector that shall disable all LightSync devices down line with the closure of a key switch. It shall also provide two RJ45 connectors to pass data through. It shall indicate with an LED when the disable switch is active.
 - .7 LightSync Occupancy Sensor Input Module: The occupancy sensor input module shall provide power and inputs for motion sensors. It shall have 4 or 8 independent inputs that shall be able to interface multiple sensors. Each input shall control any or all of the relays in the lighting controllers or the dimmer outputs on the network. It shall have the ability to set AND/OR conditional logic. It shall be installed in the control panel or remotely mounted.
 - .8 LightSync 0-10V Dimmer Output Module: The 0-10VDC dimmer output module shall be designed to control dimmable ballasts or other 0-10VDC devices. Each module shall have 4 independent output channels that can control up to 200 devices per output at .5mA per device. It shall have the capability to vary its level 256 steps between 0 and 10VDC. It shall be able to respond to photo controllers, switch inputs, DMX512 signals, and timers. Each output shall be galvanically isolated up to 1500V to protect electronics. It shall be installed in the control panel or remotely mounted.
 - .9 LightSync Motor Control Output Module: The motor control output module shall be designed to control shade motors, louver motors, blind motors, skylights, or any other class 2 DC motors. Each module shall have 4 independent outputs that can be controlled by a switch input, photocell, or timer. The control time shall be selectable from .1 to 300 seconds. Each lighting controller shall handle up to 8 modules with 4 outputs on each. Each output shall be equipped with a limit switch input for each direction of the motor.
 - .10 Graphical Touch Screen Control Station: The Touch screen control station shall display the status and control the lighting control panel relay outputs via pre-programmed control objects on standard or custom bitmap screens.
- .5 Special Purpose Modules: The following special-purpose controller nodes shall be available. Four modules shall be permitted per controller.
- .1 BACnet Control: This module shall communicate directly to the lighting controller through serial communications from the BAS system using BACnet MSTP or BACnet IP protocol. It

- shall be able to read the status of inputs and relays and control single or multiple relays in the lighting controller. It shall also be able to disable/enable inputs and shall be able to force timer options.
- .2 DMX Control: This module shall support the control of relays using the standard USITT DMX512 protocol used by theatrical lighting systems. Each relay in the lighting panel shall be configured to be controlled by any DMX channel. It shall contain a frame filter that can be set from 1 – 16 frames. It shall have a priority setting for switch inputs or DMX signals. It shall have the capability to control any 0 – 10V dimming output throughout the network. It shall display current DMX levels from the keypad.
 - .3 DMX Driver: This module shall send DMX signals from the lighting control panels using the standard USITT DMX512 protocol used by theatrical lighting systems. Each module added to the panel shall control up to 64 channels. Each dimming output channel shall be able to be mapped to 1-512 DMX channels. It shall be 1 to 1 mapped or programmed with free software. It shall be installed in the control panel or remotely mounted.
 - .4 Modbus Control: This module shall communicate directly to the lighting controller through RS485, RS232, or TCP serial communications from the BAS system using Modicon Modbus RTU or ASCII protocol. It shall be able to read the status of inputs and relays and control single or multiple relays in the lighting controller. It shall also be able to disable/enable inputs and shall be able to force timer options.
 - .5 N2 Control: This module shall communicate directly to the lighting controller through serial communications from the BAS system using the Metasys-N2 protocol. It shall be able to read the status of inputs and relays and control single or multiple relays in the lighting controller. It shall also be able to disable/enable inputs and shall be able to force timer options.
 - .6 Protocol Input Control: This module shall allow serial communications from a Modbus, N2, or BACnet network. It shall be capable of emulating LightSync switches or photocells for direct control and status of relays, dimmers, or motor controls.
- .6 Programming: Programmable controllers shall be capable of being programmed, monitored, backed up, or controlled through any of the below methods. All programming changes shall take effect immediately as they are programmed and shall not suspend or disable switches or other system functions. The same functions shall be available for any of the connection types.
- .1 Local Keypad and Display: The system user shall be able to program, monitor, and control any of the controller features and functions through the use of a simple menu-driven self-prompting user interface consisting of a 4-line 20-character backlit LCD display and 8 selection keys that change function based on the current operating mode.
 - .2 USB Serial Direct Connect: The system user shall be able to program, monitor, or control any of the controller features and functions utilizing LightLEEDer Pro Windows-based graphical user interface software using a USB port from a PC.
 - .3 TCP/IP Connect: The system user shall be able to remotely program, monitor, or control any of the controller features and functions utilizing LightLEEDer Pro Windows-based graphical user interface software using a PC with TCP/IP on a LAN or WAN.
- .7 Diagnostics: Programmable controllers shall have the ability to do the following diagnostics.
- .1 Power Status: Each programmable lighting controller shall be provided with an LED on the controller and each output board shall indicate that power is present.
 - .2 Keypad: System users shall be able to view thru the keypad the status of any relay, input, group, or preset and force any ON or OFF.
 - .3 Software: System users shall be able to view thru the LightLEEDer Pro software the status of any relay, input, group, or preset and force any ON or OFF. It shall also be able to scan the network for devices and controllers and then poll them to verify network quality.

- .4 Relay Cycle Test: The controller shall have a cycle test for relays to turn them off/on/off and then return them to the original state to verify proper operation. It shall display the results for each relay for turning the relay ON and OFF.
- .5 Device Finder: It shall have the capability through the keypad to find LightSync devices, dimmer devices, and motor devices on the network.
- .6 Switch Test Mode: It shall be able to enter a switch test mode, where a switch input status LED will light when switch inputs are activated. It shall disable normal control when in this mode.
- .7 Demo Clock: It shall have the ability to speed the clock's time by 10, 30, or 60 times for testing timer functions.
- .8 Power Failure and Power-Up: Each programmable lighting controller shall be provided with circuitry that shall automatically shut down the controller whenever the incoming power fails to be delivered to the controller within the required limits. When power is returned to the controller, one of the following power-up modes will be implemented for each controlled relay output in the system.
 - .1 No Action: Upon restoration of incoming control power, the controller electronics shall be restarted and resume normal operations and all circuits will be maintained in the condition they were last in.
 - .2 Turn ON: Controller shall turn the selected relay output to the ON state after power-up.
 - .3 Turn ON if Input Closed: Controller shall turn the selected relay output to the ON state after power-up if the local input selected is closed. It shall be able to select any input to monitor.
 - .4 Turn OFF: Controller shall turn the selected relay output to the OFF state after power-up.
 - .5 Turn OFF if Input Closed: Controller shall turn the selected relay output to the OFF state after power-up if the local input selected is closed. It shall be able to select any input to monitor.
 - .6 On if Open Time, OFF if Closed Time: Controller shall turn the selected relay output to the ON state during Open hours and shall turn selected relay outputs to the OFF state during Closed hours. This shall be used in conjunction with OPEN/CLOSED timers.
 - .7 OFF if Open Time, ON if Closed Time: Controller shall turn the selected relay output to the OFF state during Open hours and shall turn selected relay outputs to the ON state during Closed hours. This shall be used in conjunction with OPEN/CLOSED timers.
 - .8 Time of Day: Controller shall turn the selected relay output to the ON or OFF state based on the time of day in 30-minute increments for every day of the week.
- .9 True Relay Status Feedback: Each controller shall be provided with circuitry that shall monitor the actual status of each relay via a set of pilot contacts mechanically linked to the relay main contacts.
- .10 Switch Input Details: All switch inputs shall have the following options:
 - .1 Input Flexibility: Each switch input shall accept a 2 or 3-wire maintained or momentary switch. It shall be capable of accepting a dry contact, open collector closure, or a 12-24VDC signal. Each switch shall be able to have 2 switch types associated with it in an A/B form.
 - .2 Input to Output Programmability: Any switch input shall be programmed to control any or all the controller's relay outputs without limitations in the network.
 - .3 Input Logic Conditionals: All switch inputs shall have 2 conditionals that add a logic "AND" or "OR" dependent on a relay on, a relay off, an "on" input opened or closed, and an "off" input opened or closed. It shall also have a priority level setting.
 - .4 Input Active Times: All switch inputs shall have a time-of-day or open/close time of action. This shall change the switch type on the time of day every 30 minutes or change per open/closed times.
 - .5 Input Types:

- .1 Momentary ON/OFF: When momentary contact is made between the ON and COM, relay outputs controlled by this input shall be turned ON. When momentary contact is made between OFF and COM, relay outputs controlled by this input shall be turned OFF.
- .2 Momentary ON/OFF w/Blink: When momentary contact is made between the ON and COM, relay outputs controlled by this input shall be turned ON. When momentary contact is made between OFF and COM, relay outputs controlled by this input shall blink and postpone being turned OFF. The alert time shall be programmable from 2 to 99 minutes. The blink alert function shall blink each relay twice prior to turning it OFF. If an ON command is received during the blink alert time, relay output shall be overridden and left ON for the override time. Override times shall be adjustable from 5 to 999 minutes in 1-minute increments.
- .3 Momentary Push-Button ON/OFF: When momentary contact is made between the ON and COM, relay outputs controlled by this input are turned ON and OFF alternately, based on the current state, each time contact is made.
- .4 Momentary Push-Button ON: When momentary contact is made between the ON and COM, relay outputs controlled by this input shall be turned ON.
- .5 Momentary Push-Button OFF: When momentary contact is made between ON and COM, relay outputs controlled by this input shall be turned OFF.
- .6 Momentary Push-Button Toggle: When momentary contact is made between ON and COM, relay outputs controlled by this input shall toggle from the present state.
- .7 Maintained ON/OFF: When contact is made between the ON and COM, relay outputs controlled by this input are turned ON. When contact is broken between ON and COM, relay outputs controlled by this input are turned OFF.
- .8 Maintained Multi-way: When contact is either made or broken between the ON and COM, relay outputs controlled by this input will be toggled between ON and OFF conditions. This function shall be similar to that of standard 3 and 4-way switches.
- .9 Maintained ON/OFF w/Blink: When contact is made between the ON and COM, relay outputs controlled by this input are turned ON. When contact is broken between ON and COM, relay outputs controlled by this input shall blink and postpone being turned OFF. The alert time shall be programmable from 2 to 99 minutes. The blink alert function shall blink each relay twice prior to turning OFF. If an ON command is received during the blink alert time, relay output shall be overridden and left ON for the override time. Override times shall be adjustable from 5 to 999 minutes in 1-minute increments.
- .10 Timed ON: The timed-ON input shall operate either from the input closure or open. If programmed to operate from the closure, the relays turn ON when the input closes and turn OFF after the time duration. The relays do nothing when the input opens. If programmed to operate from the open, the relays turn ON when the input closes and remain ON. When the input opens, the relays turn OFF after the timed-ON duration.
- .11 HID Bi-Level: This feature requires the configuration of ON/OFF relay outputs and HI/LOW relay outputs. The first momentary contact between ON and COM sets the ON relay outputs to ON and the HI/LOW outputs to HI (for at least 15 Minutes). The second contact switches the HI/LOW outputs to LOW. Additional contact closures will toggle the HI/LOW relay outputs. The cycle then repeats until momentary contact is made between the switch input OFF and COM. then the ON/OFF outputs and HI/LOW outputs are turned OFF.
- .12 Two-Step Alternating Sequence: The first time the switch is activated, relay outputs programmed as "Group A" are turned ON, and relay outputs programmed as "Group B" are turned OFF. The second time the switch is activated, "Group A" relay

- outputs are turned OFF, and "Group B" relay outputs are turned ON. The third time the switch is activated, the pattern begins again at step one.
- .13 Four-Step Alternating Sequence: The first time the switch is activated, relay outputs programmed as "Group A" are turned ON, and relay outputs programmed as "Group B" are turned OFF. The second time the switch is activated, "Group A" relay outputs are turned OFF, and "Group B" relay outputs are turned ON. The third time the switch is activated; both "Group A" and "Group B" relay outputs are turned ON. The fourth time the switch is activated; both "Group A" and "Group B" relays are turned OFF. The fifth time the switch is activated, the process begins again at step one.
 - .14 Set Preset: When momentary contact is made between the ON and COM, the selected preset scene will be activated.
 - .15 Set Scene: When momentary contact is made between the ON and COM, the selected scene will be activated.
 - .16 Force Timer: When momentary contact is made between the ON and COM, the selected timer will be activated.
- .11 Timer Functions: Each of the programmable lighting controllers shall have the described timer options listed below for the relay outputs.
- .1 Time-of-Day Timers: Each programmable lighting controller shall be provided with a minimum of 128 available timers (scheduled events) for use in developing time-of-day automated schedules. Each timer shall have the ability to turn any or all relay outputs ON or OFF at any time in 1-minute increments. Timers shall be day-of-week selectable and may be programmed to activate on any combination of days of the week. Each shall be capable of being programmed to be enabled or disabled for any day of the calendar year.
 - .2 Astronomical Scheduling: Each controller shall contain an astronomical time clock that shall calculate sunrise and sunset times based on the geographical latitude and longitude positioning. Sunrise and sunset times may be used as activation times for any system timer. In addition to sunrise and sunset time activation, the control shall be capable of programming activation time before and after these times based on an offset of 1-999 minutes.
 - .3 Open/Closed Time Control: The user shall also have the option of controlling relay outputs in relation to the Open/Closed times of the facility. The Open/Closed times may vary for different days of the week and may be programmed for each day of the year. In addition to Open/Closed time activation, the control shall be capable of programming activation time before and after these Open/Closed times based on an offset of 1-999.
 - .4 Off-Hour Sweeps: The system shall also support after-hours OFF sweeps of selected relays or groups of relays at user-defined one, two, or three-hour intervals.
- .12 Relay Output OFF Options: Each relay shall have the option to control the relay OFF in a certain way other than the default OFF.
- .1 Single Blink Alert: Each relay output within the programmable lighting controller shall be individually programmable to blink and postponed prior to being turned OFF. The alert time shall be programmable from 2 to 99 minutes. The blink alert function shall blink each relay twice prior to turning OFF with a timer OFF sweep to warn occupants of the upcoming OFF event. If an ON command is received during the blink alert time, the relay output shall be overridden and left ON for the override time. Override times shall be adjustable from 5 to 999 minutes in 1-minute increments.
 - .2 Double Blink Alert: Each relay output within the programmable lighting controller shall be individually programmable to blink and postponed prior to being turned OFF and then blinked 1 minute before turning OFF. The alert time shall be programmable from 2 to 99 minutes. The blink alert function shall blink each relay twice for each alert to warn occupants of the upcoming OFF event. If an ON command is received during the blink alert time, the

- relay output shall be overridden and left ON for the override time. Override times shall be adjustable from 5 to 999 minutes in 1-minute increments.
- .3 HID Delay: Each relay output within the programmable lighting controller shall have the ability to be controlled like a Single Blink Alert as described above but without the blink, alert to prevent damage to HID lamps.
 - .4 Alarm ON: Relays shall be capable of performing a momentary ON function. The ON function shall be programmable from 1 to 99 seconds.
 - .5 Alarm OFF: Relays shall be capable of performing a momentary OFF function. The OFF function shall be programmable from 1 to 99 seconds.
 - .6 Alarm Pulsed ON: Relays shall be capable of being cycled ON and OFF at 1-second intervals and returning to the OFF state. It shall be programmable from 1 to 90 seconds.
 - .7 Alarm Pulsed OFF: Relays shall be capable of being cycled OFF and ON at 1-second intervals and returning to the ON state. It shall be programmable from 1 to 90 seconds.
 - .8 Automatic Control Switch-OFF: Relays shall be capable of being cycled OFF for 5 seconds and then returned to the ON state for controlling Sentry or AS110 switches.
 - .9 Automatic Control Switch-Blink: Relays shall be capable of being cycled OFF for 1.5 seconds and then returned to the ON state for controlling Delay-OFF mode on AS110 switches.
- .13 Presets: The lighting controller shall support up to 256 user-defined presets of ON/OFF relay patterns. The presets shall be invoked by a switch or timer actuation.
 - .14 Descriptive Names: The system shall support the optional assignment of descriptive names (up to 10 characters) to the lighting controller, relay outputs, relay groups, inputs, timers, and presets. These names shall be able to switch from custom names to default names.
 - .15 Password Protection: Each Programmable controller shall have user-definable 6-digit alphanumeric passwords with 2 levels of access. It shall have control and edit for level 1 and control-only access for level 2.
 - .16 Networking:
 - .1 Network Capacities: In addition to the data line devices mentioned in Section D, LightLEEDer Controllers shall be linked together on the data line to form a Local Area Network (LAN) of up to 254 controller nodes.
 - .2 Network Features: The network manager shall allow the connection of up to 254 controllers and 254 data line devices (on top of the 64 devices per panel) and provide USB communications. It shall have a high-speed LightSync scanner, 4 gateway device ports, power for LightSync devices, and TCP/IP.
 - .3 Network Universe: The network of panels shall be capable to connect to other networks over a network (LAN) or over the internet (WAN) to interconnect multiple systems.
 - .4 Network Gateway: The following special-purpose gateways shall be available and provides network-wide control from a single point for its specialized function:
 - .1 Modbus Control: The Modbus gateway shall support communications from the BAS system using Modicon Modbus protocol from a single-point connection. All network input status, relay status, and control shall be supported.
 - .2 N2 Control: The N2 gateway shall support communications from the BAS system using a Metasys-N2 protocol from a single-point connection. Network-wide group status and control shall be supported.
 - .3 BACnet Control: The BACnet gateway shall support communications from the BAS system using BACnet MSTP or BACnet IP protocol from a single point connection. It shall allow up to 500 single relays, 100 multiple relays, 48 groups, and 48 presets.
 - .4 Advanced BACnet Control: The Advanced BACnet gateway shall support communications from the BAS system using BACnet IP protocol from a single-point

connection. It shall allow up to per panel; 20 Relays, 20 Dimmers, 16 LightSync devices (128 maintained inputs), 64 Groups/Presets, and 48 Scenes.

- .17 BAS System / Lighting Control System: Programmable lighting controllers integrated/interfaced with other building control and alarm systems must remain completely functional and continue to process all programmed commands, including time schedules and local switching.
- .1 Runtime Logging and Trending: Each lighting control panel shall be capable of logging Runtime and Trending data for each relay. This data shall be able to be harvested and exported from the entire system.
 - .2 Runtime Logging: The controller shall be able to internally log the runtime of each relay for up to 30 days. This data shall be able to be harvested with a personal computer at 1-minute intervals.
 - .1 Logging and Trending Software: Runtime Logging and Trending software shall be available for harvesting data from the lighting control panels. It shall have a dedicated personal computer connected to the system through a LAN or USB cable to the panel or network controller.
 - .2 Load Configuration: Each relay in the system shall be able to have a wattage load assigned to it to represent the actual load on the relay. Loads shall be able to be named, or names shall be exported directly from the system programming software.
 - .3 Combined Loads: Up to 254 combined relay loads shall be allowed, for total wattage recording of areas in the facility. The combined loads shall allow relays from any panel in the network. Combined loads shall be able to be named for identification in reports and graphs.
 - .4 Daily or Monthly Usage Report: The software shall be capable of generating spreadsheet reports in a daily or monthly format for each relay or combined relays in the system.
 - .5 Export Data: The compiled reports shall be able to be exported to a .csv (comma-separated value) file. These files when exported shall be coded for the year, month, and date.
 - .6 Daily or Monthly Usage Graphs: The software shall be capable of generating usage graphs in a daily or monthly format for each relay or combined relays in the system.
 - .7 Printing: Daily or monthly usage graphs shall have the capability to be directly printed from the software.
 - .8 Live Usage Graphs: The software shall have 1 to 9 live usage meter dials to display the present wattage of combined loads.
 - .9 Calendar View: It shall provide a full-year calendar that shall display the number of calendar events.
- .18 Graphical Control Interface (InSite Software): The software shall be a Windows-based graphical interface that allows monitoring and control of LightLEEDer panels using icons on custom or standard graphical screens.
- .1 Graphical Background Screens: Graphical background screen shall consist of any bitmap image with any resolution or number of colors. There shall be virtually limitless numbers of screens with a limit to the capacity of the computer.
 - .2 Multiple Interfaces: It shall support an unlimited number of satellite computers controlling the same system. (1 Main computer, multiple remote computers).
 - .3 Virtual PC: It shall support web access via a virtual computer.
 - .4 Fault Log: It shall log and notify of any relay or network faults.
 - .1 The software shall monitor itself and restart if there is a communication issue with the system.
 - .2 It shall automatically send an e-mail to the user(s) notifying them of the problem.

- .3 An alarm shall report if a relay does not turn on or off correctly with real-time status updates.
- .4 It shall log the loss of communications of each network and every node per network. It shall log when it goes offline and when it goes back online.
- .5 Control Icons: Control icons shall be unlimited per screen and shall be chosen from an extensive library. It shall be able to use custom control icons that can be created and saved as BMP, JPEG, or GIF images. Control icons shall be able to be placed anywhere on the screen and edited at any time. Control icons shall control relays, LL Groups, LL Presets, LL Scenes, LL Timers, or dimmer scenes.
- .6 Control Options: It shall have the following capabilities for control and setup.
 - .1 Flood: It shall have the capability to flood areas or change the color of a defined section of the screen (floor plan) for depicting On/Off states.
 - .2 Sounds: It shall be able to trigger custom sound WAV files for on/off triggers.
 - .3 Verify: There should be settings to verify control action and relay sweep commands.
 - .4 Toggle: This shall be a selectable action for relays which shall include always, never, or selective relays.
 - .5 Sweep Enable: There shall be an option for a sweep command.
 - .6 Grid: A grid shall be available for the design and placement of icons on the screens. This shall be adjustable for size and color, plus it shall be able to allow a snap-to-grid feature.
 - .7 Tool Tips: It shall have an optional Tool Tips option that can display text when hovered over an icon.
 - .8 Extra Loads: It shall have the capability to add extra loads to a single relay control icon.
 - .9 Import: It shall have the capability to import LightLEEDer settings and objects.
 - .10 Synchronize InSite Screens: Remote computers shall have the capability to synchronize screens with a single button push.
 - .11 Text Icons: Text icons can be added to any screen and shall be able to be placed anywhere on the screen and edited at any time. They should be adjustable for size, color, font, and transparency.
 - .12 UDP Command: It shall support UDP command strings for special functions in the system.
- .7 Navigation Icons: These shall have navigation buttons for going from one screen to another. These icons shall have the capability to be Global and be visible on all screens. Icons shall have standard sizes that shall be editable for color, size, and font. It shall be able to use custom control icons that can be created and saved as BMP, JPEG, or GIF images. Navigation icons shall be able to be placed anywhere on the screen and edited at any time.
- .8 Sequence Control: It shall be able to sequences with up to 16 transitions over a 12-hour period for events. It shall be able to turn on/off single relays, LL Groups, set a Preset, or LL Scenes in a sequence.
- .9 Dimmer and Motor Control:
 - .1 Single Slider: Slide dimmers shall be available for single control and/or status of a 0-10V output or an sACN slot.
 - .2 Pop-up Multi-Sliders: It shall have up to 16 pop-up control sliders. Each shall be able to be linked to any dimmer(s) in the system. It shall have the capability to have a slider to control all dimmers, direct or proportional.

- .3 Motor Controls: It shall be able to create icons for controlling motor controls. Icons shall have standard sizes that shall be editable for color, size, and font. It shall control the motor "positive or negative" from .1 seconds to 300 seconds.
- .10 Security and User Access:
 - .1 It shall have an Administrator lock-out for specific screens and for specific users during an event in the facility.
 - .2 It shall support up to 5 levels of user security.
 - .3 There shall be advanced managed user access for up to 32 users.
 - .4 A settable administrator timeout shall be settable from 15 minutes to 4 hours.
 - .5 The Administrator shall be able to assign users' access and passwords.
- .11 Multi Network: It shall be able to link together up to 32 LightLEEDer networks with up to 254 nodes per network to operate as one system.
- .12 Schedules: It shall have programmable schedules that send commands to each network and each node in the system.
 - .1 It shall have up to 4000 programmable schedules.
 - .2 It shall automatically control relays, groups, scenes, presets, or trigger a sequence.
 - .3 Schedules shall be based on a fixed time, shared time, or before-at-after sunrise-sunset.
 - .4 It shall have settable Latitude, Longitude, and time-zone settings with adjustable DST settings.
 - .5 It shall have a search option for all schedules that include relays, LL Groups, LL Presets, InSite Presets, and Sequences.
- .13 Runtime Monitoring: It shall incorporate the "Runtime Logging and Trending" software as specified in section "Q".
- .14 Diagnostics Dashboard: It shall have a tool to monitor all of the relays and devices in the system.
- .15 Serial Interfaces:
 - .1 sACN Interface: It shall have the capability to view sACN via (no interface needed for viewing) and control sACN through an Interactive Technologies CueServer Interface optional add-on.
 - .2 DMX Control: It shall have an optional DMX output for lighting fixtures and ILC LightLEEDer dimmer outputs
 - .3 BACnet IP: It shall have an optional serial input for status and control from InSite. It shall have up to 750 control points and status for InSite Groups, InSite Presets, or InSite Sequence. It shall have an export to .csv file for documentation.
- .19 Emergency UL 924 Lighting Controller Option: Each lighting controller shall have the option to provide an emergency lighting bypass without the use of external devices. It shall be UL 924 listed and clearly marked.
 - .1 Bypass Control: If normal power is lost, if selected, the panel shall force the EM relays to the ON position. It shall also force any 0-10V dimming to 100%.
 - .2 Control Type: It shall have the option to select the EM relay control for Force On, Force Off, and No change.
 - .3 Phase Monitoring: It shall be able to monitor up to three phases of normal power. Upon loss of any phase, the panel will go into an emergency state. It shall be selectable for each phase monitored. It shall be able to monitor 120/277 VAC circuits.
 - .4 Isolation: It shall have barriers to separate Normal and Emergency circuits.

- .5 Remote Testing: It shall be provided with input for remote testing. It shall also be provided an output for driving a remote status LED.

2.02 LIGHTLEEDER EVO LIGHTING CONTROLLERS

- .1 LightLEEDer EVO Controller: Each controller shall be designed to be remotely installed and provide control of 4 remote load control relays. This controller shall have the same features as the Programmable Lighting Control Panels excluding add-ons and naming.
 - .1 Enclosure: Each controller shall be provided with a NEMA 1 galvanized steel enclosure with a removable screw cover. It shall also be provided with a 1/2" nipple and pre-drilled mounting holes.
 - .2 Plenum Rated: Each controller shall be suitable for plenum mounting. Controllers without this rating shall be unacceptable.
 - .3 Listing: Lighting control shall be UL/CUL listed and shall bear labels indicating compliance.
 - .4 Controller Power Supply: Each lighting controller shall be provided with a dual-rated, UL-listed Class 2 power supply capable of 120/277 VAC or optional 120/347 VAC primary (50 to 60 Hz). It shall contain an internal self-resetting fuse.
 - .5 High Voltage Connections: Each controller shall be provided with 6" wire leads for terminating the high voltage connections. All connections shall be made to clearly and permanently labeled termination points.
 - .6 Low Voltage Connections: Controllers shall also be provided with RJ45 connectors for the data lines, and the relay connections. It shall also be provided push-to-connect connectors for occupancy sensors, and photo sensor inputs. All connections shall be made to clearly and permanently labeled termination points.
 - .7 Occupancy Sensor Inputs: It shall have 4 independent inputs, and each input shall be able to interface multiple occupancy sensors or hardwired switches. Each input shall control any or all the relays in the lighting controllers or the dimmer outputs. Each controller shall provide 24VDC total power for the occupancy sensors with the following current capabilities:
 - .1 200mA w/4 LightSync devices connected to the controller
 - .2 160mA w/5 LightSync devices connected to the controller
 - .3 120mA w/6 LightSync devices connected to the controller
 - .4 90mA w/7 LightSync devices connected to the controller
 - .5 60mA w/8 LightSync devices connected to the controller
 - .8 Photocell Inputs: It shall provide 2 integrated interfaces for ILC photocell heads. The photo controller shall be provided with 256 light to dark levels (0-1800fc). It shall allow the selection of 8 individual setpoints for OFF and ON and includes a selectable range of dead-band. It shall be programmable for a 2- or 30-second delay. Each set point shall control any or all the relays in the lighting controllers or the dimmer outputs.
 - .9 Local Data Line Port: It shall provide an RJ45 data line port for up to 61 LightSync data line devices. It shall provide power for LightSync devices as described in #7 or additional power added with an optional Power Supply Repeater.
 - .10 Real-Time Clock: Each controller shall be provided with a Real-Time Clock used to perform all time-controlled functions. It shall use a high-voltage line-sync circuit for timing and a crystal for backup. Clock accuracy shall be held +/- 2 minutes per year and displayed to the second with the line-sync setting. Real-Time Clock functions shall include the time of day, day of the week, date, and automatic daylight-saving time and leap year adjustments. The time clock shall be protected against loss of time during a power outage for a period of up to 45 days without power of any type. Daylight Saving Time shall be adjustable with an enable/disable feature. Systems relying on a single clock device shall not be acceptable.

- .11 Pre-Configured Programs: Each controller shall have up to 16 selectable pre-configured lighting application programs and 1 default contractor program.
- .2 LightSync -EVO Room Controller: Each controller shall be designed to be remotely installed and provide control of 4 load control relays. This controller shall have the same features as the Programmable Lighting Control Panels excluding add-ons and naming.
 - .1 Enclosure: Each controller shall be provided with a NEMA 1 galvanized steel enclosure with a removable screw cover. It shall also be provided with a 1/2" nipple and pre-drilled mounting holes.
 - .2 Plenum Rated: Each controller shall be suitable for plenum mounting. Controllers without this rating shall be unacceptable.
 - .3 Listing: Lighting control shall be UL/CUL listed and shall bear labels indicating compliance.
 - .4 Controller Power Supply: Each lighting controller shall be provided with a dual-rated, UL-listed Class 2 power supply capable of 120/277 VAC or optional 120/347 VAC primary (50 to 60 Hz). It shall contain an internal self-resetting fuse.
 - .5 High Voltage Connections: Each controller shall be provided with 6" wire leads for terminating the high voltage connections. All connections shall be made to clearly and permanently labeled termination points.
 - .6 Low Voltage Connections: Controllers shall also be provided with RJ45 connectors for the data lines, and the relay connections. It shall also be provided push-to-connect connectors for occupancy sensors, and photo sensor inputs. All connections shall be made to clearly and permanently labeled termination points.
 - .7 Occupancy Sensor Inputs: It shall have 4 independent inputs, and each input shall be able to interface multiple occupancy sensors or hardwired switches. Each input shall control any or all the relays in the lighting controllers or the dimmer outputs. Each controller shall provide 24VDC total power for the occupancy sensors with the following current capabilities:
 - .1 200mA w/4 LightSync devices connected to the controller
 - .8 Photocell Inputs: It shall provide 2 integrated interfaces for ILC photocell heads. The photo controller shall be provided with 256 light to dark levels (0-1800fc). It shall allow the selection of 8 individual setpoints for OFF and ON and includes a selectable range of dead-band. It shall be programmable for a 2- or 30-second delay. Each set point shall control any or all the relays in the lighting controllers or the dimmer outputs.
 - .9 Local Data Line Port: It shall provide an RJ45 data line port for up to 4 LightSync data line devices. It shall provide power for LightSync devices as described in #7 or additional power added with an optional Power Supply Repeater.
- .3 LightLEEDer EVO Integrated -4 -8 Relay Controller: Each controller shall be designed to be remotely installed and provide control of 4 or 8 integrated load control relays. This controller shall have the same features as the Programmable Lighting Control Panels excluding add-ons and naming.
 - .1 Enclosure: Each controller shall be provided with a NEMA 1 galvanized steel enclosure with a removable screw cover. It shall also be provided with 1/2" knockouts and pre-drilled mounting holes.
 - .2 Plenum Rated: Each controller shall be suitable for plenum mounting. Controllers without this rating shall be unacceptable.
 - .3 Listing: Lighting control shall be UL/CUL listed and shall bear labels indicating compliance.
 - .4 Controller Power Supply: Each lighting controller shall be provided with a dual-rated, UL-listed Class 2 power supply capable of 120/277 VAC primary (50 to 60 Hz). It shall contain an internal fuse for protection.
 - .5 Relay Ratings: It shall be provided with 4- or 8- 50A load relays that shall be de-rated for 16 amps for durability. It shall control 16A for each set of 4 outputs:

- .1 16A, 120/277VAC Electronic Ballast (LED)
- .2 16A 120/277VAC Tungsten
- .3 1/4 HP @ 120 VAC Motor Load
- .6 High Voltage Connections: Each controller shall be provided with terminal blocks for terminating the high voltage connections. All connections shall be made to clearly and permanently labeled termination points.
- .7 Low Voltage Connections: Controllers shall also be provided with RJ45 connectors for the data lines, and photo sensor connections. It shall also be provided push-to-connect and screw connectors for occupancy sensors, dimming, and low-voltage inputs. All connections shall be made to clearly and permanently labeled termination points.
- .8 Occupancy Sensor Inputs: It shall have 4 independent inputs, and each input shall be able to interface multiple occupancy sensors or hardwired switches. Each input shall control any or all the relays in the lighting controllers or the dimmer outputs. Each controller shall provide 24VDC total power for the occupancy sensors with the following current capabilities:
 - .1 60mA w/4 LightSync devices connected to the controller
 - .2 50mA w/5 LightSync devices connected to the controller
 - .3 40mA w/6 LightSync devices connected to the controller
 - .4 20mA w/7 LightSync devices connected to the controller
 - .5 0mA w/8 LightSync devices connected to the controller
- .9 Photocell Inputs: It shall provide an integrated interface for 1 ILC photocell head. The photo controller shall be provided with 256 light to dark levels (0-1800fc). It shall allow the selection of 8 individual setpoints for OFF and ON and includes a selectable range of dead-band. It shall be programmable for a 2- or 30-second delay. Each set point shall control any or all the relays in the lighting controllers or the dimmer outputs.
- .10 Local Data Line Port: It shall provide an RJ45 data line port for up to 17 LightSync data line devices. It shall provide power for LightSync devices as described in #8 or additional power added with an optional Power Supply Repeater.
- .11 Dimming: It shall be provided with 4 or 8 independent 0-10V dimming control outputs that shall sink a maximum of 100mA per output. Each output shall be galvanically isolated up to 1500V to protect the electronics. Each output will revert to 100% upon a power loss.
- .12 Real-Time Clock: Each controller shall be provided with a Real-Time Clock used to perform all time-controlled functions. It shall use a high-voltage line-sync circuit for timing and a crystal for backup. Clock accuracy shall be held +/- 2 minutes per year and displayed to the second with the line-sync setting. Real-Time Clock functions shall include the time of day, day of the week, date, and automatic daylight-saving time and leap year adjustments. The time clock shall be protected against loss of time during a power outage for a period of up to 45 days without power of any type. Daylight Saving Time shall be adjustable with an enable/disable feature. Systems relying on a single clock device shall not be acceptable.
- .13 Pre-Configured Programs: Each controller shall have up to 1 pre-configured default contractor program or 1 job-specific custom program.
- .4 LightLEEDer EVO Integrated 2 Relay Controller: Each controller shall be designed to be remotely installed and shall provide 2 integrated load control relays with dimming.
 - .1 Enclosure: Each controller shall be provided with a polycarbonate plastic enclosure provided with a 1/2" nipple and mounting tab.
 - .2 Plenum Rated: Each controller shall be suitable for plenum mounting. Controllers without this rating shall be unacceptable.
 - .3 Listing: Lighting control shall be UL/CUL listed and shall bear labels indicating compliance.

- .4 Controller Power Supply: Each lighting controller shall be provided with a dual-rated, UL-listed Class 2 power supply capable of 120/277 VAC primary (50 to 60 Hz). It shall contain an internal fuse for protection.
- .5 Relay Ratings: It shall be provided with 2- 50A load relays that shall be de-rated for 20 amps for durability:
 - .1 16A, 120/277VAC Electronic Ballast (LED)
 - .2 20A 120/277VAC General
 - .3 1/4 HP @ 120 VAC Motor Load
- .6 High Voltage Connections: Each controller shall be provided with color-coded wire leads. All connections shall be made to clearly and permanently labeled terminations.
- .7 Low Voltage Connections: Controllers shall also be provided with RJ45 connectors for the data lines, occupancy sensor, and photo sensor connections. Dimming shall be provided with color-coded wire leads. All connections shall be permanently labeled terminations.
- .8 Occupancy Sensor Inputs: It shall have 1 input with power provided. The input shall control any or all the relays in the lighting controllers or the dimmer outputs. Each controller shall provide 24VDC total power for the occupancy sensors with the following current capabilities:
 - .1 70mA w/1 LightSync device connected to the controller
 - .2 60mA w/2 LightSync devices connected to the controller
 - .3 50mA w/3 LightSync devices connected to the controller
 - .4 40mA w/4 LightSync devices connected to the controller
- .9 Photocell Inputs: It shall provide an integrated interface for 1 ILC photocell head. The photo controller shall be provided with 256 light to dark levels (0-1800fc). It shall allow the selection of 8 individual setpoints for OFF and ON and includes a selectable range of dead-band. It shall be programmable for a 2- or 30-second delay. Each set point shall control any or all the relays in the lighting controllers or the dimmer outputs.
- .10 Local Data Line Port: It shall provide an RJ45 data line port for up to 17 LightSync data line devices. It shall provide power for LightSync devices as described in #7 or additional power added with an optional Power Supply Repeater.
- .11 Dimming: It shall be provided with 2 independent 0-10V dimming control outputs that shall sink a maximum of 100mA per output. Each output shall be galvanically isolated up to 1500V to protect the electronics. Each output will revert to 100% upon a power loss.
- .12 Pre-Configured Programs: Each controller shall have up to 1 pre-configured default contractor program or 1 job-specific custom program.
- .5 LightSync EVO Integrated 2 Room Controller: Each controller shall be designed to be remotely installed and shall provide 2 integrated load control relays with dimming.
 - .1 Enclosure: Each controller shall be provided with a polycarbonate plastic enclosure provided with a ½" nipple and mounting tab.
 - .2 Plenum Rated: Each controller shall be suitable for plenum mounting. Controllers without this rating shall be unacceptable.
 - .3 Listing: Lighting control shall be UL/CUL listed and shall bear labels indicating compliance.
 - .4 Controller Power Supply: Each lighting controller shall be provided with a dual-rated, UL-listed Class 2 power supply capable of 120/277 VAC primary (50 to 60 Hz). It shall contain an internal fuse for protection.
 - .5 Relay Ratings: It shall be provided with 2- 50A load relays that shall be de-rated for 20 amps for durability:
 - .1 16A, 120/277VAC Electronic Ballast (LED)

- .2 20A 120/277VAC General
- .3 1/4 HP @ 120 VAC Motor Load
- .6 High Voltage Connections: Each controller shall be provided with color-coded wire leads. All connections shall be made to clearly and permanently labeled terminations.
- .7 Low Voltage Connections: Controllers shall also be provided with RJ45 connectors for the data lines, occupancy sensor, and photo sensor connections. Dimming shall be provided with color-coded wire leads. All connections shall be permanently labeled terminations.
- .8 Occupancy Sensor Inputs: It shall have 1 input with power provided. The input shall control any or all the relays in the lighting controllers or the dimmer outputs. Each controller shall provide 24VDC total power for the occupancy sensors with the following current capabilities:
 - .1 70mA w/1 LightSync device connected to the controller
 - .2 60mA w/2 LightSync devices connected to the controller
 - .3 50mA w/3 LightSync devices connected to the controller
- .9 **Photocell Inputs: It shall provide an integrated interface for 1 ILC photocell head. The photo controller shall be provided with 256 light to dark levels (0-1800fc). It shall allow the selection of 8 individual setpoints for OFF and ON and includes a selectable range of dead-band. It shall be programmable for a 2- or 30-second delay. Each set point shall control any or all the relays in the lighting controllers or the dimmer outputs.**
- .10 Local Data Line Port: It shall provide an RJ45 data line port for up to 3 LightSync data line devices. It shall provide power for LightSync devices as described in #8 or additional power added with an optional Power Supply Repeater.
- .11 Dimming: It shall be provided with 2 independent 0-10V dimming control outputs that shall sink a maximum of 100mA per output. Each output shall be galvanically isolated up to 1500V to protect the electronics. Each output will revert to 100% upon a power loss.
- .12 Pre-Configured Programs: Each controller shall have up to 1 pre-configured default contractor program or 1 job-specific custom program.

2.03 LIGHTLEEDER WIRELESS PRODUCT LINE

- .1 LightLEEDer Wireless EVO Controller: Each controller shall be designed to be remotely installed and shall provide wireless control from the LightLEEDer network to the wireless devices. This controller shall have the same features as the Programmable Lighting Control Panels.
 - .1 Enclosure: Each controller shall be provided with a polycarbonate plastic enclosure provided with a 1/2" nipple and mounting tab.
 - .2 Plenum Rated: Controller shall be suitable for plenum mounting and rated to the UL 2043 standards. Controllers without this rating shall be unacceptable.
 - .3 Listing: Lighting control shall be UL/CUL listed and shall bear labels indicating compliance.
 - .4 Controller Power Supply: Each lighting controller shall be provided with a dual-rated, UL-listed Class 2 power supply capable of 120/277 VAC primary (50 to 60 Hz). It shall contain an internal fuse for protection.
 - .5 Real-Time Clock: Each controller shall be provided with a Real-Time Clock used to perform all time-controlled functions. It shall use a high-voltage line-sync circuit for timing and a crystal for backup. Clock accuracy shall be held +/- 2 minutes per year and displayed to the second with the line-sync setting. Real-Time Clock functions shall include the time of day, day of the week, date, and automatic daylight-saving time and leap year adjustments. The time clock shall be protected against loss of time during a power outage for a period of up to 45 days without power of any type. Daylight Saving Time shall be adjustable with an enable/disable feature. Systems relying on a single clock device shall not be acceptable.

- .6 Wireless Communications: It shall have a 915Mhz radio with point-to-point capabilities. It shall communicate 100 feet of line-of-sight with the wireless devices.
- .7 Bluetooth Wireless Communications: It shall have a Bluetooth radio for communications to a phone app for programming and control.
- .8 SWX Wireless Communications: It shall have the capability to communicate directly with ILC SWX occupancy sensors. It shall communicate 100 feet of line-of-sight with the wireless devices.
- .9 LightLEEDer Remote Wireless 5A Relay: The wireless remote relay shall be designed to be mounted to a junction box or fixture and shall control 1 load up to 5 Amps and 0-10V dimming.
- .10 Listing: Lighting control relays shall be individually UL/CUL listed and shall bear labels indicating compliance.
- .11 Plenum: Each relay shall be suitable for plenum mounting and rated to the UL 2043 standards. Controllers without this rating shall be unacceptable.
- .12 Labeling: Lighting control relays shall bear labels for relay current ratings.
- .13 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
- .14 SCCR: Lighting relays shall have an SCCR rating of 5,000 amps up to 277 VAC.
- .15 Relay Ratings: The lighting control load relays shall be designed for:
 - .1 5A, 120/277VAC Electronic Ballast (LED)
 - .2 5A 120/277VAC General
 - .3 1/4 HP @ 120 VAC Motor Load
- .16 Latching: Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
- .17 Mounting: It shall have a 1/2" nipple for mounting to an enclosure or fixture
- .18 Wireless Communications: It shall have a 915Mhz radio with point-to-point capabilities. It shall communicate 100 feet of line-of-sight with the wireless devices.
- .19 Wireless Direct Link/Networking: It shall support up to 6 Wireless Direct Link devices and 2 photo sensors. It shall be able to be controlled with a LLEVO-W controller.
- .2 LightLEEDer Wireless Remote 20A Relay: The wireless remote relay shall be designed to be mounted to a junction box or fixture and shall control 1 load up to 20 Amps and 0-10V dimming.
 - .1 Listing: Lighting control relays shall be individually UL/CUL listed and shall bear labels indicating compliance.
 - .2 Plenum: Each relay shall be suitable for plenum mounting and rated to the UL 2043 standards. Controllers without this rating shall be unacceptable.
 - .3 Labeling: Lighting control relays shall bear labels for relay current ratings.
 - .4 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
 - .5 SCCR: Lighting relays shall have an SCCR rating of 5,000 amps up to 277 VAC.
 - .6 Relay Ratings: It shall be provided with 1- 50A load relays that shall be de-rated for 20 amps for durability:
 - .1 16A, 120/277VAC Electronic Ballast (LED)
 - .2 20A 120/277VAC General
 - .3 1/4 HP @ 120 VAC Motor Load

- .4 It shall be suitable for plug-loads
- .7 Latching: Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
- .8 Mounting: It shall have a ½" nipple and a tab for mounting to an enclosure or fixture.
- .9 Wireless Communications: It shall have a 915Mhz radio with point-to-point capabilities. It shall communicate 100 feet line-of-sight with the wireless devices.
- .10 Wireless Direct Link/Networking: It shall support up to 6 Wireless Direct Link devices and 2 photo sensors. It shall be able to be controlled with a LLEVO-W controller.
- .3 LightLEEDer Wireless Remote 20A 2-Relay: The wireless remote relay shall be designed to be mounted to a junction box or fixture and shall control 2 loads up to 20 Amps and 0-10V dimming.
 - .1 Listing: Lighting control relays shall be individually UL and CUL listed and shall bear labels indicating compliance.
 - .2 Plenum: Each relay shall be suitable for plenum mounting and rated to the UL 2043 standards. Controllers without this rating shall be unacceptable.
 - .3 Labeling: Lighting control relays shall bear labels for relay current ratings.
 - .4 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
 - .5 SCCR: Lighting relays shall have an SCCR rating of 5,000 amps up to 277 VAC.
 - .6 Relay Ratings: It shall be provided with 2- 50A independent isolated load relays that shall be de-rated for 20 amps for durability:
 - .1 16A, 120/277VAC Electronic Ballast (LED)
 - .2 20A 120/277VAC General
 - .3 1/4 HP @ 120 VAC Motor Load
 - .4 It shall be suitable for plug-loads
 - .7 Latching: Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
 - .8 Mounting: It shall have a ½" nipple and a tab for mounting to an enclosure or fixture.
 - .9 Wireless Communications: It shall have a 915Mhz radio with point-to-point capabilities. It shall communicate 100 feet line-of-sight with the wireless devices.
 - .10 Wireless Direct Link/Networking: It shall support up to 6 Wireless Direct Link devices and 2 photo sensors. It shall be able to be controlled with a LLEVO-W controller.
- .4 LightLEEDer Wireless Remote 20A 2-Relay with Emergency Bypass: The wireless remote relay shall be designed to be mounted to a junction box or fixture and shall control 2- load circuits up to 20 Amps and 0-10V dimming. It shall combine normal relay operation with the UL924 bypass relay.
 - .1 Listing: Lighting control relays shall be individually UL/CUL/UL924 listed and shall bear labels indicating compliance.
 - .2 Plenum: Each relay shall be suitable for plenum mounting and rated to the UL 2043 standards. Controllers without this rating shall be unacceptable.
 - .3 Labeling: Lighting control relays shall bear labels for relay current.
 - .4 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
 - .5 SCCR: Lighting relays shall have an SCCR rating of 5,000 amps up to 277 VAC.

- .6 EM Function: It shall have one normal power relay and one EM relay. Both shall be controlled by a wireless system. Upon loss of power, the EM relay shall be forced to the ON state. During the EM state, 0-10 V dimming shall be forced to 100%.
- .7 Relay Ratings: It shall be provided with 2- 50A load relays that shall be de-rated for 20 amps for durability:
 - .1 16A, 120/277VAC Electronic Ballast (LED)
 - .2 20A 120/277VAC General
 - .3 1/4 HP @ 120 VAC Motor Load
 - .4 It shall be suitable for plug-loads
- .8 Latching: Normal power lighting control relay shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
- .9 Mounting: It shall have a 1/2" nipple for mounting to an enclosure or fixture.
- .10 Test Button: It shall have a test button for testing the EM function.
- .11 Test Input: It shall have an input for testing the EM function from a remote location.
- .12 Wireless Communications: It shall have a 915Mhz radio with point-to-point capabilities. It shall communicate 100 feet line-of-sight with the wireless devices.
- .13 Wireless Direct Link/Networking: It shall support up to 6 Wireless Direct Link devices and 2 photo sensors. It shall be able to be controlled with a LLEVO-W controller.
- .14 Wireless Direct Link/Networking: It shall support up to 6 Wireless Direct Link devices and 2 photo sensors. It shall be able to be controlled with a LLEVO-W controller.

2.04 LIGHTING CONTROL RELAYS

- .1 LightLEEDer Reliant40-1 Single Pole Relay: It shall be designed for controlling high-inrush single pole lighting circuits. It shall employ 4 latching nickel-silver contacts.
 - .1 Listing: Lighting control relays shall be individually UL/CUL listed and shall bear labels indicating compliance.
 - .2 Labeling: Lighting control relays shall bear labels for relay current and SCCR ratings.
 - .3 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
 - .4 SCCR: Lighting relays shall have an SCCR rating of 18,000 amps up to 347 VAC.
 - .5 Relay Ratings: It shall be rated for the following:
 - .1 16A, 120/277/347 VAC Electronic Ballast (LED)
 - .2 40A 120/277/347 VAC Ballast
 - .3 40A 120/277/347 VAC Tungsten
 - .4 1/5 HP @ 120 VAC Motor Load
 - .5 It shall be suitable for plug-loads
 - .6 Latching: Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
 - .7 Auxiliary Contacts: Each Lighting control relay shall contain an auxiliary set of contacts rated at 1 AMP 30 VAC/VDC electrically isolated but mechanically linked to the main contacts for the purpose of true status monitoring and pilot light activation.
 - .8 Mounting: Relays shall be capable of panel mounting.
 - .9 Lock-Out: Relays shall be equipped with an Enable/Disable switch to lock out On/Off control from the controller.

- .10 Actuator: Relays shall be equipped with a manual actuator switch for turning the relay ON or OFF along with status indication.
- .2 LightLEEDer Reliant40-2 and 3 Pole Relay: It shall be designed for controlling high-inrush 2-, 3-pole lighting circuits. Each pole shall employ 4 latching nickel-silver contacts.
 - .1 Listing: Lighting control relays shall be individually UL/CUL listed and shall bear labels indicating compliance.
 - .2 Labeling: Lighting control relays shall bear labels for relay current and SCCR ratings.
 - .3 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
 - .4 SCCR: Lighting relays shall have an SCCR rating of 18,000 amps up to 347 VAC.
 - .5 Relay Ratings: Each relay shall be designed for the control of 208, 240, and 480 VAC lighting loads at the following per pole.
 - .1 16A, 120/277/347 VAC Electronic Ballast (LED)
 - .2 40A 120/277/347 VAC Ballast
 - .3 40A 120/277/347 VAC Tungsten
 - .4 1/5 HP @ 120 VAC Motor Load
 - .5 It shall be suitable for plug-loads
 - .6 Latching: Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
 - .7 Auxiliary Contacts: Each Lighting control relay shall contain an auxiliary set of contacts rated at 1 AMP 30 VAC/VDC electrically isolated but mechanically linked to the main contacts for the purpose of true status monitoring and pilot light activation.
 - .8 Mounting: Relays shall be capable of panel mounting.
 - .9 Lock-Out: Relays shall be equipped with an Enable/Disable switch to lock out On/Off control from the controller.
 - .10 Actuator: Relays shall be equipped with a manual actuator switch for turning the relay ON or OFF along with status indication.
 - .11 Mechanical Link: Poles within the relay shall be electrically isolated but mechanically linked so as to open and close together without the possibility of one pole being closed while the other remains open. Systems that utilize two single-pole relays to accomplish this function are not acceptable.
- .3 LightLEEDer Remote R20 Single Pole Relay: The remote relay shall be designed to be mounted to a junction box or fixture and shall control 1 load up to a 16 Amp circuit.
 - .1 Listing: Lighting control relays shall be individually UL/CUL listed and shall bear labels indicating compliance.
 - .2 Plenum: It shall be plenum rated.
 - .3 Labeling: Lighting control relays shall bear labels for relay current and SCCR ratings.
 - .4 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
 - .5 SCCR: Lighting relays shall have an SCCR rating of 5,000 amps up to 347 VAC.
 - .6 Relay Ratings: It shall be rated for the following:
 - .1 16A, 120/277/347 VAC Electronic Ballast (LED)
 - .2 16A 120/277/347 VAC Ballast
 - .3 16A 120/277/347 VAC Tungsten

- .4 16A 120/277/347 VAC Resistive
- .5 1/5 HP @ 120 VAC Motor Load
- .6 It shall be suitable for plug-loads
- .7 Latching: Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
- .8 Mounting: It shall have a ½" nipple for mounting to an enclosure or fixture
- .4 LightLEEDer Remote R20D Single Pole Relay W/Dimming: The remote relay shall be designed to be mounted to a junction box or fixture and shall control 1 load up to 16 Amp circuit and 0-10V dimming.
 - .1 Listing: Lighting control relays shall be individually UL and CUL listed and shall bear labels indicating compliance.
 - .2 Plenum: Each relay shall be suitable for plenum mounting and rated to the UL 2043 standards. Controllers without this rating shall be unacceptable.
 - .3 Labeling: Lighting control relays shall bear labels for relay current ratings.
 - .4 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
 - .5 SCCR: Lighting relays shall have an SCCR rating of 5,000 amps up to 277 VAC.
 - .6 Relay Ratings: It shall be rated for the following:
 - .1 16A, 120/277/347 VAC Electronic Ballast (LED)
 - .2 16A 120/277/347 VAC Ballast
 - .3 16A 120/277/347 VAC Tungsten
 - .4 16A 120/277/347 VAC Resistive
 - .5 1/5 HP @ 120 VAC Motor Load
 - .6 It shall be suitable for plug-loads
 - .7 Dimming: Shall be able to control 0-10V dimming ballast and be able to sink up to 100 mA.
 - .8 Latching: Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
 - .9 Mounting: It shall have a ½" nipple for mounting to an enclosure or fixture
- .5 LightLEEDer Remote 20 Amp Dimming Relay with Emergency Bypass: The remote relay shall be designed to be mounted to a junction box or fixture and shall control 2- load up to 20 Amps circuits and 0-10V dimming. It shall combine normal relay operation with UL924 bypass relay.
 - .1 Listing: Lighting control relays shall be individually UL/CUL/UL924 listed and shall bear labels indicating compliance.
 - .2 Plenum: Each relay shall be suitable for plenum mounting and rated to the UL 2043 standards. Controllers without this rating shall be unacceptable.
 - .3 Labeling: Lighting control relays shall bear labels for relay current ratings.
 - .4 Endurance: Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
 - .5 SCCR: Lighting relays shall have an SCCR rating of 5,000 amps up to 347 VAC.
 - .6 EM Function: It shall have one normal power relay and one EM relay. Both shall be controlled by a LightLEEDer controller. Upon loss of power, the EM relay shall be forced to the ON state. During the EM state, 0-10 V dimming shall be forced to 100%.

- .7 Relay Ratings: It shall be provided with 2- 50A load relays that shall be de-rated for 20 amps for durability:
 - .1 16A, 120/277VAC Electronic Ballast (LED)
 - .2 20A 120/277VAC General
 - .3 1/4 HP @ 120 VAC Motor Load
 - .4 It shall be suitable for plug-loads
- .8 Latching: Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid-state or electrically held relays are not acceptable.
- .9 Mounting: It shall have a 1/2" nipple for mounting to an enclosure or fixture.
- .10 Test Button: It shall have a test button for testing the EM function.
- .11 Test Input: It shall have an input for testing the EM function from a remote location.
- .12 Wireless Communications: It shall have a 915Mhz radio with point-to-point capabilities. It shall communicate 100 feet line-of-sight with the wireless devices.
- .6 ILC EM20 Emergency Bypass Relay: The remote relay shall be designed to be mounted to a junction box or fixture. It shall provide automatic bypass for emergency power.
 - .1 Listing: Lighting control relays shall be individually UL/CUL/UL924 listed and shall bear labels indicating compliance.
 - .2 Labeling: Lighting control relays shall bear labels for relay current ratings.
 - .3 SCCR: Lighting relays shall have an SCCR rating of 5,000 amps up to 2777 VAC.
 - .4 Loads: Lighting bypass relays shall be designed for bypass of 120 or 277 VAC @ 20 amps.
 - .5 Bypass: It shall automatically bypass normal power upon loss of emergency power
 - .6 Mounting: It shall have a 1/2" nipple for mounting to an enclosure or fixture.

2.05 SWITCH STATIONS AND COVER PLATES

- .1 Hardwired Switches and Cover Plates: Electrical contractor shall provide and install switch plates and switches of the quantities and types shown on the drawings and specified herein.
 - .1 Heavy Duty Switch
 - .1 Switch: It shall consist of a single-pole double-throw center OFF momentary heavy-duty toggle or Decora® paddle switch rated at 15-20 Amps @ 120/277 VAC. They shall be available in ivory or white colors.
 - .2 Cover Plates: Plates shall be available for Decora® switches in ivory, white, or stainless steel with or without visible screws and come in 1-4 gangs.
 - .3 Nomenclature: Engraving shall be available on phenolic labels or directly on the plate.
 - .2 Key Switch
 - .1 Key Switch: Key switch shall consist of a single-pole double-throw momentary or maintained switch. They shall be available to allow the key to being removed in the ON position or the OFF position.
 - .2 Cover plates: Plates shall be available in stainless steel, brushed aluminum, or painted cold rolled steel. They shall be available with 1-2 switches per gang plate and up to 4 gangs.
 - .3 Status: LED status indicators shall be optional for each switch provided.
 - .4 Nomenclature: Engraving shall be available on phenolic labels or directly on the plate.
 - .3 Touch Activated Switch

- .1 Switch: Touch activated switch shall be a momentary output push-button with an IP65 rating.
 - .2 Cover plates: Plates shall be available in stainless steel, brushed aluminum, or painted cold rolled steel. They shall be available with 1-3 switches per gang plate and up to 4 gangs.
 - .3 Gasket: Cover plate neoprene gaskets shall be available for weatherproof applications.
 - .4 Status: LED status indicators rings shall be optional for each switch provided.
 - .5 Nomenclature: Engraving shall be available on phenolic labels or directly on the plate.
- .2 Custom Switch Plates and Graphic Switch Stations: Electrical contractor shall provide and install custom switch plates and graphical switching stations of the quantities and types shown on the drawings and specified herein.
- .1 Switch Plates: Switch plates shall consist of a control panel faceplate, switches, and other control devices as required, LED pilot lights and all mounting hardware.
 - .2 Material: Switch plates shall be manufactured from a single piece of stainless steel, aluminum, brass or bronze, finished and labeled as per the plans and specifications or as indicated on approved drawings.
 - .3 Mounting: Switch plates shall be designed to mount either to a standard electrical gang box supplied by the electrical contractor for either flush or surface mounting or to a custom back-box supplied by the manufacturer.
 - .4 Nomenclature: Switch plate graphics and labeling shall be accomplished through the use of one or a combination of multi-color anodized, engraving or phenolic labels; laser etched or painted graphics.
 - .5 Graphics: Each switch station shall contain a graphic representation of the controlled space with switches and other control devices graphically located on the station so as to indicate their associated areas of control.

PART 3 - EXECUTION

3.01 EXECUTION

- .1 Verify that wiring conditions, which have been previously installed under other sections or at a previous time are acceptable for product installation in accordance with manufacturer's instructions.
- .2 Field measurements and coordinating the physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.
- .3 Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.02 INSTALLATION

- .1 Receive, mount, connect and place into operation all equipment. Provide all conduit, wire, connectors, hardware and other incidental items necessary for a properly functioning lighting control and relay system as described herein and shown on the plans.
- .2 Comply with manufacturer's product data, including shop drawings, technical bulletins, product catalog installation instructions and product carton instructions for installation.
- .3 Test that all branch load circuits are operational before connecting loads to system load terminals and then de-energize all circuits before installation.
- .4 Power shall not be applied to the relay system during construction and prior to turn-on unless specifically authorized by written instructions from the manufacturer.

3.03 TESTING

- .1 Upon completion of the installation, notify the manufacturer that the system is ready for formal check out. Notification shall be given in writing a minimum of 21 days prior to the time factory-trained personnel are required on site.
- .2 Upon completion of all line, load and interconnection wiring and after all fixtures are installed and lamped, manufacturer's rep shall completely check the installation prior to energizing the system. Each installed relay system shall be tested for proper ON/OFF operations, and proper LED illumination. Each installed control panel shall be tested verifying that each controlled load adjusts to the selected setting and that all switch LED's illuminate properly.
- .3 At the time of check out and testing, the Owner's representative shall be thoroughly instructed in the proper operation of the system.

3.04 SITE PROTECTION

- .1 Contractor shall protect installed product and finished surfaces from damage during all phases of installation including storage, preparation, testing and clean-up.

END OF SECTION 25 56 26



A member of the MCW Group of Companies
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207 Queen's Quay West, Suite 615
Toronto, Ontario
M5J 1A7

ELECTRICAL SPECIFICATIONS

FOR

YORK REGION

NORTH ROADS OPERATIONS CENTRE

TO

GEC ARCHITECTURE

DATED

MAY 23, 2025

REISSUED FOR TENDER

Contact Person: Desmond Lau
Phone: 647-968-0637
Email: dlau@mcw.com

MCW Project No. 23137

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END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 In case of discrepancy of the specifications details, the Owner's standards and requirements attached in the Appendices shall take precedence.**
- .2 Comply with the requirements of Division 1 and all documents referred to therein.

1.2 APPLICATION

- .1 This Section applies to and is a part of all Sections of Division 26.

1.3 DEFINITIONS

- .1 Wherever the term "This Sub-Contractor" is used in the Division 26 Drawings and Specifications, it means the firm having a subcontract with the "Contractor" to perform, supervise and co-ordinate all work of this Division.
- .2 Wherever the term "install" (and tenses of "install") is used in the Division 26 Drawings and Specifications, it means install and connect complete.
- .3 Wherever the term "supply" is used in the Division 26 Drawings and Specifications, it means supply only.
- .4 Wherever the term "Provide" or "Provision of" are used in relationship to equipment and other materials specified for the Work of Division 26 it means "Supply, Install and Connect". Wherever the terms "Provide" or "Provision of" are used in connection with services such as testing, start-up and commissioning for any part of the Work of Division 26, it means procure, supervise, take responsibility and pay for these services.
- .5 Whenever "Drawings and Specifications" are referred to herein, it means "the Contract Documents".
- .6 Wherever the terms "Authorities" or "Authorities having jurisdiction" are used in the Division 26, Drawings and Specifications, it shall mean any and all current laws and/or by-laws of any Federal, Provincial or local authorized agencies having jurisdiction over the sum total or parts of the work including, but not restricted to the Municipal Planning and Building Department, Municipal Fire Department, the Construction Safety Act, Municipal Public Works Department, Federal and/or Provincial Fire Marshall, the Gasoline Handling Act, the Ontario Electrical Safety Code and other codes in effect at the time of construction.
- .7 Wherever the term "Work" is used in the Division 26 Drawings and Specifications, it means all equipment, permits, materials and labour to provide a complete electrical installation as required and detailed in the Drawings and Specifications.
- .8 Wherever the term "Acceptable" is used in the Division 26 Drawings and Specifications it means acceptable to the Consultant.

1.4 WORK INCLUDED

- .1 Sections of Division 26 are not intended to delegate functions nor to delegate work and supply to any specific trade and the Work shall include all labour, materials, equipment and tools required for a complete and working installation as described, but not necessarily limited to items in the following Sections:

Section 26 05 00	Electrical General Requirements
Section 26 05 01	Shop Drawings, Product Data and Samples
Section 26 05 03	Electrical Systems Commissioning
Section 26 05 05	Basic Materials and Methods
Section 26 05 08	Firestopping
Section 26 05 10	Electrical Identification
Section 26 05 11	Testing and Coordination Study of Distribution
Section 26 05 12	Arc Flash Hazard Study
Section 26 05 14	Work In Existing Facility
Section 26 05 21	Wire and Cable Up To 600 Volts
Section 26 05 27	Grounding and Bonding
Section 26 05 29	Hangers and Supports
Section 26 05 31	Splitter Trough
Section 26 05 33	Raceways and Boxes
Section 26 09 23	Digital Metering System
Section 26 11 10	Electrical High Voltage Service
Section 26 12 16	Low Voltage Dry Type Transformers
Section 26 24 01	Service Entrance LV Switchboard
Section 26 24 16	Panelboards
Section 26 27 26	Wiring Devices
Section 26 28 13	Fuses
Section 26 28 23	Safety Switches
Section 26 28 33	Quick Connect Switches
Section 26 29 01	AC Contactors
Section 26 32 13	Gas Generator (SU)
Section 26 36 23	Automatic Transfer Switches
Section 26 50 00	Lighting Luminaires
Section 26 80 00	Electric Vehicle Charger
Appendix A	YRND – Lighting Standard
Appendix B	YRND – Receptacle and Circuit Labelling Standard
Appendix C	YRND – Electrical Power Monitoring Standard
Appendix D	YRND – Electrical & ICAT Works Proposed Phasing
Appendix E	YRND – Proposed Phasing

1.5 PERMITS, FEES AND INSPECTIONS

- .1 Apply for, obtain, and pay for all permits, licenses, inspections, examinations and fees required for Work of Division 26. If the municipality is structured as a "single permit jurisdiction", the Contractor will apply, pay for and obtain the municipal building permit. In this case, the Division 26 contractor has no financial obligation for permit application except for permits not covered in the "single permit".
- .2 Arrange for inspection of all Work by the Authorities having jurisdiction over the Work. On completion of the Work, present to the Consultant the final unconditional certificate of approval of the inspecting Authorities.
- .3 Comply with the requirements of the latest edition of the applicable CSA standards, the requirements of the Authorities, Federal, Provincial and Municipal Codes, the applicable standards of the Underwriters' Association and all other Authorities having jurisdiction. These codes and regulations constitute an integral part of these specifications.

- .4 In case of conflict, the codes take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the drawings and specifications by applying any of the codes referred to herein.
- .5 Before starting any work, submit the required number of copies of drawings and specifications to the Authorities for their approval and comments. Comply with any changes requested as part of the contract, but notify the Consultant immediately of such changes. Prepare and furnish any additional drawings, details or information as may be required.

1.6 CONTRACT DRAWINGS

- .1 The Drawings for Electrical work are performance drawings, diagrammatic, intended to convey the scope of work and indicate general arrangement and approximate location of apparatus, fixtures and conduit runs. The Drawings do not intend to show architectural and structural details.
- .2 Do not scale Drawings. Obtain information involving accurate dimensions from dimensions shown on Architectural and Structural drawings, and by site measurement.
- .3 Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (conduits around beams, columns, etc.)
- .4 Alter, at no additional cost, the locations of materials and/or equipment as directed, that do not necessitate additional material.
- .5 Install ceiling mounted components (e.g., light fixtures, speakers, heat or smoke detectors) in accordance with reflected ceiling drawings.
- .6 Confirm on the site the exact location and mounting elevation of outlets and fixtures as related to Architectural and Structural details.

1.7 EXAMINATION OF SITE AND DOCUMENTATIONS

- .1 Prior to submitting tender, carefully examine conditions at the site which could affect the Work. Refer to and examine all contract documents.
- .2 Be responsible for any damage done to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.
- .3 Refer to room finish schedules to determine finished, partially finished and unfinished areas of the building.
- .4 Ensure that materials and equipment are delivered to the site at the proper time and in such assemblies and sizes so as to enter into the building and to be moved into the spaces where they are to be located without difficulty. Be responsible for any cutting and patching involved in getting assemblies into place.

1.8 CO-ORDINATION DRAWINGS

- .1 Prepare drawings in conjunction with all trades concerned, showing sleeves and openings for passage through structure, and all inserts, equipment bases, and supports, and relate these to suitable grid lines and elevation datum.

- .2 When requested, provide weights of major items of equipment.
- .3 Prepare interference and co-ordination drawings for all areas where the work of this Division could conflict with and/or obstruct the work of other trades and/or other Sections of this Division. Submit drawings for review by the Consultant.

1.9 RECORD DRAWINGS

- .1 The drawings for this Project have been prepared using Revit/BIM 360. For the purpose of exchanging model and producing record (as-built) drawings, a model file will be made available to the trade for a cost of \$850+HST. Edit Note: Price for model should be based on actual # of output drawings, example:

For 1 to 10 files	\$550.00
For 11 to 20 files	\$650.00
For 21 to 50 files	\$850.00
For 51 to 100 files	\$1,350.00
For greater than 100 files, charge \$10.00 per file + \$350.00.	

In using the model from the Consultant to produce record drawings, the Contractor is deemed to have agreed to take full responsibility for any and all information on the drawings.

- .2 Obtain a set of white prints as the job progresses, mark this set to accurately indicate installed work. Show location by dimension from walls or columns for all buried services as well as invert depths. Have these white prints available for inspection at the site at all times, and present for scrutiny at each job meeting.
- .3 At completion of the project, transfer all information from the white prints to the CAD files, and provide one CD with updated CAD files to the Consultant as part of the close out documents.
- .4 The contractor is responsible for all cost associated with the production and services required, such as recreating, plotting and printing to produce "as-built" drawings.

1.10 PRODUCT STANDARDS AND ALTERNATIVES

- .1 Provide new material and equipment as specified and to the acceptance of the Consultant.
- .2 Manufacturer's names are listed as the "Basis of Design" and to set a standard of quality, performance, capacity, appearance and serviceability. Other acceptable manufacturers where listed may be used in the submission of the Electrical bid, however it is the bidders responsibility to ensure the equipment will perform and fit the available space used in the design.
- .3 Where no other acceptable manufacturers are indicated, provide the exact make specified. Requests for acceptance of manufacturers not listed must be submitted not less than seven working days prior to closing date of the tender, and submissions must bear proof of acceptance by the Consultant if used in the tender.
- .4 Assume full responsibility for ensuring that when providing other acceptable manufacturers all space, weight, connections, power and wiring requirements, etc., are considered, and costs therefore included in the tender. Equipment

requiring greater than specified energy requirements or unduly limiting service space requirements will not be accepted.

- .5 All electrical equipment, material, wiring and devices to conform to the Ontario Electrical Safety Code for the purpose for which they are to be used and bear the approval of CSA or other acceptable testing agency, alternately the equipment must bear special approval of the inspection authority.

1.11 PATENTS

- .1 Pay all royalties and licence fees, and defend all suits or claims for infringement of any patent rights, and save the Owner and Consultant harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters, patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters, patent or rights.

1.12 RIGHTS RESERVED

- .1 Rights are reserved to furnish any additional detail drawings, which in the judgement of the Consultant may be necessary to clarify the work, and such drawings shall form a part of this contract.

1.13 EQUIPMENT NAMEPLATES

- .1 Provide apparatus with proper nameplates affixed thereto, showing the size, name of equipment, serial number and all information usually provided, which also includes voltage, cycle, phase, horsepower of motors and the name and address of the manufacturer.

1.14 EXPEDITING AND DELIVERY

- .1 Continuously check and expedite delivery of equipment and materials. If necessary, inspect at the source of manufacture.
- .2 Continuously check and expedite the flow of necessary information to and from all parties involved.
- .3 Immediately inform the Consultant in case information is required from him.
- .4 Provide delivery records updated monthly.

1.15 SUPERINTENDENCE

- .1 Maintain at the job site, at all times, qualified personnel and supporting staff, with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.
- .2 The supervising personnel and their qualifications are subject to the approval of the Consultant.

1.16 WORKMANSHIP

- .1 Install equipment, conduit and cables in a workmanlike manner to present a neat appearance to function properly to the satisfaction of the Consultant. Install runs parallel and perpendicular to building lines, in chases, behind furring or above

ceilings, where such concealment is possible. In areas where systems are to be exposed install neatly and group to present a tidy appearance.

- .2 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement with due allowance therefore.
- .3 Include in the work all requirements of manufacturers shown on the shop drawings or manufacturers installation instructions.
- .4 Replace work unsatisfactory to the Consultant without extra cost.
- .5 Make provision to accommodate future plant and equipment indicated on drawings.
- .6 Protect from damage all equipment delivered to the site and during installation. Any damage or marking of finished surfaces shall be made good to the satisfaction of the Consultant.

1.17 TRIAL USAGE AND TESTS

- .1 The Owner has the privilege of the trial usage of Electrical Systems or parts thereof for the purpose of testing and learning the operational procedures.
- .2 Assist in trial usage over a length of time as deemed reasonable by the Consultant at no extra cost and do not waive any responsibility because of trial usage.
- .3 Trial usage shall not be construed as Substantial Completion of the Work, or acceptance by the Owner.
- .4 Provide and pay for all testing required on the system components where, in the opinion of the Consultant, manufacturers ratings or specified performance is not being achieved.

1.18 CLEANING

- .1 Before energizing any systems, inspect and clean the inside of panel boards, switchgear and cabinets to ensure that they are completely free from dust and debris.
- .2 Clean all polished, painted and plated work bright. Clean all lighting fixtures.
- .3 Remove all debris, surplus material and all tools.
- .4 Carry out additional cleaning operating of systems as specified in other sections of the specification.

1.19 COMPLETION

- .1 Leave electrical work in specified working order.

1.20 WARRANTIES

- .1 Provide warranty certificates, wherever given or required, in excess of the normal warranty period showing the name of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.

1.21 INSTRUCTION TO OWNERS

- .1 Instruct the Owner's representatives in all aspects of the operation of systems and equipment.
- .2 Arrange for and pay for services of service engineers and other manufacturers' representatives required for instruction on specialized portions of the installation.
- .3 Submit to the Consultant at the time of final inspection a complete list of systems stating for each system:
 - .1 Date instructions were given to the Owner's staff.
 - .2 Duration of instruction.
 - .3 Name of persons instructed.
 - .4 Other parties present (manufacturer's representative, consultants, etc.).
- .4 Signatures of the Owner's staff stating that they properly understood the system installation, operation and maintenance requirements.

1.22 DOCUMENTATION AND SYSTEMS ACCEPTANCE

- .1 Assemble three (3) copies of operating and instruction manuals in three ring binders with index tabs each containing this subcontractor's and suppliers names and telephone numbers.
- .2 Each manual shall contain the following data:
 - .1 A set of as-built prints.
 - .2 Letters of Owner's Instructions
 - .3 Final ESA Certificate.
 - .4 A copy of each "reviewed" shop drawing.
 - .5 Complete explanation of operation principles and sequences.
 - .6 Complete part lists with numbers.
 - .7 Recommended maintenance practices and precautions.
 - .8 Complete wiring and connections diagrams.
 - .9 Certificate of warranty.
 - .10 Representative certificates for:
 - .1 Fire Alarm System
 - .2 Generator Assemblies
- .3 Ensure that operating and maintenance instructions are specific and apply to the models and types of equipment provided.

1.23 OWNER'S RIGHT TO RELOCATE ELECTRICAL ITEMS

- .1 The Owner reserves the right to relocate electrical outlets at a later date, but prior to installation, without cost, assuming that the relocation per outlet does not exceed 3000 mm from the original location. No credits shall be anticipated where relocation per outlet of up to and including 3000 mm reduces materials, products and labour.
- .2 Should relocations per outlet exceed 3000 mm from the original location the Contract Price will be adjusted accordingly.

- .3 Necessary changes, due to lack of co-ordination, and as required and when approved, shall be made at no additional cost, to accommodate structural and building conditions. The location of conduits and other equipment shall be altered without charge to the Owner, if approved, provided the change is made before installation.

1.24 ELECTRICAL LIST OF MANUFACTURERS, SUBTRADES AND PRICES

- .1 At the time of tender closing, list the names of manufacturers or subtrades carried (one per item), the total cost of the Electrical Works, any separate, unit and alternative prices where indicated.
- .2 If this Subcontractor neglects to list the specified or acceptable manufacturers or lists more than one manufacturer per item, or lists manufacturers not specified, the Consultant will have the option of making the selection of the manufacturer.
- .3 There will be no substitutions of named manufacturers or subtrades after tender close except as approved by the Consultant.

1.25 PHASING AND SCHEDULING OF WORK

- .1 Refer to Scope of work for a detailed description of the phasing and scheduling of the work. Execute work in accordance with the phasing and construction schedule. Provide all necessary temporary connections and equipment to provide functional, operational systems during construction period when part of the building will be occupied and construction is still continuing in other portions.

1.26 MATERIALS FURNISHED BY OTHERS

- .1 Where materials are furnished by others for installation under this Division, the Sub-Contractor shall notify the supplier of dates he will be ready for delivery as specified in the General Conditions. The Sub-Contractor shall receive, unload, handle, store, protect and insure the material until ready for actual installation. Upon receipt of material furnished by others, the Sub-Contractor shall spot-check or check the entire shipment and promptly advise the Consultant in writing of any damage and/or missing components. Any material which is subsequently lost or damaged due to negligence on the part of the Sub-Contractor shall be promptly replaced (or repaired to the satisfaction of the Owner) at the Sub-Contractor's expense.

1.27 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS.

- .1 Where the Drawings indicated equipment to be furnished by others, provide Electrical rough-in for each unit pursuant to its shop drawings, and make final connections, disconnect switches and other electrical facilities for a complete installation.

1.28 ELECTRICAL LEGEND & SCHEDULES

- .1 Refer to Electrical Drawings for Legend and Schedules

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 NIL

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.
- .2 Designate in the Construction Schedule, or in a separate coordination schedule, dates for submission and dates that reviewed Shop Drawings, Product Data and Sample will be required. Give due consideration for review time required by the Consultant, with a minimum of fifteen (15) working days required. The submission of Appendix 'X' will be considered an acceptable submittal schedule.
- .3 All data and dimensions on shop drawings, product data and sample information to be based on units (Imperial or Metric) as shown on the contract documents.
- .4 Shop Drawings with errors or omissions and deviations will be returned "Not Reviewed".
- .5 The Contractor's responsibility for deviations in submission from the requirements of Contract Documents is not relieved by the Consultant's review of submittals, unless a deviation on the submittal is noted as such in writing and has been accepted by the Consultant.
- .6 Keep one (1) reviewed copy of each submission on site.

1.2 SHOP DRAWINGS

- .1 Review and stamp Shop Drawings, Product Data and Samples prior to submission to the Consultant. Confirm that necessary requirements have been determined and verified and that each submittal has been checked and coordinated with requirements of the Work and the Contract Documents. Submittals not stamped, signed, dated and identified as to the specific project, will be returned without being examined and shall be re-submitted when completed.
- .2 Submit drawings in a clear and thorough manner:
 - .1 Identify details by reference to drawing No. and detail, schedule or room numbers as shown on Contract Documents.
 - .2 Minimum sheet size and larger sheets to be multiples of 8½" x 11".
 - .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated. Indicate cross references to design drawings and specification.
 - .4 Adjustments to shop drawings by the Consultant do not change the cost of the work. If adjustments affect the cost of Work, advise through normal channels in writing prior to proceeding with the Work.
 - .5 Make changes in shop drawings as directed by the Consultant. Resubmit and note any revisions other than those requested.
 - .6 If only minor adjustments are made, shop drawings to be returned and fabrication and installation of work to proceed.

- .3 Determine and verify:
 - .1 Field measurements.
 - .2 Field construction criteria.
 - .3 Catalogue numbers and similar data.
 - .4 Conformance with Specifications.
- .4 Co-ordinate each submittal with requirements of the Contract documents.
- .5 Each Shop Drawing will be stamped by the Consultant in the following format:
 - ☐ NOT REVIEWED ☐ REVIEWED
 - ☐ RESUBMIT ☐ REVIEWED AS MODIFIED
 - ☐ NOT SPECIFIED BY MCW, REVIEWED FOR MEP ONLY
- .6 This review by the Consultant is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which shall remain with this Subcontractor submitting same, and such review shall not relieve this Subcontractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the contract documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication.
- .7 Products not specified by MCW are reviewed to confirm compliance with services provided only. Any changes required between provided services and shop drawing requirements will be identified for coordination between trades.
- .8 Shop drawings shall be accompanied by a complete copy of the attached "Shop Drawing Submittal Sheet" Section 26 05 01, Appendix 'X'.
- .9 Begin no fabrication or work which requires submittals until return of submittals reviewed by Consultant.

1.3 **PRODUCT DATA**

- .1 Where specified, Manufacturer's standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data is acceptable provided there is conformance with the following:
 - .1 Clearly identify pertinent products or models.
 - .2 Show performance characteristics and capacities.
 - .3 Show dimensions and clearances required.
 - .4 Show wiring or piping diagrams and controls.
- .2 Manufacturer's standard schematic drawings and diagrams may require modifications to drawings and diagrams to provide information applicable to the Work.
- .3 Provide information specifically applicable to the Work.

1.4 **SAMPLES**

- .1 Samples to be labelled, of sufficient size and quantity to clearly illustrate:
 - .1 Functional characteristics integrally related parts and attachment devices.

- .2 Full range of colour, texture and pattern.
- .2 Field Samples and mock-ups:
 - .1 Erect, at the project site and in location acceptable to the Consultant.
 - .2 Fabricate each sample and mock-up complete and finished.
 - .3 Remove mock-ups at conclusion of Work or as specified by the Consultant.

1.01 SUBMISSION REQUIREMENTS

- .3 Submit promptly to approved schedule and in sequence to prevent submission delay in the Work.
- .4 Submission requirements:
 - .1 Shop Drawings: Acceptable submissions are: Submit shop drawings electronically as agreed to during the kick off meeting with the Consultant.
 - .2 Product Data: Submit a copy for each O & M Manual.
 - .3 Samples: Submit as specified, or as requested during the shop drawing review period.

1.5 RESUBMISSION REQUIREMENTS

- .1 Make corrections or changes to the submittals noted by the Consultant and resubmit.
- .2 Shop Drawings and Product Data:
 - .1 Revise drawings or data, and resubmit as noted on the initial submittal.
 - .2 Indicate any changes which have been made other than those noted by the Consultant.
- .3 Samples: Submit new samples as required for initial submittal as soon as possible after notification of the rejection of the original submission and mark "resubmitted samples".

1.6 DISTRIBUTION

- .1 Distribute reproductions of Shop Drawings and copies of Product Data which carry the Consultant's stamp to all parties as specified by Division One General Requirements.
 - .1 Job site file
 - .2 Project record document file
 - .3 Other affected contractors
 - .4 Subcontractors
 - .5 Supplier or fabricator (as applicable)
 - .6 Operations Manual

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 NIL

END OF SECTION

SHOP DRAWING SUBMITTAL SHEET

Project: North Roads Operations Centre Date: _____

Project No. 23137 Submittal No. _____

Section: _____

[illegible]

Contractor: _____

Sub-Contractor: _____

Suppliers Name: _____

Manufacturer: _____

Catalogue No.: _____

Variations From
Tender Documents _____

Engineer: MCW Consultants Ltd.
207 Queen's Quay West, Suite 615
Toronto, Ontario
M5J 1A7

SECTION 26 05 01 – APPENDIX 'X' PROJECT: North Roads Operations Centre		SHOP DRAWING SUBMITTAL SCHEDULE						Page 1	
PROJECT No: 23137		DIVISION 26						Date: May 23, 2025	
SECTION	DESCRIPTION (List Equipment Example only Edit to Suit)	MANUFACTURER	SHOP DRAWING				DELIVERY		COMMENTS
			SUBMITTED		RETURNED				
			SCHED	ACTUAL	SCHED	ACTUAL	SCHED	ACTUAL	
26 05 08	Firestopping								
26 05 11	Testing and Coordination Study of Distribution								
26 05 12	Arc Flash Hazard Study								
26 05 14	Work in Existing Building								
26 05 31	Splitter Trough								
26 09 23	Digital Metering System								
26 12 16	Low Voltage Dry Type Transformers								
26 24 01	Service Entrance LV Switchboard								
26 24 16	Panelboards								
26 27 26	Wiring Devices								
26 28 13	Fuses								
26 28 23	Safety Switches								
26 28 33	Quick Connect Switches								
26 29 01	AC Contactors								
26 32 13	Gas Generator (SU)								
26 36 23	Automatic Transfer Switches								
26 50 00	Lighting Luminaires								
26 80 00	Electric Vehicle Charger								

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 SCOPE OF WORK

- .1 The Electrical Consultant is not acting as Commissioning Agent or Commissioning Authority and is not responsible for developing Commissioning Plans, manage and administer the commissioning process.
- .2 The Contractor shall provide all services, materials and labour required to fully Commission the Electrical Systems as specified herein.
- .3 The Contractor shall provide all services, materials and labour required to successfully complete Functional Performance Testing of the Electrical Systems as part of Commissioning the overall building systems as a holistic operation. Functional Performance Testing shall be as defined in CSA Z320.
- .4 The Contractor shall participate in the integrated systems testing per the requirements of CAN/ULC-S1001-11, Integrated Systems Testing of Fire Protection and Life Safety Systems.
- .5 Equipment Suppliers and Vendors are expected to support the Contractor complete Electrical Commissioning Specified in this Section. Support may come in the form of attendance on site to verify correct installation, performance, trouble shooting, training and final documentation at turn-over. The Contractor shall ensure Equipment Suppliers and Vendors provide the support necessary for successful Electrical Commissioning.

1.3 COORDINATION

- .1 Appoint a single person as Commissioning Coordinator who shall be responsible for advancing the commissioning activities of the Electrical Division.

1.4 QUALITY ASSURANCE

- .1 The following Standards shall be used to guide the commissioning process:
 - .1 CSA Z320-11 (R2016) Building Commissioning
 - .2 CAN/ULC-S1001-11 Integrated Systems Testing of Fire Protection and Life Safety Systems
 - .3 CAN/ULC-S537-13 Standard For Verification of Fire Alarm Systems
 - .4 CSA C282-15 Emergency Electrical Power Supply For Buildings
- .2 Hold and attend regular meetings during the commissioning process. Prepare detailed progress reports to coincide with regular commissioning meetings.
- .3 In addition to all tests listed under this section, the Electrical Division shall complete its own tests and any additional tests required by the Owner / Owner's Commissioning Authority to ensure that all facility, in its entirety, operates as intended.

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 DESIGN AND PERFORMANCE REQUIREMENTS

- .1 Provide a schedule with regular updates for the completion of Electrical Division equipment and systems.
- .2 Six (6) weeks prior to the target Substantial Performance date, submit a detailed and comprehensive installation completion/ start-up/ testing schedule. Update the schedule and resubmit for review, on a bi-weekly basis, during the course of Commissioning. Provide regular revisions and updates to the schedule to suit the updated construction schedule. This schedule shall include, but is not limited to the following items:
 - .1 Low voltage switchboard
 - .2 Low voltage distribution panels
 - .3 Low voltage branch circuit panels
 - .4 Low voltage cables
 - .5 Emergency generator
 - .6 Automatic Transfer Switches
 - .7 Metering & provisions for 3rd party metering
 - .8 Current transformers
 - .9 Overcurrent and ground fault protective devices settings
 - .10 Transformers tap settings
 - .11 Ground gird resistance
 - .12 Grounding & bonding
 - .13 Interior lighting & control
 - .14 Exterior lighting & control
 - .15 Emergency lighting
 - .16 Exit signs
 - .17 Fire alarm system
 - .18 Fire alarm system interface & control
 - .19 Hold-open devices
 - .20 Electromagnetic locks
 - .21 Electric heat tracing cables for fire protection system
 - .22 Mechanical service electrical connections
 - .23 Start-up of various equipment and systems
 - .24 Operational testing of system components
 - .25 Performance testing of equipment and systems
 - .26 Acceptance testing of equipment installations and systems by Authorities Having Jurisdiction ("AHJs") and the Owner's insurance company
 - .27 Troubleshooting

- .28 Calibration of controls and point checkout
- .29 Control software setup and checkout
- .30 Submittal of completed equipment and system checkout sheets
- .31 Demonstration of systems and equipment
- .32 Maintenance manual preparation and submittal
- .33 Operator training program
- .34 Record documentation submittal

3.2 RECORD DOCUMENTATION

- .1 Prepare record documentation for each equipment installation covering:
 - .1 Equipment identification and supplier
 - .2 Shop Drawing submittal, review, production release, and delivery dates
 - .3 Dates for completion of all work required to prepare for equipment installation
 - .4 Dates for equipment installation, supplier prestart checkout and system availability for start-up
 - .5 Dates for equipment start-up, performance testing, proposal for temporary use, acceptance testing, demonstration, turnover and warranty start/finish
 - .6 List all specialist personnel and equipment required for the test and ensure that these are available by the test date.
 - .7 Provide documentation of the commissioning process for inclusion into the maintenance manuals. These are to include checkout sheets, equipment data sheets, start-up certificates from suppliers involved in start-up, documentation concerning demonstration to the Owner. Include all records and result sheets from commissioning tests.
 - .8 Maintain a log of key operating parameters, problems encountered, solutions employed and verification of effectiveness of solutions. Include log in maintenance manuals.

3.3 START-UP

- .1 Coordinate and supervise the start-up of the various pieces of equipment and systems. Utilize the start-up services of the manufacturer's representative. Ensure that the equipment is operating in a satisfactory manner. Check the following items:
 - .1 Initial site energization
 - .2 Voltage measurements
 - .3 Phase rotation
 - .4 Thermographic survey/report
 - .5 Load balance
 - .6 Temperature measurements and liquid sampling for transformers where applicable
 - .7 Visual inspections post energization
- .2 Prior to the equipment start-up, arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations.

- .3 Functional testing is intended to begin upon successful completion of start-up. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the Owner and the Owner's Commissioning Consultant. Beginning system functional testing prior to full completion does not relieve the Electrical Division from fully completing the system, including all start-up checklists.

3.4 TROUBLESHOOTING

- .1 Resolve inter-Division coordination problems.
- .2 Where problems become apparent during the commissioning process, identify and resolve these problems. The basic functions of troubleshooting include:
 - .1 Identify and define the problems
 - .2 Determine and evaluate the causes
 - .3 Determine the time available to resolve the problem
 - .4 Involve the designing authority in the review of the problem and proposed resolution
 - .5 Coordinate remedial action with the appropriate parties
 - .6 Evaluate the effectiveness of the remedial action
 - .7 Record the problem, cause, remedial action and result

3.5 OPERATIONAL TESTING

- .1 Test the operation of the individual components and systems. Go through each step of the sequence of operation and verify that each component operates correctly. Direct and ensure that all trades involved make the required changes and adjustments to effect the proper operation of all components and systems. Meet commissioning test requirements.
- .2 Document the operation and testing.
- .3 Ensure operational tests are completed for all seasons and modes of operation.
- .4 For any systems and assemblies where some testing has been deferred, coordinate seasonal commissioning for those systems that have been functionally tested and handed over in seasons where retesting and commissioning will be required during the opposite season.

3.6 DEMONSTRATION AND TRAINING

- .1 Demonstrate to the operating staff the proper operation of all Electrical equipment and systems. Demonstrations shall occur only after the operation and testing has been successfully completed. Ensure that all affected Electrical Division Trade Contractor(s) and equipment suppliers participate in the demonstrations as required.
- .2 Thoroughly instruct the operating staff in the safe and efficient operation and maintenance of all systems and equipment.
- .3 Provide designated operating personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of Electrical equipment including, but not limited to, pumps, boilers, chillers, heat rejection equipment, air conditioning units, air handling units, fans,

terminal units, controls and water treatment systems, fuel systems and other Electrical systems.

- .4 Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including start-up, shutdown, fire/smoke alarm, power failure, and other similar modes of operation.
- .5 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- .6 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative.
- .7 Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
- .8 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
- .9 Training shall include:
 - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - .2 A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - .3 Discussion of relevant health and safety issues and concerns.
 - .4 Discussion of warranties and guarantees.
 - .5 Common troubleshooting problems and solutions.
 - .6 Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
 - .7 Discussion of any peculiarities of equipment installation or operation.
 - .8 Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
 - .9 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
 - .10 The Electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
 - .11 During any demonstration or hands-on training, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

3.7 OPERATING AND MAINTENANCE MANUALS

- .1 Ensure that O&M Manuals are complete in accordance with the requirements of Section 26 05 00.

3.8 “AS-CONSTRUCTED” DRAWINGS

- .1 Ensure that Electrical Trade(s) “As-constructed” drawings have been produced and that they accurately reflect the completed Electrical systems.

3.9 COMPLETION

- .1 Confirm completion of all Electrical Work, including, but not limited to:
 - .1 Removal of all debris from inside Electrical systems and equipment.
 - .2 Compliance with manufacturer's written instructions.
 - .3 Removal of all temporary protection and covers.
 - .4 Record all settings of devices, equipment and systems.

3.10 COMMISSIONING TESTS

- .1 Factory tests/verification documents
- .2 Field electrical tests
- .3 Field test values
- .4 Operation of control circuits
- .5 Operation of trip circuits
- .6 Safety interlocks and operations
- .7 Demonstrate access to all junction boxes per code for servicing.
- .8 Verify the operation of all Electrical equipment.
- .9 Verify that interfacing to the work of other Divisions results in complete and operational systems.

3.11 POST OCCUPANCY EVALUATION

- .1 The post-occupancy evaluation period shall run for one full year following occupancy of the facility. The Commissioning Coordinator shall meet regularly with the operating staff throughout this period to review the operation of all Electrical systems and equipment. The Commissioning Coordinator shall provide written advice regarding questions and concerns raised by the operating staff.
- .2 Resolutions of operational problems shall, where appropriate, be used to modify the Operation and Maintenance Instructions for the equipment and systems involved.
- .3 Identify areas that may come under warranty and conduct a review of condition and operation. Seek remedy under warranty for any outstanding issues and problems before end of warranty period.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide materials as specified herein to complete the work as required by the contract documents.

1.3 SUBMITTALS

- .1 Submit Shop drawings as required.

Part 2 Products

2.1 SLEEVES

- .1 In concrete slabs, except as noted below, sleeves shall be #24 gauge galvanized steel or factory fabricated plastic sleeves, each with an integral flange to secure the sleeve to form work construction.
- .2 In waterproof concrete slabs and in other slabs where waterproof sleeves are required, provide Schedule 40 mild galvanized steel.
- .3 40 mild galvanized steel or suitable rigid, factory fabricated plastic sleeves.

2.2 ESCUTCHEON PLATES

- .1 One-piece chrome plated steel sized to completely cover sleeves and complete with set screws to secure the plates to the conduit. Split plates will not be acceptable.

2.3 INSERTS AND BEAM CLAMPS

- .1 Inserts for concrete form work shall be Crane Canada Ltd., #4-M Unistrut Ltd., or approved equal cast iron inserts, multiple type where required.
- .2 Inserts for precast concrete and existing concrete shall be lead cinch anchors of "WEJ-IT" or self-drilling "STARR" or "PHILLIPS" anchors.
- .3 Beam clamps for hanging and support to structural steel shall be Crane Canada Ltd., or equal.

2.4 ACCESS DOORS

- .1 Minimum #12 gauge prime coat painted bonderized steel flush access doors, each complete with a heavy frame and anchor, heavy duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing provisions to suit the particular construction in which it is installed. Access door sizes shall suit the concealed work for which they are supplied. Access doors in fire rated ceilings, walls, partitions, structures, etc., shall be ULC listed and labelled and of a rating to maintain the fire separation integrity.

- .2 Where access doors are located in surfaces where special finishes are required, they shall be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout.

Part 3 Execution

3.1 INSTALLATION OF SLEEVES

- .1 Where conduits, raceways and conductors pass through structural poured concrete, supply sleeves, unless otherwise noted.
- .2 Size sleeves, unless otherwise noted, to leave 12mm clearance around the conduit, raceway, etc. Pack and seal the void between the sleeves and the conduit, raceway, conductor etc. for the length of the sleeves.
- .3 Pack all sleeves with a ULC and CSA approved one part intumescent elastomer as manufactured by 3M. The installation shall be formed for each specific application using the manufacturers recommended combination of the following:
- .4 P25 caulk, Puty 303, penetration sealing system 7902 or 7904, composite sheet CS195 or wrap strip FS-195.
- .5 In poured concrete construction, accurately locate sleeves, and turn these sleeves over to the Division performing the concrete work for placement in the concrete form work. Sleeves shall be sufficiently rigid to prevent sleeve deformation when the concrete is poured, and shall be suitably plugged to prevent concrete from entering the sleeve.
- .6 Submit to the concrete reinforcement detailer at the proper times, drawings, indicating all required sleeves, recesses and formed openings in poured concrete work. Such drawings shall be completely and accurately dimensioned and shall relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
- .7 Supply sleeves of a water protecting type for installation in the following locations:
 - .1 In Mechanical and Fan Room floor slabs except where on grade;
 - .2 In slabs over Mechanical, Fan, Electrical and Telephone equipment rooms or closets;
 - .3 In all floors equipped with waterproof membranes;
 - .4 In the roof.
- .8 "Gang" type sleeving will be permitted only with the Consultant's approval.
- .9 Terminate sleeves for work which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeves may be completely covered by escutcheon plates.
- .10 Openings for multiple conduit or conductor runs, etc., will be provided by the Division responsible for the particular construction in which the opening is required. Carefully co-ordinate the opening locations with the particular Division and ensure that openings are suitably sized and located. Seal the space between the opening and the conduit, conductors, etc., for the length of the opening as for sleeves above.

- .11 Where a round or formed opening is required, where placement of a sleeve has been missed, or where provision of an opening has not been properly co-ordinated with the Concrete Division, neatly cut a suitably sized hole or opening using proper tools to the approval of the Consultant. Prior to cutting any such holes or openings, determine whether or not any reinforcing steel or services, are concealed behind the surface where the hole or opening is to be cut and be responsible for all costs incurred for correcting any damage caused to the structure or services due to cutting holes or openings without prior study and approval.

3.2 INSTALLATION OF ESCUTCHEON PLATES

- .1 Provide escutcheon plates over all exposed conduit passing through walls, floors, ceilings, partitions, furrings, etc., in finished areas.

3.3 INSTALLATION OF INSERTS AND BEAM CLAMPS

- .1 Provide all inserts, beam clamps, fasteners, and similar hardware required for conduit, duct, raceway, conductor, etc., and equipment hanger and/or support materials unless otherwise noted.
- .2 Accurately and properly set concrete inserts in the concrete framework.
- .3 For runs of three (3) or more conduits, raceways, or conductors in concrete form work, use multiple type inserts used for the smallest conduit in the group.
- .4 Where inserts are required in pre-cast concrete and in concrete work where concrete inserts have not been installed, drill a neat hole of the proper diameter and depth in the concrete and insert an anchor to accept the hanger rod, bolt, etc. or where concrete mass permits, use self-drilling concrete anchors.
- .5 Fasten hangers and support provisions to brick or masonry with expansion shields and machine bolts, or for light loads, use plugs and screws.
- .6 In cavity walls and/or ceilings, use two (2) wing toggles and for heavy loads, provide steel anchor plates with two (2) or more toggles to spread the load.
- .7 Provide beam clamps for attaching, hanging and/or support provisions to structural steel, or where approved by the Consultant, weld the hanging and support provisions to the structural steel.
- .8 Explosive power actuated fasteners will not be permitted unless specific approval for their use has been obtained from the Consultant.
- .9 Use fibre or lead screw anchors for anchoring screws.

3.4 SUPPLY OF ACCESS DOORS

- .1 Supply access doors to give access to all junction boxes, pullboxes, conductor joints and other similar electrical work which may need maintenance or repair but which is concealed in inaccessible construction except as otherwise specified herein or on the drawings.
- .2 Before commencing installation of electrical work, prepare on a set of reflected ceiling plans with complete layouts of all ceiling access door which will be required. Submit these layouts to the Architect for approval and show the exact sizes and locations of such ceiling access doors. Locate access doors in walls and partitions to the Consultant's approval, and arrange electrical work to suit.

- .3 Supply the respective trade with panels, doors or the frames therefore complete with all pertinent information and pay their trade for installation.
- .4 Access doors shall be, wherever possible, of a standard size, for all applications. Confirm exact dimensions with the Consultant, prior to ordering.
- .5 Submit a sample of each proposed type of access door to the Consultant for approval.

3.5 PLYWOOD

- .1 Provide all plywood indicated on the drawings required for the work of Division 26. The backboards shall be 19mm thick, good both sides and shall be impregnated with white fire retardant paint on both sides.

3.6 EQUIPMENT CURBS, BASES AND SUPPORTS

- .1 Set all floor mounted equipment on 100mm high concrete housekeeping pads 100mm wider and longer than the equipment base dimensions.
- .2 Furnish dimensioned drawings, templates and anchor bolts for proper setting of equipment on bases and pads. Provide all structural steel frames, brackets, etc., for equipment bases and supports unless otherwise noted, and be responsible for all required levelling, alignment and grouting of the equipment.
- .3 Provide structural steel stands for equipment where indicated or specified. Flange bolt stands to housekeeping pads.
- .4 Where equipment is suspended above floor level it shall be, unless otherwise noted, supported on a suitable structural steel angles or channels bracketed to the wall or secured by hanger rods to slab construction, or where loading is excessive, from separate structural steel members carried to either the floor or ceiling, or both as required.

3.7 EXCAVATION AND BACKFILL

- .1 Do all excavating bedding backfill and related work for the work of Division 26 as specified therein.
- .2 For all electrical excavation, excavate to 150mm below and a minimum of 200mm to either side of the cable or duct run. Fill back with a bedding of granular 'A' gravel or sand. Minimum coverage shall be 750mm.
- .3 Refer to details on the drawings and to utility company requirements for concrete encased duct installation.
- .4 Where excavation is necessary in proximity to and below the level of any footings, bed with concrete to the level of the highest adjacent footing. Concrete strength shall be as directed by the Consultant.
- .5 Carry out pavement cutting and repair of the Owners and Public Property as may be required for excavation and backfill work.

3.8 CONCRETE

- .1 Do all concrete or related work required for the work of Division 26 as specified herein.

- .2 Division 26 shall be responsible for all co-ordination to meet authority having jurisdiction requirements for ducts, provision of ducts and fittings as specified.

3.9 CUTTING AND PATCHING

- .1 Inform other trades in time concerning required openings. In work already finished, cutting and patching shall be done by the trades installing the affected work, at the expense of Division 26. Obtain the approval of the Consultant, before doing any cutting.

3.10 PROVISION FOR SERVICES CROSSING BUILDING EXPANSION JOINTS

- .1 Wherever services (conduit, cables etc.) cross building expansion joints, install the services in such a manner to permit free movement without imposing additional stress or loading upon the support system, and to prevent excessive movement at joints and connections.

3.11 SPRINKLER PROTECTION

- .1 Weatherproof equipment where noted in the specifications and/or drawings shall have EEMAC Type 3 enclosure in accordance with the requirements of CSA C22.2 No. 94 Standard.

3.12 FLASHING

- .1 Flash all electrical parts passing through or built into an outside wall, or a waterproof floor.
- .2 Provide copper flashing for sleeves passing through exterior walls or water proof floors.
- .3 Provide counter flashing on conduits passing through roofs to fit over flashing or curb. Supply flashing to appropriate division for installation.

3.13 METALS

- .1 Steel construction required solely for the work of electrical trades and not shown on architectural or structural drawings shall be provided by Division 26 to the acceptance of the Consultant.

3.14 MOUNTING HEIGHTS

- .1 Maximum mounting height of equipment is from finished floor to centre line of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not indicated verify before proceeding with installation.
- .3 Prior to rough-in, co-ordinate and have approved by the Consultant all mounting heights of devices.
 - .1 Mounting heights shall meet the requirements of the "Barrier Free" section of OBC.
 - .2 Local switches: 1050mm
 - .3 Local switches in suites: 1050mm
 - .4 Wall receptacles:
 - .1 General: 400mm

- .2 Above top of continuous baseboard heater: 200mm
- .3 Above top of counters or splash back: 1100mm
- .4 In mechanical room: 1050mm
- .5 Panelboards (to top of panel trim): 1850mm
- .6 Data, telephone, television outlets: 400mm
- .7 Wall-mounted telephone and interphone outlets: 1050mm
- .8 Wall-mounted A/V speakers: 2100mm or as noted
- .9 Clocks: 2100mm
- .10 All fire alarm devices shall be installed in accordance with CAN/ULC-S524-14 including:
 - .1 Manual stations: 1150mm
 - .2 Audible devices (not less than): 2300mm or 150mm below ceiling
 - .3 Visual devices: entire lens shall be not less than 2000mm and not more than 2400mm above finished floor.
 - .4 Smoke detectors 100 – 300mm from ceiling to top edge of device.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Through Penetration Firestopping.
 - .2 Fire Resistive Joint Systems.
- .2 Related Sections
 - .1 Division 1 – General Requirements.
 - .2 Division 3 – Concrete.
 - .3 Division 4 – Masonry.
 - .4 Division 7 – Thermal and Moisture Protection.
 - .5 Division 9 – Finishes.
 - .6 Division 22 – Plumbing.
 - .7 Division 23 – Heating Ventilating and Air Conditioning.
 - .8 Division 26 – Electrical.
 - .9 Division 27 – Communication.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI):
 - .1 ANSI/UL 263 - Fire Tests of Building Construction and Materials.
 - .2 ANSI/UL 723 - Surface Burning Characteristics of Building Materials.
 - .3 ANSI/UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.
 - .4 ANSI/UL 2079 - Tests for Fire Resistance of Building Joint Systems.
- .2 American Society for Testing and Materials (ASTM):
 - .1 ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .2 ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - .3 ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Firestops.
 - .4 ASTM E 1399 - Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
 - .5 ASTM E 1966 - Standard Test Method for Fire Resistive Joint Systems.
 - .6 ASTM E 2174 - Standard Practice for On-Site Inspection of Installed Firestops.
 - .7 ASTM E 2307 - Fire Tests of Perimeter Fire Barrier Systems Using Intermediate Scale, Multi-Story Test Apparatus.
 - .8 ASTM E 2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
- .3 Factory Mutual (FM) - FM4991 - Standard for Approval of Firestop Contractors.

- .4 International Code Congress (ICC):
 - .1 International Building Code (IBC).
 - .2 International Residential Code (IRC).
 - .3 International Mechanical Code (IMC)
 - .4 International Fire Code (IFC)
 - .5 International Code Congress Evaluation Service (ICC ES)
- .5 National Fire Protection Association (NFPA):
 - .1 NFPA 70 - National Electrical Code.
 - .2 NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
 - .3 NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
 - .4 NFPA 101 - Life Safety Code.
 - .5 NFPA 5000 - Building Construction and Safety Code.
- .6 Underwriters Laboratories (UL) - UL Building Materials Directory:
 - .1 Through-Penetration Firestops Systems (XHEZ).
 - .2 Joint Systems (XHBN).
 - .3 Firestop Devices (XHJI).
 - .4 Forming Materials (XHKU).
 - .5 Wall Opening Protective Materials (CLIV).
 - .6 Fill, Void or Cavity Materials (XHHW).
- .7 American Society of Sanitary Engineering (ASSE):
 - .1 ASSE Series 9000 – Professional Qualification Standard for Firestop Systems and Device Installers, Inspectors and Surveyors.
- .8 International Association of Plumbing and Mechanical Officials (IAPMO):
 - .1 Uniform Plumbing Code (UPC).
 - .2 Uniform Mechanical Code (UMC).
- .9 International Standards Organization (ISO):
 - .1 ISO 6944
 - .2 ISO 10295-1: 2007.
 - .3 ISO 10295-2: 2009.
 - .4 ISO 10295-3:

1.3 PERFORMANCE REQUIREMENTS

- .1 Provide systems that are listed by at least one the following:
 - .1 Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory".
 - .2 Intertek Testing Service (Formerly known as Omega Point Laboratories), in "Directory of Listed Products".
 - .3 Factory Mutual (FM), in FMRC Approval Guide.
 - .4 Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.

- .2 Provide firestop products that are flexible enough to allow for pipe vibration in a through penetration application.
- .3 Provide fire resistive sealants and sprays for construction joint applications that are flexible enough to satisfy the movement criteria per the test standards ASTM E 1399, ASTM E 1966 or ANSI/UL 2079.
- .4 Provide products with the appropriate flame spread index and smoke develop index, when tested in accordance with ASTM E 84.
- .5 Provide products that meet the intent of the L rating classification for the movement of smoke per ANSI/UL 1479 for through penetrations and ANSI/UL 2079 for construction joints.
- .6 Provide products identical to those tested and listed for classification by UL, Intertek or any other qualified independent testing agency.
- .7 Provide products that bear classification marking of qualified independent testing agency.
- .8 Where firestop systems not listed by any listing agency are required due to project conditions, submit a substitution proposal with evidence specified.
- .9 Use only products specifically listed for use in listed systems.
- .10 Provide products that are compatible with each other, with the substrates forming openings, and with the items, if any, penetrating the firestopping, under the conditions represented by this project, based on testing and field performance demonstrated by manufacturer.
- .11 Firestopping materials must meet and be acceptable for use by all building codes and NFPA codes cited in this section.
- .12 Provide products that meet the intent of the state or local guidelines on volatile organic compounds (VOC).
- .13 Where applicable provide products that meet the intent of the F rating classification for passage of flame per ANSI/UL 1479 for through penetrations.
- .14 Where applicable provide products that meet the intent of the T rating classification for the transfer of temperature per ANSI/UL 1479 for through penetrations.
- .15 Provide products that meet the intent of the L rating classification for the movement of smoke per ANSI/UL 1479 for through penetrations and ANSI/UL 2079 for construction joints.
- .16 Where applicable provide products that meet the intent of the W rating classification for passage of water per ANSI/UL 1479 for through penetrations.

1.4 SUBMITTALS

- .1 Submit under provisions of the Contract and Division 01 – General Requirements.
- .2 Shop Drawings: For each firestopping system, provide the following:
 - .1 Listing agency's detailed drawing showing opening, penetrating item(s), and firestopping materials, identified with listing agency's name and number or designation and fire rating achieved.

- .2 For proposed systems that do not conform strictly to the listing, submit written instructions showing modifications and approved by firestop system manufacturer.
- .3 Submit under provisions of the International Building Code (IBC) section 107 and 703 requiring a submittal package for fire-resistance ratings and fire tests.
- .3 Product Certificates: Submit certificates of conformance signed by firestop system manufacturer certifying that materials furnished comply with requirements.
- .4 Product Data: Furnish manufacturer's product data sheets on each material to be used in firestop systems. Information on manufacturer's product data sheet should include:
 - .1 Product characteristics including compliance with appropriate ASTM/UL/ANSI test standards.
 - .2 Storage and handling requirements and recommendations.
- .5 Installation Instruction: Furnish manufacturer's installation instructions.
- .6 Sustainable or LEED Submittals:
 - .1 VOC Content: For sealants and sealant primers, furnish documentation of VOC content.

1.5 QUALITY ASSURANCE

- .1 General: All through-penetration firestop systems and construction gap fire resistive systems shall be installed with approved methods using materials that have been tested and classified to produce an approved assembly.
- .2 Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of twenty five (25) years experience.
 - .1 Products shall be manufactured in a facility that follows ISO 9001 best practices.
- .3 Installer Qualifications: Firm must be qualified by having experience, staff, and be properly trained to install the specified products, and meets the following criteria:
 - .1 Contractor is a **3M** Master Contractor.
 - .2 Contractor is a Certified **3M** Trained contractor.
 - .3 Contractor is acceptable to manufacturer.
 - .4 Contractor is acceptable to Authority Having Jurisdiction (AHJ).
 - .5 Contractor has completed the manufacturer's certified product installation training.
 - .6 Contractor must provide a list of completed projects as evidence of experience; include project name and address, owner's name and address, and architect's name and phone number.
 - .7 Certificate: Contractor should provide certificate of qualification.
- .4 Codes: Where manufacturer's application procedures are in conflict with those of the local Authority Having Jurisdiction, the more strict guidelines will prevail.

- .5 Pre-installation Meetings: Meetings to agree on firestop requirements, conditions, manufacturer's instructions.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver and store products until ready for installation in manufacturer's original unopened packaging, legibly marked with manufacturer's name and product identification, date of manufacture, lot number, listing agency's classification marking, curing/dry time, mixing instructions (if applicable) and MSDS reference number.
- .2 Store and handle in such a manner as to prevent deterioration or damage due to moisture, temperature changes, contaminants, and other causes; follow manufacturer's instructions.
- .3 Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local Authority Having Jurisdiction.

1.7 PROJECT CONDITIONS

- .1 Coordinate construction and cutting of openings so that each particular firestop system may be installed in accordance with its listing, including assembly rating, L rating, sizing, sleeves, manufacturer's published STC rating and penetrating items.
- .2 Coordinate firestopping of dynamic and static construction joints (top-of-wall, bottom-of-wall, floor-to-floor, floor-to-wall), wall-to-wall, perimeter so that each particular system may be installed in accordance with its listing, including assembly rating, sizing, movement capabilities and manufacturer's published STC rating.
- .3 Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install firestopping under environmental conditions outside manufacturer's absolute limits.
- .4 Provide ventilation as required by firestopping manufacturer, including mechanical ventilation if required.

1.8 WARRANTY

- .1 At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions, and exclusions from coverage.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturer: **3M** Fire Protection Products, which is located at: **3M** Center Bldg. 223-2N-21 ; St. Paul, MN 55144-1000; Toll Free Tel: 800-328-1687; Email: request info (firetech1@mmm.com); Web: www.**3M**.com/firestop
- .2 Requests for substitutions will be considered in accordance with provisions of Division 1- General Requirements.

- .3 Single Source: To maintain control and integrity of the firestop applications a single manufacturer should be used. Specific UL or approved listing agencies systems applicable to each type of firestop condition should be supplied by one manufacturer.

2.2 SCOPE/APPLICATION

- .1 Provide installed firestop products that limit the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, and similar locations, restoring the integrity of the fire rated construction to its original fire rating.
- .2 Provide firestop systems listed for the specific combination of fire-rated construction, type of penetrating item, annular space requirements, and fire rating, and the following criteria:
 - .1 F-Rating: Equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
 - .2 T-Rating: In habitable areas where penetrating items are exposed to potential contact with materials on fire side(s) of rated assembly, T-rating must equal its F-rating.
 - .3 L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum at ambient temperatures.
 - .4 W-Rating: meets UL Water Leakage Test, W Rating – Class 1 requirements for systems tested and listed in accordance with ANSI/UL 1479.
 - .5 Wall Penetrations: Through penetration systems must be symmetrical, with the same rating from both sides of the wall. Membrane penetrations may be asymmetrical.
 - .6 Testing: Determine ratings in accordance with ASTM E 814 or UL 1479.
- .3 Provide fire-resistive systems listed for construction gaps per the specific combination of fire-rated construction type, configuration, gap dimensions, and fire rating, and the following criteria:
 - .1 Fire resistance rating must be equal to or greater than that of the assembly in which it is to be installed.
 - .2 Movement capability must be appropriate to the potential movement of the gap, demonstrated by testing in accordance with ASTM E 1399/ASTM E 1966/UL 2079 for minimum of 500 cycles at 10 cycles per minute.
 - .3 L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum.
 - .4 Determine ratings in accordance with ASTM E 1966/UL 2079.

2.3 THROUGH PENETRATION FIRESTOP PRODUCTS

- .1 **3M** Fire Barrier Cast-in-Place Devices: Firestopping device for use prior to a concrete pour. Adjustable height with pull tabs, straight edge design for close placement to walls and adjacent devices.
 - .1 Fire Resistance: For use in 1, 2, or 3 hour fire-rated systems.
 - .2 Locations: Horizontal assemblies only.

- .2 **3M** Fire Barrier Ultra RC Pack: One piece metal collar assembly encasing intumescent material for firestopping of pipes and cables through rated walls and floors.
 - .1 Fire Resistance: For use in 1 or 2 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .3 **3M** Fire Barrier Ultra Plastic Pipe Device: Intumescent device for firestopping of plastic pipe and cables through rated walls and floors.
 - .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - .2 Configuration: One-piece metal collar, with locking latch and bendable tabs to secure; equipped also for conventional anchoring.
 - .3 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .4 **3M** Fire Barrier RC-1 Restricting Collar with either FS 195+ Wrap Strip or 3M Interam Ultra GS Wrap Strip . (See product descriptions below): For firestopping of plastic pipes from 4 inches (102 mm) to 10 inches (254mm) in diameter.
 - .1 Fire Resistance: For use in 1 or 2 hour fire-rated systems.
 - .2 Material: 28 gauge steel.
 - .3 Size: 25 foot (7.6 m) roll.
 - .4 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .5 **3M** Fire Barrier CP25WB+ Sealant: High-performance, intumescent, water-based sealant. No-sag, fast drying, paintable, red in color. Versatile firestop sealant for pipes (not for use with CPVC), cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
 - .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 - .3 STC rating of 54 when tested in STC 54-rated wall assembly.
- .6 **3M** Fire Barrier IC 15WB+ Sealant: General-purpose, intumescent, water-based sealant. No-sag, fast drying, paintable, yellow in color. Economical firestop sealant for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
 - .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 - .3 STC rating of 54 when tested in STC 54-rated wall assembly.
- .7 **3M** Fire Barrier Sealant FD 150+: Single-part, water-based, acrylic latex sealant. No-sag, low-shrinkage, low VOC. Blue, red or limestone color. Used to firestop for pipe penetrations (not for use with CPVC).
 - .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 - .3 STC rating of 54 when tested in STC 54-rated wall assembly.
- .8 **3M** Fire Barrier Water Tight Sealant 3000 WT: Single-part, water-tight, intumescent silicone firestop sealant for filling voids in concrete gypsum, metal, plastic, wood and insulation. Light gray color with black flecks. Meets UL Water Leakage Test, W Rating – Class 1 requirements.

- .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 - .3 STC rating of 53 when tested in STC 54-rated wall assembly.
- .9 **3M** Fire Barrier Water Tight 1000 NS Sealant: Single-part, non-slump firestopping silicone sealant for floor and wall openings. Light gray color. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
- .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
 - .3 STC rating of 56 when tested in STC 56-rated wall assembly.
- .10 **3M** Fire Barrier Water Tight Sealant 1003 SL: Single-part, self-leveling firestopping silicone sealant for floor openings. Light gray color. Meets UL Water Leakage Test, W Rating – Class 1 requirements.
- .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems..
 - .2 Locations: For horizontal assemblies only.
 - .3 STC rating of 56 when tested in STC 56-rated wall assembly.
- .11 **3M** Fire Barrier Sealant 2000 NS: Single-part, non-slump elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, non-metallic pipe (FGG/BM system CPVC compatible), conduit, power and communication cable and telephone or electrical wiring.
- .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - .2 Locations: Vertical and horizontal assemblies.
 - .3 STC-Rating of 56 when tested in STC 56-rated wall assembly.
- .12 **3M** Fire Barrier Sealant 2000+: Single-part, elastomeric silicone firestop sealant. Sag-resistant, low VOC. Light grey color. Used in mechanical, electrical and plumbing applications to firestop openings and penetrations through fire-rated floor or wall assemblies. Typical penetrants include: metallic pipe, non-metallic pipe (FGG/BM system CPVC compatible), conduit, power and communication cable and telephone or electrical wiring.
- .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - .2 Locations: Vertical and horizontal assemblies.
 - .3 STC-Rating of 56 when tested in STC 56-rated wall assembly.
- .13 **3M** Fire Barrier Moldable Putty+: One-part, 100 percent solids intumescent firestop. Remains pliable, flexible and easily re-enterable. Non-toxic synthetic formula. Versatile putty for pipes, cables, cable tray, blank opening and other penetrations along with mineral wool or other fire-rated assembly products.
- .1 Type: Stick or Pad
 - .2 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - .3 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .14 **3M** Fire Barrier 2001 Silicone RTV Foam: Two-part, liquid-silicone elastomer, foams in place when mixed. For use sealing large or complex openings such as cable bundles, cable trays and conduit banks.

- .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
- .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .15 **3M** Fire Barrier Mortar: For sealing openings in concrete and masonry walls and floors. Self Leveling, non-sag, low VOC.
 - .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .16 **3M** Fire Barrier Self-Locking Pillow: Self-contained, intumescent firestop pillow with interlocking strips. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
 - .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .17 **3M** Fire Barrier Pillow: Self-contained, intumescent firestop product. Meets fire rating without the use of wire mesh. For use in firestopping larger openings
 - .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .18 **3M** Fire Barrier CS-195+ Composite Sheet: Organic/inorganic intumescent elastomeric sheet, bonded on one side to a layer of 28 gauge galvanized steel. Other side reinforced with steel-wire mesh and covered with aluminum foil. Re-enterable. For use in firestopping larger openings
 - .1 Thickness: Nominal 0.3 inch (7.6 mm).
 - .2 Thermal Expansion: 8 - 10 times original size.
 - .3 Tensile Strength (ASTM D412): 93.6 psi (645 kPa)/489 percent.
 - .4 Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - .5 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .19 **3M** Interam Ultra GS Wrap Strip: Graphite based, flexible, largely inorganic, intumescent mat. For use around non-metallic piping with or with RC-1 collar.
 - .1 Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .20 **3M** Fire Barrier FS-195+ Wrap/Strip: One-part, organic/inorganic intumescent strip with foil on one side. May be cut to fit irregular shapes. For use around non-metallic piping with or with RC-1 collar.
 - .1 Length: 24 inch (610 mm).
 - .2 Width: 1 or 2 inches.
 - .3 Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - .4 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .21 **3M** Fire Barrier Pass-Through Devices: One-Piece device for firestopping of cable penetrations through rated walls and floors.
 - .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .22 **3M** Fire Barrier Tuck-In: Graphite-based, flexible, intumescent wrap strip for use around non-metallic piping. Adhesive closure tab.

- .1 Fire Resistance: For use in 1, 2 or 3 hour fire-rated systems.
- .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.
- .23 **3M** Fire Barrier Putty Sleeve Kit: Device used for firestopping of cable penetrations through fire rated walls and floors.
 - .1 Fire Resistance: For use in 1, 2 3 or 4 hour fire-rated systems.
 - .2 Locations: Vertical assemblies, horizontal assemblies and smoke barrier.

2.4 FIRE RESISTIVE JOINT PRODUCTS

- .1 **3M** Fire Barrier Sealant FD 150+: Single-part, water-based sealant. Sag-resistant, low-shrinkage, low VOC.
 - .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire-rated systems.
 - .2 Location: For use at top-of-wall, bottom-of-wall, wall-to-wall and floor-to-floor.
 - .3 Compression/Extension Recovery: +/- 19 percent of original joint width.
 - .4 Meets optional L rating requirements.
 - .5 STC rating of 56 when tested in STC 56-rated wall assembly.
- .2 **3M** Fire Barrier Water Tight Sealant 1000 NS: Single-part, non-slump elastomeric silicone sealant. Sag-resistant, low VOC.
 - .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire rated systems.
 - .2 Meets UL Water Leakage Test, W Rating – Class 1 requirements.
 - .3 Location: For use at top-of-wall, bottom-of-wall, wall-to-wall, floor-to-floor, floor-to-wall and perimeter joints.
 - .4 Compression/Extension Recovery: +/- 15 percent of original joint width.
 - .5 STC-Rating of 56 when tested in STC-56-rated wall assembly.
- .3 **3M** Fire Barrier Water Tight Sealant 1003 SL: Single-part, self-leveling elastomeric silicone sealant. Sag-resistant, low VOC.
 - .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire rated systems.
 - .2 Meets UL Water Leakage Test, W Rating – Class 1 requirements.
 - .3 Location: For use at top-of-wall, bottom-of-wall, floor-to-wall and floor-to-floor joints.
 - .4 Compression/Extension Recovery: +/- 15 percent of original joint width.
 - .5 STC-Rating of 56 when tested in STC-56-rated wall assembly.
- .4 **3M** Fire Barrier Sealant 2000 NS: Single-part, non-slump elastomeric silicone sealant. Sag-resistant, low VOC.
 - .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire rated systems.
 - .2 Service Flexibility: Accommodate vibration from normal building movement.
 - .3 Location: For use at top-of-wall, bottom-of-wall, wall-to-wall, floor-to-wall, floor-to-floor and perimeter joints.
 - .4 Compression/Extension Recovery: +/- 31 percent of original joint width.
 - .5 STC-Rating of 56 when tested in STC 56-rated wall assembly.

- .5 **3M** Fire Barrier Sealant 2000+: Silicone Sealant: Single-part, elastomeric silicone sealant. Sag-resistant, low VOC.
 - .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire rated systems.
 - .2 Compression/Extension Recovery: +/- 13 percent of original joint width.
 - .3 Location: For use at top-of-wall, bottom-of-wall, wall-to-wall, floor-to-wall and floor-to-floor joints.
- .6 **3M** FireDam Spray 200: Water-based, paintable, low VOC, freeze/thaw resistant spray applied fire resistive product. Applied with conventional airless spray equipment.
 - .1 Fire Resistance: For use in 1, 2, 3 or 4 hour fire rated systems.
 - .2 Compression/Extension Recovery: +/- 50 percent of joint width.
 - .3 Location: For use at head-of-wall, wall-to-wall, floor-to-floor, bottom-of-wall, floor-to-wall and perimeter joints.
 - .4 STC-Rating of 56 when tested in STC 56-rated wall assembly.

2.5 FIRESTOPPING FOR SINGLE MEMBRANE PENETRATIONS

- .1 **3M** Fire Barrier Moldable Putty+: One-part, 100 percent solids intumescent firestop. Remains pliable, flexible and easily re-enterable. Non-toxic synthetic formula.
 - .1 Type: Pad.
 - .2 Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
- .2 **3M** Endothermic Mat E-5A-4: Endothermic heat absorbing mat.
 - .1 Type: Mat.
 - .2 Fire Resistance: For use in 1 or 2 hour fire rated systems.

Part 3 Execution

3.1 EXAMINATION

- .1 Do not begin installation until substrates have been properly prepared.
- .2 Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.
- .3 Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.
- .4 Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.
- .5 Verify that environmental conditions are safe and suitable for installation of firestopping.
- .6 If substrate preparation is the responsibility of another installer, notify Architect or Engineer of Record of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- .1 Prepare substrates in accordance with manufacturer's instructions and recommendations.
- .2 Install masking and temporary coverings as required to prevent contamination or defacement of adjacent surfaces due to firestopping installation.

3.3 INSTALLATION

- .1 Install in strict accordance with manufacturer's detailed installation instructions and procedures.
- .2 Install so that openings are completely filled and material is securely adhered.
- .3 Where firestopping surface will be exposed to view, finish to a smooth, uniform surface flush with adjacent surfaces.
- .4 After installation is complete, remove combustible forming materials and accessories that are not part of the listed system.
- .5 Repair or replace defective installations in accordance with manufacturer's recommendations, listed systems details and applicable code requirements.
- .6 At each through penetration or fire-resistive joint system, attach identification labels on both sides in location where label will be visible to anyone seeking to remove penetrating items or firestopping.
- .7 Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned.
- .8 Notify Authority Having Jurisdiction when firestopping installation is ready for inspection; obtain advance approval of anticipated inspection dates and phasing, if any, required to allow subsequent construction to proceed.
- .9 Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.

3.4 FIELD QUALITY CONTROL

- .1 Owner will engage an independent testing agency to inspect installed firestopping and to prepare reports indicating whether the installed work complies with the contract documents.
- .2 Notify testing agency at least 7 days prior to date when firestopping installation will be ready for inspection; obtain advance approval of general schedule and phasing, if any, required to allow subsequent construction to proceed.

3.5 CLEANING AND PROTECTION

- .1 Remove left over material and debris from Work area. Use necessary means to protect fire protection product(s) before, during, and after installation.
- .2 Touch-up, repair or replace damaged products before Substantial Completion.
- .3 Install identification Labels for Through Penetration and Construction Joint Systems: Pressure sensitive self-adhesive vinyl labels, preprinted with the following information:

- .1 The applicable words "Warning - Through Penetration Firestop System - Do not Disturb. Notify Building Management of Any Damage." or "Warning – Construction Gap Fire Resistive System - Do not Disturb. Notify Building Management of Any Damage."
- .2 Listing agency's system number or designation.
- .3 System manufacturer's name, address, and phone number.
- .4 Installer's name, address, and phone number.
- .5 General contractor's name, address, and phone number (if applicable).
- .6 Date of installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide lamacoid nameplates and other identification means for a complete installation.

1.3 SUBMITTALS

- .1 Submit a list of proposed labels for review prior to manufacturing.

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 STANDARD IDENTIFICATION

- .1 Identify electrical work as specified herein:
 - .1 For each piece of electrical distribution equipment from the electrical source of supply up to and including panelboards and motor systems, for special control panels and cabinets, and for any other piece of equipment where specified in this Section, provide engraved lamacoid identification nameplates.
 - .2 Nameplates shall generally be black-white-black with bevelled edges, secured to apparatus with stainless steel screws. Generally lettering shall be 6mm high but equipment in the main electrical room shall be provided with lettering 13mm high.
 - .3 Warning signs, if and when required, shall be red with white lettering.
 - .4 Equip large multiple cell or component apparatus such as switchboards and distribution panels with main nameplates identifying the equipment, voltage characteristics and capacity and with sub-nameplates clearly identifying each cell or component and its service.
 - .5 Panelboard nameplates shall identify the panelboard numbers designated on the drawings, unless otherwise instructed. Nameplates for disconnect switches, control panels and cabinets shall outline their service.
 - .6 Motor starters, magnetic and manual, shall identify the piece of motorized equipment being serviced.
 - .7 Exact nameplate wording and sizes must be approved by and confirmed by the Consultant prior to manufacture.
 - .8 Directories for branch circuit panelboards shall be clearly and neatly typewritten, accurately identifying the type, location and wattage of the connected load for each circuit breaker. Directories shall be secured to the rear of the cabinet door under protective plastic. Incorporate copies

- of all panel board directories in each copy of operating and instruction manuals.
- .9 Clearly identify each branch circuit breaker in a permanent manner to correspond with directories. Glued paper identification will not be acceptable.
- .10 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting the outside of the covers. Paint colours shall be in accordance with the following schedule:
- | | | | |
|----|-----------------------|---|--------|
| .1 | Lighting | - | Yellow |
| .2 | Power | - | Blue |
| .3 | Emergency Power | - | Orange |
| .4 | Fire Alarm | - | Red |
| .5 | Telephone | - | Cream |
| .6 | Miscellaneous Signals | - | Brown |
- .11 In addition to painting miscellaneous signal boxes clearly identify the specific system in which the box is installed.
- .12 Colour code empty conduit capped and terminated for future use as specified above and clearly identify its intended use by means of securely attached tags.
- .13 Colour code conductors throughout to identify phases, neutrals and grounds, by means of coloured conductor insulation. Colours shall be as follows:
- | | | | |
|----|---------|---|-------|
| .1 | Phase A | - | Red |
| .2 | Phase B | - | Black |
| .3 | Phase C | - | Blue |
| .4 | Ground | - | Green |
| .5 | Neutral | - | White |
- .14 Control conductors, in addition, shall be numbered with Brady Ltd., or Electrovert Ltd., Z-type markers. Colour code conductors, for special component per manufacturer's recommendations.
- .15 Use dymo tape to label each receptacle with its circuit number (e.g., UA-27).

3.2 PAINTING AND FINISHES

- .1 Painting of exposed electrical work will be done as part of the work of Division 9. Equipment to be located in finished areas shall be provided to site prime coated.
- .2 All exposed electrical fittings, supports, hangers, frames conduit, racks, boxes, raceways and similar material and apparatus shall be galvanized or finished with corrosion resistant primer ready to accept paint. Take special care when priming work exposed to the elements or in wet areas to prevent rust or corrosion from damaging adjacent surfaces.
- .3 All large switchgear, transformers, distribution centres, panelboard, starters, disconnects or similar apparatus shall be factory finished in gloss air dry enamel over corrosion resistant sealer primer. Unless specified to the contrary, this finish shall be ASA #61 grey.

- .4 Touch-up and/or repaint any factory finished equipment not scheduled to be painted by Division 9 that has been scratched or otherwise damaged during installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Include in the tender price the cost of an independent agency for on-site engineering inspection and testing and co-ordination of the following main distribution equipment:
 - .1 Secondary Switchboard,
 - .2 Distribution Equipment,
 - .3 Generator

1.3 SUBMITTALS

- .1 Submit the co-ordination study in the form of shop drawings before the submission of equipment shop drawings for review to the:
 - .1 Consultant
 - .2 Inspection Authority, if required

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 EXTENT OF TESTING & INSPECTION

- .1 This engineering inspection and testing shall be done prior to the system being energized and shall include the following items where applicable:
- .2 Testing, cleaning where necessary, and calibrating all relays and circuit breaker trip devices. (Calibration of all protective devices shall conform to requirements of approved co-ordination curves.)
- .3 Transformers of 100 KVA and over shall be subject to the following tests:
 - .1 Insulation Resistance
 - .2 Ratio
 - .3 Polarity
 - .4 Phase Angle
- .4 Function test of associated control devices.
- .5 Megger test interconnecting cables.
- .6 Replacement of fuses destroyed or damaged during the testing.

- .7 Under a minimum of 50% rated load conditions perform an infra red scan of the main distribution equipment.
- .8 The presence, for the length of the required, or qualified and competent equipment service representatives during start-up.
- .9 Forward for approval prior to energization of the distribution system and equipment, four neat, typewritten copies of the engineering and testing report.

3.2 CO-ORDINATION STUDY

- .1 The protective system devices have been selected such that protection is adequate and good co-ordination is possible, however, since differences do exist between manufacturers, some changes in trip ratings or relay settings may be necessary and shall be carried out.
- .2 Arrange for the independent testing company to carry out the following:
 - .1 Immediately upon award of the contract and prior to the manufacture of the switchboards, prepare a set of co-ordination curves on KE No. 336E time current characteristic graph paper and forward eight copies to the Consultant for his approval. Make any changes as directed by the consultant at no additional charge to the Owner.
 - .2 This shall be accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to verify protection of the various elements of the system under maximum and minimum fault conditions at the various points in the system.
- .3 The time-current characteristic curves for the following shall be plotted
 - .1 The relays and fuses protecting the incoming service.
 - .2 Main and feeder protective devices at all voltage levels used in the distribution system.
 - .3 Protective devices associated with the largest motor in each MCC, the refrigeration compressor, and largest device in each distribution panel.
 - .4 Transformer damage curves and cable damage curves co-operate with and obtain from the utility and other manufacturers of equipment requiring protective devices to be used in the distribution system and prepare co-ordination curves as soon as possible. Be responsible, along with the other manufacturers of equipment connected to the distribution system, to ensure that the proper control and protective devices are selected such that they co-ordinate with all protective devices.
 - .5 Single line diagram indicating the emergency generator, emergency distribution, automatic transfer switch, breakers and fuses.
- .4 It shall be the responsibility of the switchgear manufacturer to examine the plans and specifications to ensure that all the relays and protective devices being installed in the distribution system will provide satisfactory co-ordination.
- .5 Breaker frame sizes, sensors, delay types, power fuses, and fuses shall be provided in accordance with the approved co-ordination study.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.
- .2 Ontario Electrical Safety Code, Rule 2-306.
- .3 CSA Z462 Electrical Workplace Safety.
- .4 IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.
- .5 ANSI/NEMA Z535.4 – Product Safety Signs and Labels.

1.2 Scope

- .1 Retain the services of and independence 3rd party to provide an Arc Flash Hazard Analysis Study per the requirements set forth in the above noted standards.
- .2 The scope of the study shall include all new distribution equipment supplied for the project.

1.3 Submittals For Review/Approval

- .1 The arc flash hazard analysis study shall be submitted to the Consultant prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the study may cause delay in equipment manufacturing, approval from the Consultant may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
- .2 The results of the arc flash hazard analysis study shall be summarized in a final report.
- .3 The report shall include the following sections:
 - .1 Executive Summary.
 - .2 Descriptions, purpose, basis and scope of the study
 - .3 Details of the incident energy and flash protection boundary calculations.
 - .4 Recommendations for system improvements, where needed.
 - .5 One-line diagram.

1.4 Qualifications

- .1 The arc flash hazard analysis study shall be conducted under the supervision and approval of a Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- .2 The Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

Part 2 Products

2.1 Data Collection

- .1 The Engineer performing arc flash hazard analysis study shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the study as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

2.2 Arc Flash Hazard Analysis

- .1 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations.
- .2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- .3 The Arc-Flash Hazard Analysis shall include all significant locations in 600 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
- .4 Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2 .
- .5 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- .6 The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- .7 The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
- .8 Fault contribution from induction motors should not be considered beyond 3-5 cycles.
- .9 Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions

from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

- .10 For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- .11 When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- .12 Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- .13 Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.3 Report Sections

- .1 Submit the report incorporating the following sections:
 - .1 Arcing fault magnitude.
 - .2 Protective device clearing time.
 - .3 Duration of arc.
 - .4 Arc flash boundary.
 - .5 Working distance.
 - .6 Incident energy.
 - .7 Hazard Risk Category.
 - .8 Recommendations for arc flash energy reduction.

Part 3 Execution

3.1 Arc Flash Warning Labels

- .1 The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- .2 All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- .3 The label shall include the following information, at a minimum:
 - .1 Location designation
 - .2 Nominal voltage.

- .3 Flash protection boundary.
- .4 Hazard risk category.
- .5 Incident energy.
- .6 Working distance.
- .7 Engineering report number, revision number and issue date.
- .4 Labels shall be machine printed, with no field markings.
- .5 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - .1 For each 600, 208 and applicable 120 volt panelboard, one arc flash label shall be provided.
 - .2 For each motor control center, one arc flash label shall be provided.
 - .3 For each low voltage switchboard, one arc flash label shall be provided.
 - .4 For each switchgear, one flash label shall be provided.
 - .5 For medium voltage switches one arc flash label shall be provided.
- .6 Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.2 Arc Flash Training

- .1 The contractor of the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment, minimum of 4 hours is required.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.
- .2 Comply with Section 27 05 00, Communications General Requirements and all documents referred to therein.
- .3 Comply with Section 28 05 00, Security General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Demolition and restoration of areas as identified on the contract documents.
- .2 Continuity of services and systems to entire existing facility.
- .3 Planning and phasing of construction activities that allow for the continued operation of the facility, or designated areas of the facility, during the construction period, including, but not necessarily limited to:
 - .1 Limitations on access to areas of the site,
 - .2 Limitations on use of the site,
 - .3 Coordination with site personnel,
 - .4 Maintenance of identified existing mechanical services during construction, or construction related activities, under control of the Contractor.

1.3 SUBMITTALS

- .1 Submit a Work Plan identifying how existing electrical, communications, security, and other technology systems services identified to be maintained during construction activities are intended to continue in operation unless approved as part of a pre-planned scheduled service disruption. The Work Plan will address the following:
 - .1 Services being disrupted,
 - .2 Anticipated start of disruption, length of disruption, and date when electrical services are anticipated to be re-established,
 - .3 Electrical services in the operational areas of the facility outside of the construction site that will be affected during the service disruption,
 - .4 How the electrical, communications, security, and other technology systems service, or portion of the electrical, communications, security, and other technology systems service, will be maintained during construction activities, or construction related activities, under control of the Contractor,
 - .5 The Contractor's plan for remedial work to reestablish any required electrical services to be maintained, but disrupted because of construction related activities, regardless of the effort to maintain the electrical services intended by the Work Plan.
- .2 Carefully schedule all disruption and/or shutdowns and ensure that the duration of same is kept to the absolute minimum.

- .3 The Contractor shall not execute any work on site until the Work Plan has been submitted and reviewed by the Owner.

1.4 WORK IN EXISTING FACILITY

- .1 Areas of the facility identified in the Documents, Appendix D, and Appendix E shall remain open and in operation during construction, or construction related activities under the control of the Contractor.
- .2 Where existing services such as electrical power, communications system, security system, other similar technology systems, etc., are required to be disrupted and/or shut-down, co-ordinate the shut-downs with the Owner and carry out the work at a time and in a manner acceptable to them. Carefully schedule all disruption and/or shut-downs and ensure that the duration of same is kept to the absolute minimum. Submit for approval a written, concise schedule of each disruption at least 72 hours in advance of performing work and obtain Owner's written consent prior to implementing.
- .3 Where disruption to life safety systems are required, comply with paragraph above and provide continuous monitoring during shut down period and ensure that all systems are reactivated prior to leaving site at the end of each working day.
- .4 Should any temporary connections be required to maintain services during work in the existing facility, supply and install all necessary material and equipment and provide all labour at no extra cost. Should any existing system be damaged, make full repairs without extra cost, and to the satisfaction of the Consultant.
- .5 Refer to Owner's General Requirements and Division 1 for phasing and staging of work and adhere to that program. Comply with instructions regarding working hours necessary to maintain the facility in operation.
- .6 The drawings indicating items of equipment to be deleted or relocated have been prepared as a guideline for this subcontractor, but shall not be construed as indicating every item of equipment or conduit. The Contractor shall be responsible for determining site conditions by their own examination.
- .7 Where existing services (conduits, receptacles, switches, etc.) presently mounted on and/or concealed behind existing finishes become exposed during the renovation work and where these services will not be concealed behind or mounted on new finishes, include for relocating the service so as to be concealed behind or on new or existing finishes. Co-ordinate new locations with the Consultant.

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 Phasing of Works

- .1 Complete the scope of works per the proposed phasing strategy and sequencing of works identified as part of Appendix 'D'.

- .2 The proposed sequencing of works is provided for reference only. The Contractor shall propose new/revise the proposed phasing strategy to suit site conditions, the construction schedule, maintain existing facility operations, and minimize any downtime for any service interruptions.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide all wiring as specified herein for a complete installation, as required by the contract documents.

1.3 SUBMITTALS

- .1 Submit shop drawings of building wire and cables.
- .2 Submit a list of feeders used on the project, indicating cable type and size.

1.4 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers are; Canada Wire and Pirelli.

Part 2 Products

2.1 BRANCH CIRCUIT CONDUCTORS

- .1 "RW90" single conductor to CSA C22.2 No. 38-95, colour coded 90°C rated, with approved manufactured connectors at joints.
- .2 "RWU90" (-40°C) single conductor to CSA C22.2 No. 38-95, colour coded, 90°C rated, with joints soldered and taped to the Consultant's approval.
- .3 Flexible armoured cable, CSA type "AC-90" to CSA C22.2 No. 51-95.
- .4 "TWH" single conductor to CSA C22.2 No. 75-M1983 (R1992), colour coded, 90°C, rated with approved manufactured connectors at joints.
- .5 Single conductor colour-coded, rubber insulated wire to CSA type "R90" 90°C rated.
- .6 Aluminum conductors where shown to be used, shall be provided with compression terminations, applied with corrosion preventing compound, and hydraulic or power activated tools shall be used for all connections.
- .7 Branch circuit conductors up to and including #12 AWG shall be solid. Branch circuit conductors in sizes larger than #12 AWG shall be stranded. All branch circuit conductors shall be constructed of 98% conductive copper, unless otherwise noted, and shall be approved for 600 volts.
- .8 Electric service, distribution and special conductors are specified in this Section and/or on the drawings.
- .9 Lubricant shall be Ideal "Yellow 77" or approved equal.

2.2 LOW VOLTAGE (24 VOLT) CONDUCTORS

- .1 Colour-coded #18 AWG TFF thermoplastic insulated wire for 600 volt service, complete with the number of copper conductors required.

2.3 MICC CABLE

- .1 Pyrotenax of Canada Ltd. two hour rated mineral insulated cables and accessories to CSA standard C22.2 No. 124.
- .2 Conductors shall be solid bare soft annealed copper.
- .3 Insulation shall be compressed powdered magnesium oxide to form compact homogeneous mass throughout the entire length of the cable.
- .4 The overall covering shall be an annealed seamless copper sheath type MI rated 600V, 250°C.
- .5 Terminations shall be factory pre-packaged kits.

Part 3 Execution

3.1 INSTALLATION OF BRANCH CIRCUIT CONDUCTORS

- .1 Provide all required branch circuit conductors.
- .2 Conductors for branch circuit work inside the building and above ground, except as noted below, shall be as specified in Article #2.01 Item .1 above.
- .3 Conductors for branch circuit work underground as specified in Article #2.01, Item .2 above.
- .4 Conductors for branch circuit lighting work (fixture tails) in accessible ceiling spaces, maximum length 1500mm, and branch circuit work in cavity wall construction from wiring devices to ceiling spaces, maximum length 6m, shall be as specified in Article #2.01, Item 3 above.
- .5 Conductors for branch circuit work to electric heating coils and/or units shall be as specified in Article #2.01, Items .4 and .5 above.
- .6 Branch circuit conductor sizes are scheduled and/or specified on the drawings. Such sizes are minimum requirements and must be increased, where required, to suit the length of run and voltage drop.
- .7 Do not use conductors smaller than #12 AWG in systems over 30 volts, unless otherwise noted.
- .8 Use lubricant when pulling wires into conduit. Ensure that wires are kept straight and are not twisted or abraded.
- .9 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.
- .10 Splicing of all conductors shall be done with Ideal Wing nut #450 Series for conductors from #14 Awg to #8 Awg.
- .11 For all conductors larger than #8 AWG, splicing shall be done with Burndy Serut connectors wrapped with 3 m #33 scotch tape.
- .12 Provide a dedicated neutral for each branch circuit conductor unless noted otherwise.
- .13 Joints in all conductors shall be kept to a minimum and all conductors shall be installed in continuous unbroken runs.

3.2 INSTALLATION OF LOW VOLTAGE (24) VOLT CONDUCTORS

- .1 Install all low voltage wiring in conduit.
- .2 Refer to manufacturer's shop drawings for special requirements pertaining to low voltage wiring.
- .3 Refer to individual specification section and the drawings for additional wiring requirements.

3.3 INSTALLATION OF MICC CABLE

- .1 For feeders and branch circuit conductors which are used in connection with fire alarm systems and all life safety systems connected to a standby generator power source, and where such feeders and conductors are not embedded in concrete, or utilize Pyrotenax MICC cables as specified.
- .2 Cables shall be installed and terminations made as directed by the manufacturer.
- .3 MICC cables shall be clipped and fastened on maximum 12" centres and shall be fastened within 6" of each bend.
- .4 All MICC cables shall be meggered out using a 1000 volt megger upon completion of terminations.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide a complete system of electric service grounding as outlined herein and as specified and detailed on the drawings. Grounding shall comply with the requirements of all grounding work, which is required but not specified herein or shown on the drawings.

Part 2 Products

2.1 MATERIALS

- .1 All grounding conductors shall be stranded copper, bare or insulated as indicated on Drawings or in Specifications.
- .2 Use Cadweld or Burndy Thermoweld process for all weld connections. AMP of Canada Ltd. Wrench-Lok grounding connectors are an acceptable equivalent to welded connections.
- .3 All ground connectors to be designed and approved for grounding purposes.
- .4 Ground buses - 7 mm x 40 mm x 915 mm (1/4" x 1-1/2" x 36") solid copper.
- .5 Ground electrodes - 3050 mm x 20 mm (120" x 3/4") copper clad steel ground rods.

Part 3 Execution

3.1 INSTALLATION

- .1 Bond the electrical system ground to the main water supply pipe on the street side of the main water valve. Ground conductors shall be a minimum 3/0 copper wire connected with approved fittings.
- .2 Provide electrodes to code requirements. Ground electrode to comprise three 3050 mm x 20 mm (120" x 3/4") copper clad steel ground rods with their tops driven 300 mm (12") below grade. Space ground rods 3050 mm (120") apart. Where required provide additional ground rods.
- .3 Provide a perimeter ground bus in electrical rooms containing high voltage switchgear, power class transformers and secondary switchboards of 7 mm x 40 mm (1/4" x 1-1/2") solid copper rigidly supported on the wall. Connect all electrical systems and equipment ground wires back to ground bus in the electrical rooms. Make connections to ground bus with cable lugs, bolted through the copper with shake-proof lock washers and nuts. This ground bus to be the sole interconnection point for ground connections to:
 - .1 Main secondary switchboards.
 - .2 High voltage switchgear.

- .3 Power transformers.
- .4 All exposed metal work.
- .4 Bond all interior non-electrical metallic piping systems to the electrical system ground including, but not limited to, water supply, waste water, and gas systems.
- .5 Ground the neutral point of each secondary wye connected transformer.
- .6 Connect the ground bus inside each switchgear assembly to the grounding system.
- .7 Inside main secondary switchboards, connect the neutral bus to the ground bus with conductor rated minimum 25% main bus rating.
- .8 Final arrangement of grounding main secondary switchboards as approved by the ground fault system manufacturer.
- .9 Connect the ground bus in each 600 volt emergency distribution panel to the grounding system.
- .10 Ground all conduit, and all non-current carrying metal parts, equipment cases, frames, bases, brackets, frames of motors, duct systems, building steel, elevators, etc.
- .11 Where conduit systems are used for grounds, provide all necessary bushings, studs and jumpers as may be required to maintain effective continuity of ground. Provide separate ground conductors in all non-metallic conduits, concrete encased conduit, conduit below grade and EMT conduit. Bond the ground wire to all boxes and luminaries.
- .12 Ground each piece of fixed equipment back to the switchboard or panel feeding that equipment, by one of the following methods:
 - .1 Where equipment is fed by a steel conduit, provided sizing is adequate, utilize conduit for the ground return conductor. At switchboard provide a grounding bushing, and strap such conduits to the ground bus (size per Code).
 - .2 Where the size of the conduit is inadequate (per Code), or if the conduit is flexible, install a separate bare soft drawn copper ground inside the conduit. At the switchboard or distribution panel, provide a grounding bushing, loop the ground conductor through the bushing, and connect to the switchboard ground bus. At the fixed equipment, connect to an internal ground bus, or connect to the inside of the metal enclosure utilizing approved screws and connectors (remove all paint).
 - .3 For branch circuits, the conduits may be used for grounding, provided seamless steel fittings are used on EMT and threaded fittings are used on rigid conduit. At each receptacle connect a stranded copper ground wire from the outlet box to the grounding terminal on the receptacle. Install a separate grounding conductor in all PVC conduits.
 - .4 Where equipment is fed by a bus duct, provide a bare soft drawn copper ground bus inside the bus duct enclosure. Connect to the ground bus in the feeding switchboard, and to the equipment.
 - .5 Where equipment is fed by a multi-conductor power cable, provide a ground conductor in the cable. At the switchboard or panel, connect to the ground bus. Use a grounding connector on the cable for positive

grounding of the metallic sheath. Loop the ground wire to the grounding connector.

- .13 Where equipment is fed by single conductor flexible armoured cables, provide separate ground conductor and non-ferrous metallic plate and grounding connectors at the switchboard or panel for terminating cables. Run grounding conductor inside fixed equipment and terminate at the grounding connection. At the load end provide an insulating plate for terminating cables; the outer sheaths to be ungrounded.
- .14 Run a separate ground wire in all flexible conduits. Connect each end to ground bus or lug or connector.
- .15 Where mechanical protection is required for insulated grounding conductors install in rigid conduit. Use rigid PVC conduit in concrete or below grade slab and aluminum conduit in other locations.
- .16 Provide weld connection or wrench type grounding connectors for:
 - .1 All connections between grounding conductors.
 - .2 All connections to building steel.
 - .3 All connections between grounding conductors and cable lugs.
- .17 Arrange grounding to provide the minimum impedance paths for ground fault currents. Provide any additional grounding required for approval by the inspecting authorities.
- .18 Ground uninsulated metallic materials, which are located below surfaces heated by electric heating cable.
- .19 Where isolated grounding requirements are indicated, this shall be compromised of green insulated copper conductors sized as indicated and installed in conduit from the street side of the incoming water meter to the panelboard isolated ground bus. Maximum resistance to ground shall be 5 ohms.

3.2 TESTING

- .1 Test the resistance of the grounding system. Add additional ground wires and ground rods if required as directed by the Consultant and retest. Repeat this process until ground resistance is 2 ohms or less. Conduct all tests using Megger Null Balance or Megger Universal ground resistance test equipment.
- .2 Test all receptacles for proper connections with a neon lamp type polarity tester. Check that ground resistance is less than 0.2 ohms with an Edgecumbe Peebles Ltd., ground loop impedance tester.
- .3 Test and log all ground connections at panels, switchboards, transformers and ground buses prior to and after the computer is put into operation. Trace and isolate all equipment causing current in ground wires to exceed one ampere. Replace such equipment if furnished as part of this contract.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide all hangers and supports as required to provide a complete and operational system as required by the contract documents.

Part 2 Products

2.1 SUPPORT CHANNELS

- .1 U-shape, size 41 x 41 x 2.5mm thick, surface mounted, suspended or set in poured concrete walls and ceilings, as required for the specific application.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to hollow or solid masonry, tile and plaster surfaces with nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .6 Suspended support systems
 - .1 Support individual cable or conduit runs with 6mm dia. threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6mm dia. threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface-mounting of two or more conduits, use channels at 1.5m o.c. spacing.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide all splitter trough(s) for a complete installation, as required by the contract documents.

Part 2 Products

2.1 SPLITTER TROUGH

- .1 Provide CSA approved splitter boxes, each complete with a formed, primed and painted steel box with knock-outs, hinged coverplate, suitable mounting provisions, porcelain blocks complete with one (1) main conductor lug and six (6) branch conductor lugs per block, and a nameplate giving its rating.
- .2 Splitter boxes ratings shall be as specified on the drawings.
- .3 Splitter boxes mounted outside the building or exposed to weather shall be weatherproof.

Part 3 Execution

3.1 INSTALLATION OF SPLITTER TROUGH

- .1 Install splitter trough wherever shown, and/or specified on the drawings.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide all conduits, fastenings, fittings and boxes for a complete installation, as required by the contract documents.

Part 2 Products

2.1 CONDUITS

- .1 Rigid galvanized steel, CSA C22.2 No. 45, with exterior zinc and interior enamel coatings, galvanized threads where factory cut, red lead coated threads where site cut, factory made bends where site bending is not possible, factory made and threaded fittings and "tomic" joints and terminations made with rigid couplings, concrete tight where required.
- .2 EMT (Thinwall), to CSA C22.2 No. 83, complete with factory made bends where site bending is not possible and joints and terminations made with set screw type connectors, concrete tight where required, maximum allowable size shall be 50mm diameter.
- .3 Galvanized steel flexible liquid-tight metallic conduit, to CSA C22.2 No. 56, complete with proper and suitable liquid-tight flexible conduit connectors at terminations.
- .4 Galvanized steel flexible metallic conduit to CSA C22.2 No. 56, complete with suitable type connectors at terminations.
- .5 Rigid plastic (PVC) conduit to CSA C22.2 No. 211.1 complete with site made heat gun bends to 50mm diameter, factory made bends for conduit larger than 50mm, solvent weld joints with socket couplings and proper connectors and adaptors at terminations.
- .6 Electrical non-metallic tubing to CSA C22.2 No 211.0 complete with suitable type connections and couplings.
- .7 Conduit racks shall be Unistrut Ltd. Electrovert Ltd., "Cantruss", Burndy Ltd., "Flexible" or equivalent.

2.2 STANDARD OUTLET BOXES

- .1 Sheet Steel outlet boxes:
 - .1 Electro galvanized steel single and multi gang flush device boxes for flush installation.
 - .2 Electro galvanized steel utility boxes for outlets connected to surface mounted EMT conduit in interior application.
 - .3 102mm octagonal boxes for lighting fixture outlets
 - .4 102mm square outlet boxes with extension and plaster ring for flush mounting in finished plaster walls.

- .2 Masonry boxes: Electro galvanized steel masonry single and multi gang boxes for devices flush-mounted in exposed block walls.
- .3 Concrete boxes: Non-metallic concrete boxes with matching extension and plaster rings as required for flush-mounting in concrete.
- .4 Conduit boxes: Type FS and FD ferralloy boxes with factory threaded hubs and mounting feet for exterior surface wiring of switches and receptacles.
- .5 Each outlet box must be suitable in all respects for the application, and complete with securing lugs, knock-outs, and where necessary, suitable plaster rings, concrete rings, covers and any other required accessory.
- .6 Outlet boxes for special wiring devices, for special equipment and for special applications, if and where required, are specified hereinafter in this Section or on the drawings.
- .7 347 volt outlet boxes for 347 volt switching devices.
- .8 Provide blank cover plates for all boxes without wiring devices.

2.3 PULLBOXES AND JUNCTION BOXES

- .1 Pullboxes and junction boxes shall be constructed of galvanized or prime coated steel. Each shall be suitable in all respects for the applications, and complete with screw-on hinged covers as required.
- .2 The physical size of pullboxes shall be as required by the "Ontario Electrical Safety Code" to suit the number and size of conduits and conductors.

Part 3 Execution

3.1 INSTALLATION OF CONDUITS

- .1 Install conduit concealed in all finished areas, and concealed to the degree made possible by finishes in partially finished and unfinished areas. Conduit may be exposed in unfinished areas such as Electrical Rooms and Mechanical Rooms, unless otherwise noted on the drawings or specified herein. Refer to and examine the architectural drawings and on the drawings or specified herein. Refer to and examine the architectural drawings and room finish schedules to determine finished, partially finished and unfinished areas of the building.
- .2 Where conduits are exposed, arrange same to avoid interference with other work and parallel to the building lines. Where horizontal conduits are exposed, install as high as possible. Do not install conduit within 150mm of "hot" pipes or equipment unless the conduit is associated with the equipment.
- .3 Provide conduit for all electric service distribution and branch circuit conductors except armoured cable, and bus duct and except for applications where duct, cable tray and similar raceway material is provided.
- .4 Conduit for branch circuit and distribution conductors, except as noted hereinafter, shall be as specified in Article #2.01, Item .1 above.
- .5 From 1200mm above the ground floor slab.
 - .1 Conduit for branch circuit conductors concealed in masonry work in drywall, in shafts and furrings above ground and;

- .2 For branch circuit conductors exposed inside the building shall be as specified in Article #2.01 Item .2 above.
- .6 For distribution and branch circuit conductors concealed in poured concrete work above ground (not on grade); shall be as specified in Article #2.01 Item .6 above.
- .7 Conduit for short branch circuit connections to motorized equipment (minimum length 450mm; maximum length 600mm with 180 degree loop where possible) shall be as specified in Article #2.01, Item .3 above.
- .8 Conduit for short branch circuit connections to electric heating units where 90°C rated conductors are required (minimum length 450mm - maximum length 600mm with 180 degree loop where possible) and at points where distribution and/or branch circuit conductors cross building expansion joints shall be as specified in Article #2.01, Item .4 above.
- .9 Conduit for distribution and branch circuit conductors underground and for distribution and branch circuit conductors in special corrosive areas as defined herein shall be as specified in Article #2.01, Item .5 above.
- .10 Conduit for branch circuit conductors where concealed in walls or encased in concrete shall be as specified in Article #2.01 Item 6 above.
- .11 Conduits supplying equipment classified as explosion proof (i.e., fuel pumps and associated and adjacent equipment) shall be rigid galvanized steel for their entire length from their power source. Provide all required seals as specified in CEC Section 20.
- .12 Provide a separate ground conductor in all plastic and EMT conduit.
- .13 Secure conduit located in poured concrete work in place in a manner such that conduit will not float or move when concrete is poured. Protect conduit from concrete and water penetration during the concrete pour.
- .14 Support and secure surface mounted and suspended single or double runs of metal conduit at support spacing in accordance with "Canadian Electrical Code" requirements by means of galvanized pipe straps, conduit clips, ring bolt type hangers, or by other manufactured devices. Support multiple mixed size metal conduit runs with conduit racks spaced to suit spacing requirements of the smallest conduit in the group.
- .15 Install conduit parallel or perpendicular to building lines.
- .16 Generally, conduit is sized on the drawings. Conduit not sized on the drawings shall be sized in accordance with the latest edition of the Canadian Electrical Code. Note that the sizes of branch circuit conductors scheduled and/or specified on the drawings are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with the Canadian Electrical Code. Where conductor sizes are increased to suit voltage drop requirements, increase the scheduled or specified conduit size to suit.
- .17 Increase conduit sizes for heavily insulated conductors (i.e., "TWU"), a minimum of one (1) conduit size, regardless of the size indicated or required.
- .18 The maximum allowable size of conduit for installation in poured concrete work must be determined in consultation with the Consultant prior to installation. The placement of reinforcing steel in structural concrete work will take precedence

- over the placement of conduit. Multiple runs of conduit in poured concrete work must be adequately spaced as directed by the Consultant.
- .19 Do not install horizontal runs of conduit in masonry walls.
 - .20 Ensure that all conduit systems which are left empty are clean, clear, capped and properly identified. Provide suitable fish wires in all such conduit.
 - .21 Provide a minimum of two (2) 25mm diameter conduits up to and into ceiling spaces from flush mounted panelboards located below and/or near a hung ceiling.
 - .22 Support and secure surface mounted and suspended rigid PVC plastic conduit with hangers and supports as specified above for metal conduit but at support spacing in accordance with the conduit manufacturer's published recommendations.
 - .23 Support all conduit installed underground on well tamped flat bed of earth, free from rocks or protrusions of any kind.
 - .24 Conduit fittings shall be, unless otherwise noted, constructed of the same material as the conduit and suitable in all respects for the application.
 - .25 Provide proper adaptors for joining conduits of different materials.
 - .26 Ends of all site cut conduit must be square and properly reamed.
 - .27 All conduits for high voltage cable installation shall be rigid galvanized steel.
 - .28 Electrical conductors supplying all equipment connected to a source of emergency supply shall use Pyrotenax Mineral Insulated copper sheathed cables (MI).
 - .29 As an alternate to the use of MI Cables, electrical conductors supplying equipment connected to a source of emergency supply may be installed in service spaces that do not contain other combustible material or shall be protected against exposure to fire as allowed by the Building Code. Provide fire rated enclosures or provide concrete enclosure as required to ensure continued operation for a minimum period of 2 hours from the source of power supply to the branch circuit supplying the equipment.

3.2 INSTALLATION OF OUTLET BOXES

- .1 Provide an outlet box for each lighting fixture, wiring device, telephone outlet and any other outlet specified herein or shown or specified on the drawings, unless otherwise noted.
- .2 Generally, mounting heights and locations for outlets are shown on the drawings and/or specified herein, however, confirm the exact location and arrangement of all outlets with the Consultant prior to roughing-in. Architectural drawings and the Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.
- .3 Do not install outlet boxes "back-to-back" in walls and partitions. Such outlets must be staggered and sealed against noise transmission. "Thru-Wall" type outlet boxes will not be permitted for any application.
- .4 Support and secure boxes independent of the conduit or cable connected thereto.

- .5 All recessed outlet boxes for surface mounted devices or lighting fixtures must be totally concealed by the device or fixture.

3.3 INSTALLATION OF PULLBOXES AND JUNCTION BOXES

- .1 Provide pullboxes in conduit systems wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30m in length, or with more than two (2) 90 degree bends shall be equipped with a pullbox installed at a convenient and suitable intermediate location.
- .2 Provide a junction box wherever required and where shown and/or specified on the drawings.
- .3 All pullboxes and junction boxes must be accessible after the building is completed.
- .4 Accurately locate and identify all concealed pullboxes and junction boxes on "as-built" record drawings.
- .5 Support and secure all boxes independent of the conduit or cable connected thereto.
- .6 Install identification labels indicating system name on all pullboxes and junction boxes.

END OF SECTION

Part 1 GENERAL

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.
- .2 Provide Digital Metering System (DMS) per Owner's Standards. Refer to Specification Appendix for details.

1.2 WORK INCLUDED

- .1 Provide a system of conduits, backboxes, power outlets, etc. to allow the installation of a digital metering system as specified herein.

1.3 DIGITAL METERING SYSTEM

- .1 A Digital Metering System shall be provided per the drawings to meter energy consumption for the Facility electrical distribution system.
- .2 Scope of work responsibility shall be as described herein:

ELECTRICAL METERING			
EQUIPMENT	SUPPLIED BY	INSTALLED BY	ON SITE REQUIREMENTS
METER BACK BOXES, HARNESSSES AND CURRENT TRANSFORMERS (CTS)	CONTRACTOR	CONTRACTOR	SUITE DISTRIBUTION PANELS INSTALLED
METER HEADS	CONTRACTOR	CONTRACTOR	ELECTRICAL CLOSET DOOR AND LOCKS
VOLTAGE REFERENCE FOR ALL METERS (15A-3P BREAKER)	CONTRACTOR	CONTRACTOR	N/A
POWER FOR ALL ENCLOSURES (120v RECEPTACLE)	CONTRACTOR	CONTRACTOR	N/A
ALL COMMUNICATION WIRE (CAT5E, BELDEN 6820UE/650UE)	CONTRACTOR	CONTRACTOR	N/A
PHONE JACK AND NETWORK SWITCHES	CONTRACTOR	CONTRACTOR	N/A
ENCLOSURES AND RECEPTACLES (MECHANICAL METERING)	CONTRACTOR	CONTRACTOR	ELECTRICAL ROOM/CLOSET DOORS AND LOCKS
ALL CABLE TERMINATIONS	N/A	CONTRACTOR	N/A

MECHANICAL METERING			
EQUIPMENT	SUPPLIED BY	INSTALLED BY	ON SITE REQUIREMENTS
RESIDENTIAL WATER METERS	CONTRACTOR	CONTRACTOR	SYSTEM FLUSHED
RESIDENTIAL THERMAL METERS AND TAILPIECES	CONTRACTOR	CONTRACTOR	N/A
COMMERCIAL WATER, GAS AND THERMAL METERS	CONTRACTOR	CONTRACTOR	SYSTEM FLUSHED
COMMON AREA WATER, GAS AND THERMAL METERS	CONTRACTOR	CONTRACTOR	SYSTEM FLUSHED
WATER METER TAILPIECES AND SPACERS	CONTRACTOR	CONTRACTOR	N/A
INCREASERS AND/OR REDUCERS	CONTRACTOR	CONTRACTOR	N/A
SHUT-OFF VALVES	CONTRACTOR	CONTRACTOR	N/A
PRESSURE TEST POINTS (GAS METERING)	CONTRACTOR	CONTRACTOR	N/A
PIPE-O-LET (GAS METERING)	CONTRACTOR	CONTRACTOR	N/A
BYPASS	CONTRACTOR	CONTRACTOR	N/A

Note: Division 26 to provide power for all mechanical data gathering panels required.
Co-ordinate all service with system supplier.

Part 2 PRODUCTS

2.1 CONDUITS AND DEVICES

- .1 Triaca 6000 series – powerhawk smart meters or approved equal.

Part 3 EXECUTION

3.1 INSTALLATION OF CONDUIT SYSTEM

- .1 Install conduit and power devices as required.
- .2 The metering system will be supplied and installed under direct contract with the client.
- .3 Conduits shall be minimum 20mm complete with pull strings. There shall not be more than two (2) 90° bends in any run of conduit and pullboxes shall be provided in runs in excess of 100' or where more than two (2) 90° bends are required.
- .4 Conduit shall be left clear and free of all obstructions and shall be terminated as shown. Equip terminations with bushings and clearly identify each run.
- .5 Co-ordinate the work with the Metering Supplier and obtain the exact location of equipment, conduit sizes, outlet box requirements prior to roughing-in.

- .6 Provide power outlets as required.
- .7 Where security equipment requires special back-boxes to be mounted, they will be provided by the Metering Contractor for installation by this Contractor.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 The main electric service will be supplied for this project underground by the Local Utility Company (LUC).
- .2 Supply all labour, tools, services and equipment and provide all the materials as required by the contract documents, per the LUC's standards, and Offer to Connect requirements.

1.3 SUBMITTALS

- .1 Submit shop drawings and installation details, to the consultant, and supply utility for review.

Part 2 Products

2.1 MATERIALS

- .1 Duct bank shall be as shown on the plans and provided per the LUC's standards and Offer to Connect requirements.
- .2 Ducts to be Scepter Super Duct enclosed in a reinforced concrete envelope.
- .3 Duct spacers to be cast concrete or fibre, installed at maximum 1200 mm ('x 4'-0") centres to maintain a clear space of 51mm (2") between ducts/
- .4 Plastic duct spacers will not be acceptable.

2.2 DUCT SEALANT

- .1 At all duct joints provide a duct sealant compound to ensure water tightness of the duct.
- .2 Sealant shall be Q-tel-2027, as manufactured by CHEMQUE
- .3 Sealant is a two-component polyurethane paste-like compound that provides gas tight seals.

Part 3 Execution

3.1 INSTALLATION

- .1 Size and brace all primary cables and equipment to withstand the forces of the available fault current of 500 MVA.
- .2 Provide suitable lugs and stress cones for the termination of the incoming cables.
- .3 Provide suitable method of support in main electrical room for incoming cables.
- .4 Obtain approval from Local Utility Company inspection prior to proceeding with the work.

- .5 On completion of installation, all ducts to be cleaned and all blocks cleared, to the approval of applicable authority.

3.2 INSTALLATION OF DUCT SEALANT

- .1 Provide duct sealant at all duct joints and at all sleeve points in the duct run.
- .2 Create a dam at the duct openings using rags or paper and dispense the compound into the duct opening.
- .3 Use a wooden stick to spread the compound around the cables and the edges of the duct, to create an airtight seal.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 01 – Shop Drawings, Product Data and Samples.

1.3 REFERENCE STANDARDS

- .1 Design, manufacture and test the dry type transformers in accordance with good industry practices and in accordance with the latest versions of the following Standards.
 - .1 CSA Std C22.2 No 0.12-M1985 Equipment Rated 750V or Less.
 - .2 CAN/CSA-C22.2 No 47-M90.
 - .3 UL 1561- 4 Ed.
 - .4 CSA C802.2-06 Minimum Efficiency Values for Dry-Type Transformers.
 - .5 NEMA ST-20 for sound level

1.4 STORAGE

- .1 Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations.
- .2 Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable service conditions. Handle transformer using proper equipment for lifting and handling; use when necessary lifting eye and/or brackets provided for that purpose.

1.5 ACCEPTABLE MANUFACTURERS

- .1 All transformers shall be of one manufacturer. Acceptable manufacturers are: STI, Hammond, Rex Transformers, Cutler Hammer, Square D and Siemens.

Part 2 Products

2.1 TRANSFORMER TYPE

- .1 Transformer shall be standard general purpose dry type unless otherwise indicated on drawings as K-Rated or Harmonic Mitigation type.

2.2 GENERAL PURPOSE TRANSFORMERS

- .1 Transformers shall have the following characteristics:
 - .1 Type: AN/AA Ventilated self-cooled.
 - .2 KVA, primary voltage and secondary voltage and as indicated.
 - .3 Single or three phase as indicated.

- .4 Delta connected primary for three phase transformers.
- .5 Secondary winding shall be wye connected for three phase transformers unless Harmonic Mitigation type, or unless otherwise noted.
- .6 Four full capacity 5% adjustment taps, 2 at 2.5% FCBN and 2 at 2.5% FCAN.
- .7 Copper Windings.
- .8 220°C Insulation Class.
- .9 150°C Temperature rise.
- .10 Standard Impedance.
- .11 10kV BIL.
- .12 Sound level per NEMA ST-20.
 - .1 Ventilated Type 1 enclosure with Grey finish (Options Type 2 (drip-proof), Type 3R (weatherproof), Type 4 (totally enclosed), Sprinkler-proof]
- .13 Anti-vibration pads shall be used between the core and the enclosure.
- .14 The impregnation process for the core-and-coil assembly shall include a period under vacuum, followed by pressure impregnation (VPI).
- .15 Transformer shall have embossed aluminum or stainless steel nameplate indicating, but not restricted to the following.
 - .1 KVA rating
 - .2 Voltage rating
 - .3 Impedance
 - .4 Type
 - .5 Insulation class
 - .6 Temperature rise
 - .7 Connection diagram

2.3 K-RATED TRANSFORMERS

- .1 In addition to all general purpose transformer characteristics in section 2.2, K-Rated transformers shall have the following features.
 - .1 Transformers shall be K-13 rated for non-linear loads.
 - .2 Transformers shall have 200% Rated Neutral.
 - .3 Transformers shall have an electrostatic shield between primary and secondary windings.

2.4 HARMONIC MITIGATION TRANSFORMERS

- .1 In addition to all general purpose transformer characteristics in section 2.2, Harmonic Mitigation transformers shall have the following features.
 - .1 Transformers shall be compatible with load profile up to K20.
 - .2 Transformers shall have 200% Rated Neutral.
 - .3 Transformers shall have an electrostatic shield between primary and secondary windings.

- .4 3rd, 9th & 15th harmonics and other zero sequence currents shall be treated within the secondary windings through cancellation of the zero sequence fluxes. Simply trapping these currents in the delta primary winding is NOT acceptable.
- .5 For 5th, 7th, 17th & 19th harmonics provide the appropriate primary-secondary phase shift at 60 Hz as shown on drawings, in order to cancel these harmonic currents with those of other loads fed from the same primary supply.
- .6 Harmonic mitigation shall be by electromagnetic means only. No capacitors or electronics shall be used.
- .7 Positive & negative sequence impedance at 60Hz: 2.5% to 3.8% (up to 75 kVA), 3.0% to 4.8% (112.5 to 300 kVA)
- .8 Zero sequence impedance/reactance at 60Hz: Less than 0.95% and 0.3% respectively for sizes up to 300 Kva.

Part 3 Execution

3.1 MOUNTING

- .1 Floor or wall-mount the dry type transformers up to 75 kVA as indicated.
- .2 Mount transformers 75 kVA and above, on floor. Floor mounted transformer shall be installed on an isolated housekeeping concrete pad (100mm) poured on 3 layers of "Duracoustic" continuous cushion material as detailed on the drawings..
- .3 Ensure adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports is any only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Supply and install anti-vibration dampers for wall or ceiling mounted transformers.
- .8 Make primary and secondary connections with flexible conduit and in accordance with wiring diagram.
- .9 Energize transformers as soon as possible after installation is completed.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide service entrance switchboards and all necessary equipment.

1.3 SUBMITTALS

- .1 Submit Shop drawings of the entire assembly and all components.
- .2 Provide to the Owner a framed single line as-built diagram of the electrical distribution system and install in each electrical room.

1.4 ACCEPTANCE MANUFACTURERS

- .1 Schneider Canada, Cutler Hammer and Siemens.

Part 2 Products

2.1 LOW VOLTAGE SWITCHBOARDS

- .1 General:
 - .1 Service entrance switchboard(s) shall be provided and installed as shown on the plans.
 - .2 The switchboard(s) shall consist of a main incoming section and one or more distribution sections as required for the feeder circuits, and shall be suitable for use on a 347/600V, 3-phase, 4-wire and solidly grounded system.
- .2 Construction:
 - .1 The vertical sections shall be of bolted steel channel frame with removable side and rear panels of code gauge steel. Provision for padlocking shall be provided for the main switch and the utility metering compartments. Provision for sealing shall be made on all panels covering unmetered bus. Full barriers shall be provided between the main section and the adjacent distribution sections.
 - .2 The distribution section shall be constructed so that operating handles of feeder devices are recessed from the face of the switchboard. The trim shall be split for ease of installation and safety.
 - .3 The switchboard shall be designed to be installed with the rear panels against a wall, so that ventilation and connection of all cables will be from the front.
- .3 Enclosure:
 - .1 The enclosure shall be sprinklered-proof with an extended top cover located on the front of the unit.

- .2 The switchboard frame and panels shall be thoroughly de-greased and painted with light grey ASA 61 enamel (other colours may be substituted as an option).
- .3 Engraved lamaroid nameplates, fastened with screws, shall identify main and distribution breakers and fusible switches as shown on the drawings.
- .4 Main Bus:
 - .1 The main bus shall be electrolytically tin-plated copper rated as shown on plans.
 - .2 Supported on a 2 inch stand-off insulator and braced to withstand stresses imposed by a short circuit of 50,000A RMS symmetrical, unless noted otherwise on the plans.
 - .3 Single bolt joints utilizing high strength steel bolts, large Belleville washers and locking strap shall be provided for ease of installation.
 - .4 Provision shall be made for future extension.
 - .5 A ground bus, bonded to each steel frame, shall be provided with a lug at each end suitable for 4/0 copper grounding cable.
- .5 Entry Options: Top entry and exit.
- .6 Main Device - Breaker:
 - .1 Electronic trip moulded case full function 100% rated circuit breaker, size as shown on plans and rated at 50 kA symmetrical, unless noted otherwise on the plans.
 - .2 The entire trip system shall be a microprocessor-based, true RMS sensing design.
 - .3 Provide the following time/current curve shaping adjustments to maximize system selective co-ordination. Each adjustment shall have discrete settings and each function is independent from all other adjustments:
 - .1 Adjustable Long Time Ampere Rating and Delay
 - .2 Adjustable Short Time Pick-up and Delay (delay includes 1st in and 1st OUT)
 - .3 Adjustable Instantaneous Pick-up
 - .4 Adjustable Ground Fault Pick-up and Delay (delay includes 1st in and 1st out)
 - .5 High Level Selective Override
 - .4 Circuit breakers(s) shall be provided with integral equipment protection for grounded systems.
 - .5 All lugs shall be UL Listed to accept solid and/or stranded copper conductors. Lugs shall be suitable for 90°C rated wire, sized according to the 75°C temperature rating.
- .7 Utility Metering: Space and provision shall be made under the main switches to mount utility current and potential transformers in accordance with the local utility requirements. The contractor shall obtain the transformers and mount them in the switchboard. Secondary wiring shall be done by utility personnel.
- .8 Distribution Devices

- .1 Circuit breakers 225 ampere frame and below shall be Square D with thermal-magnetic trip units and inverse time-current characteristics.
- .2 Circuit breakers 400 ampere through 1200 ampere frame shall be Square D with microprocessor-based RMS sensing electronic trip units and the following features:
 - .1 Each moulded case circuit breaker microprocessor-based tripping system shall consist of three current sensors, a trip unit, and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when pre-determined trip levels and time delay settings are reached.
 - .2 Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - .3 The microprocessor-based trip unit shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
 - .4 When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override. Internal ground fault protection adjustable pick-up ratings shall not exceed 1200 amperes. Provide neutral ground fault current sensor for four wire loads.
 - .5 System co-ordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
 - .1 Adjustable long time pick-up and delay
 - .2 Adjustable short time pick-up and delay with selective curve shaping
 - .3 Adjustable instantaneous pick-up
 - .4 Adjustable ground fault pick-up and delay with selective curve shaping
- .9 Owner's Instrumentation:
 - .1 Digital Meter Panel (type PM850): A digital meter panel for customers use shall be installed and factory wired in the first distribution section of the switchboard. The system shall be microprocessor based, displaying volts and current for each phase as well as power factor, frequency, THD voltage, THD current, K factor, KVA, KVAR, KW, and the accumulated MWH. The meter shall monitor and store the minimum values of volts and power factor and the maximum values of amperes, KW, KVA, KVAR, and KWD.
 - .2 The meter shall be designed to operate on systems to 600V without the need for control or metering transformers.

- .3 All programmable parameters and accumulated values shall be stored in a non volatile memory in the event of a power failure.
- .4 The power meter shall have a KYZ / KY pulse output.
- .5 The power meter shall have a MODBUS RS 485 communications port

2.2 METERING CABINET

- .1 Provide metering equipment for the incoming electric services as shown.
- .2 Provide empty conduit between the incoming switchboard to the metering cabinet as shown.
- .3 Provide a 1/2" empty conduit complete with bushings at both ends between the revenue metering cabinet and the incoming telephone room for telephone service access.

Part 3 Execution

3.1 INSTALLATION A LOW VOLTAGE SWITCHBOARD

- .1 Install secondary switchboard as noted on the drawings and secure to a concrete housekeeping pad.

3.2 INSTALLATION OF METERING CABINET

- .1 Install metering equipment as shown.
- .2 Connect the equipment with conduit and provide fish wire for use by Toronto Hydro.
- .3 The conduit for telephone services shall be terminated at the top right hand corner of the cabinet.
- .4 Provide a 120 volt duplex receptacle in the bottom right hand corner of the cabinet and connect to emergency circuit.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.
- .2 The panelboards and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of EEMAC and CSA.

1.2 WORK INCLUDED

- .1 Provide all panelboards as specified and shown for a complete installation, as required by the contract documents.

1.3 SUBMITTALS

- .1 Submit shop drawings showing the following information:
 - .1 Breaker layout drawing with dimensions indicated and nameplate designation.
 - .2 Component list.
 - .3 Conduit entry/exit locations.
 - .4 Assembly ratings including:
 - .1 Short circuit rating.
 - .2 Voltage
 - .3 Continuous current
 - .5 Cable terminal sizes.
- .2 Where applicable, the following additional information shall be submitted:
 - .1 Key interlock scheme drawing and sequence of operations.

1.4 QUALIFICATIONS

- .1 The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.
- .2 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Consultant, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.5 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers are: Schneider Canada, Eaton (Cutler Hammer) and Siemens.

Part 2 Products

2.1 RATINGS

- .1 Panelboards shall have short circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.

- .2 Panelboards shall be labelled with a CSA short circuit rating. When series ratings are applied with integral or remote upstream devices, a label shall be provided. Series ratings shall cover all trip ratings of installed frames. It shall state the conditions of the CSA series ratings including:

- .1 Size and type of upstream device.
- .2 Branch devices that can be used.
- .3 CSA series short circuit rating.

2.2 CONSTRUCTION

- .1 Interiors shall be completely factory assembled with bolt-on devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- .2 Trims for lighting and appliance panelboards shall have doors with concealed hinges over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi-flush cylinder lock and catch assembly. Trim fastening screws shall not be visible.
- .3 Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.
- .4 Surface trims shall be same height and width as box. Flush trims shall overlap the box by one (1) inch on all sides.
- .5 A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
- .6 All locks shall be keyed alike.

2.3 BUS

- .1 Main bus bars shall be plated aluminum sized in accordance with CSA standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.
- .2 Full-size insulated neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

2.4 POWER DISTRIBUTION PANELBOARDS – CIRCUIT BREAKER TYPE

- .1 Power distribution panelboards and the devices contained therein shall have series interrupting ratings as indicated on the drawings. Panelboards shall be Square D Type I-line. Panelboards shall have molded case circuit breakers as indicated below.
- .2 Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics and shall be Square or approved equal. Ground fault protection shall be provided where indicated.
- .3 Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-centre switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the

handle position. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

- .4 Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
- .5 Where indicated, circuit breakers shall be CSA listed for series rating.
- .6 Where indicated, circuit breakers shall be current limiting.
- .7 Circuit breakers 400 ampere frame and below shall be Square D with thermal-magnetic trip units and inverse time-current characteristics.
- .8 Circuit breakers 600 ampere through 1200 ampere frame shall be Square D with microprocessor-based RMS sensing electronic trip units and the following features:
 - .1 Each molded case circuit breaker microprocessor-based tripping system shall consist of three current sensors, a trip unit, and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when pre-determined trip levels and time delay settings are reached.
 - .2 Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - .3 The microprocessor-based trip unit shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
 - .4 When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override. Internal ground fault protection adjustable pick-up ratings shall not exceed 1200 amperes. Provide neutral ground fault current sensor for four wire loads.
 - .5 System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
 - .1 Adjustable long time pick-up and delay
 - .2 Adjustable short time pick-up and delay, with selective curve shaping
 - .3 Adjustable instantaneous pick-up
 - .4 Adjustable ground fault pick-up and delay, with selective curve shaping.
 - .6 Where indicated, provide circuit breakers CSA listed for application at 100% of their continuous ampere rating in their intended enclosure.
 - .7 Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

2.5 POWER DISTRIBUTION PANELBOARDS – FUSIBLE SWITCH TYPE

- .1 Power distribution panelboards shall have fusible switches as specified below and include fuses with ratings indicated on the drawings. Panelboard shall be Square D type QMQB or QMB.
- .2 Fusible switch units shall be quick-make, quick-break design. Units 30 through 600A shall be rated not less than 200 kAIC with rejection-type clips for Class J type fuses. Units 800A and 1200A shall be rated for 200 kAIC with Class L fuse provisions. Fuses for these switches shall be supplied and field installed by the electrical contractor.

2.6 BRANCH CIRCUIT PANELBOARDS

- .1 The Minimum Integrated Short Circuit Rating for branch circuit panelboards shall be indicated on the drawings. Panelboards shall be Square D type NF or NQOD. Panelboards shall have circuit breakers as indicated below.
- .2 Bolt-in type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
- .3 Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100 ampere frame and through 100 ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be CSA listed as type SWD for lighting circuits.
 - .1 Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management and control system (EMCS) panels and fire alarm panels.
- .4 Circuit breakers shall have a minimum interrupting rating of 10,000 amperes symmetrical at 240 volts and 14,000 amperes symmetrical at 600 volts.

2.7 ENCLOSURE

- .1 Enclosures shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with the Canadian Electric Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
- .2 Enclosures shall be provided with one (1) blank end and one end with knock-outs.
- .3 All enclosures shall be EEMAC 1 c/w drip shield for surface-mounted enclosure unless otherwise noted.

2.8 NAMEPLATES

- .1 Provide an engraved nameplate for each panel section.

2.9 FINISH

- .1 Surfaces of the trim assembly shall be properly cleaned, primed, and a finish coat of grey ANSI 49 paint applied.
- .2 Suite panel shall have WHITE finish.

Part 3 Execution

3.1 FACTORY TESTING

- .1 The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of EEMAC and CSA standards.

3.2 INSTALLATION

- .1 The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.3 FIELD SETTINGS

- .1 The Contractor shall perform field adjustments of the circuit breakers as required to place the equipment in final operation condition. The settings shall be in accordance with the approved protective device co-ordination study or as directed by the Consultant.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide all wiring devices and cover plates for a complete installation as required by the contract requirements.

1.3 SUBMITTALS

- .1 Submit shop drawings of all wiring devices.
- .2 Submit samples of receptacles, switches, dimmers and plates.

1.4 ACCEPTABLE MANUFACTURERS

- .1 The specifications are based on Hubbell wiring devices, unless noted otherwise. Acceptable alternates are Pass and Seymour, Leviton, Arrow Hart and Bryant.
- .2 Dimmer specifications are based on Lutron.

Part 2 Products

2.1 STANDARD LINE VOLTAGE SWITCHES, RECEPTACLES AND PLATES

- .1 Provide specification grade switches and receptacles as specified below:
 - .1 Provide CSA approved, commercial specification grade switches and receptacles in all areas to suit the intended function – type and ratings to suit the drawings. Provide Hubbell or approved equal devices with white finish.
- .2 Generally, faceplates for flush-mounted toggle switches and receptacles shall be 0.04 inch thick type 302/304 non-magnetic stainless steel, smooth satin finish each supplied individually wrapped in a sealed protective envelope.
- .3 Unfinished areas - 0.06 inch thick impact resistant type 302/304 non-magnetic stainless steel, smooth satin finish each supplied individually wrapped in a sealed protective envelope.
- .4 Faceplates for surface-mounted switches and receptacles unless otherwise noted, shall be galvanised steel.
- .5 The colour of all devices must be approved by and confirmed with the Consultant prior to installation.
- .6 Receptacles located in all rooms, containing personal washing facilities such as washbasins bath tubs, showers, or similar devices and located within 3 metres of such devices shall provide GFCI protection (Hubbell Cat. No. GF5252IA).

- .7 All receptacles designated 'WP' (weatherproof) on the drawings shall be Hubbell GF5252IA receptacles with Hubbell non-metallic in use covers (MM or ML series – to be confirmed prior to order).
- .8 Special switches and/or receptacles are specified on the drawings and shall be complete with proper faceplates conforming to requirements specified herein before.

2.2 DIMMER SWITCHES

- .1 Dimmers shall be UL listed for a broad range of dimmable CFL's, LED, halogen and incandescent sources.
- .2 The dimmers shall have adjustable low end trim to suit various dimmable sources.
- .3 Dimmers shall be provided with built in switch to turn off positively as dimmer is set to zero.
- .4 Dimmers shall be Lutron Maestro C L Series, rated for load and source based on proposed LED sources.

Part 3 Execution

3.1 INSTALLATION OF STANDARD LINE VOLTAGE SWITCHES, RECEPTACLES AND PLATES

- .1 Provide standard switches and receptacles in locations shown and/or specified on the drawings.
- .2 Equip each switch and receptacle with a faceplate with an opening or openings suitable for the device it conceals. Secure faceplates to the device frames with metal screws finished to match the faceplate.
- .3 The exact colour of switches and receptacles, and associated faceplates in any area must be approved by and confirmed by the Consultant prior to installation.
- .4 Furnish and turn over to the Owner, a sufficient quantity of keys for key lock switches.
- .5 Change location of outlets at no extra cost or credit providing distance does not exceed 3 m and information is given before installation.

3.2 INSTALLATION OF DIMMER SWITCHES

- .1 Provide dimmer switches in single and multiple ganged 3" deep outlet boxes as required for the application, shown on the drawings.
- .2 When grouping dimmers, refer to manufacturer's requirements regarding derating of dimming switches.
- .3 Provide matching line voltage switches, as specified, in rooms where dimmers and line voltage switches are shown.
- .4 Provide multi-gang coverplates where multiple dimmers/switches are used within the same area. Provide coverplates to suit dimmer line-up requirements.
- .5 Provide engraved identification for all slide controls. Exact description of zone designations to Consultant's approval.

- .6 The exact colour of dimmers and associated face plates shall be approved by and confirmed by the Consultant and Interior Designer prior to installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide all fuses for a complete installation, as required by the contract documents.

1.3 SUBMITTALS

- .1 Submit shop drawings of all fuses required.

1.4 ACCEPTABLE MANUFACTURERS

- .1 Little Fuse, Mersen and Bussman (Eaton).

Part 2 Products

2.1 FUSES

- .1 For services up to 600 volts and up to and including 600 amps, provide HRCI-J (AJT) time delay fuses for motor and transformer circuits.
- .2 All remaining fuses up to 600 volts and up to and including 600 amps, shall be HRCI-J (CJ) fast acting fuses.
- .3 For services up to 600 volts and over 600 amps, provide class L-HRC (CL) fuses.

Part 3 Execution

3.1 INSTALLATION OF FUSES

- .1 Install fuses in all fuse holders to suit design requirements.
- .2 Provide three (3) spare fuses of each type and size used above 600 amp and six (6) spare fuses for each type and size up to and including 600 amps. Mount the spare fuses in clips neatly arranged and labelled in a suitably sized type "D" cabinet in the main electrical room.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide enclosed switches, fused and/or unfused, for a complete installation, as required by the contract documents.

1.3 SUBMITTALS

- .1 Submit shop drawings of enclosed switches.

1.4 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers are: Schneider Canada, Eaton (Cutler Hammer) and Siemens.

Part 2 Products

2.1 ENCLOSED SWITCHES (DISCONNECTS)

- .1 Provide heavy duty, CSA approved enclosed switches.
- .2 Each enclosed switch shall be front operated with a handle suitable for padlocking in the "OFF" position and arranged so that the enclosure cover cannot be opened while the handle is in the "ON" position. Operating mechanisms shall be quick-make, quick-break, positive acting with visible blades and a line terminal shield.
- .3 Fusible units shall be complete with fuse clips suitable for HRC, Class "J" fuses unless otherwise noted. Each unit shall also be equipped with solderless lugs and a front cover nameplate identifying the catalogue number and electrical characteristics.
- .4 Enclosures shall be, unless otherwise noted, NEMA 1 general purpose enclosures and NEMA 3 weatherproof enclosures.
- .5 The ampere rating, number of poles and fuse requirements for enclosed switches shall be as specified on the documents.
- .6 Where the enclosed switch is for use on a hydraulic elevator application, such switches shall be provided with auxiliary contacts. These contacts shall be Commander positive action switches or equivalent.
- .7 Where the enclosed switch is for use on a variable frequency drive application, such switches shall be heavy duty type complete with auxiliary contacts, to wire remote stop to variable frequency drive.

Part 3 Execution

3.1 INSTALLATION OF ENCLOSED SWITCHES (DISCONNECTS)

- .1 Provide disconnects:
 - .1 Wherever shown on the drawings and/or specified herein.
 - .2 Wherever required by starter schedule drawings:
 - .3 For motorized equipment which cannot be seen from the motor starter location or is more than 10m away from the starter location.
 - .4 For all "packaged" equipment supplied by other Divisions and fed from a motor starter panel.
- .2 Enclosures mounted indoors and not exposed to the weather shall be NEMA 1 type.
- .3 Enclosures mounted outdoors or in locations exposed to the weather shall be NEMA 3 type.
- .4 Where the enclosed switch is for use on a variable frequency drive application, wire the normally closed contact on the switch to the stop circuit on the variable frequency drive.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide enclosed switches, fused and/or unfused, for a complete installation, as required by the contract documents.

1.3 SUBMITTALS

- .1 Submit shop drawings of enclosed switches.

1.4 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers are: Schneider Canada, Eaton (Cutler Hammer) and Siemens.

Part 2 Products

2.1 MECHANICAL

- .1 All quick connect power panels shall be Type 3R compliant and constructed of aluminum, mild steel or Stainless Steel. The Type 3R rating shall be maintained with the temporary cables installed.
- .2 Cables shall enter and exit the wiring chamber via access holes specifically designed for conductors and shall be provided with a bushing or shall be formed so that there are no sharp edges with which conductor insulation may come in contact.
- .3 Connections shall be arranged so that cables drape downward when connected.

.4 Up to 800 Amp Models

- .1 The quick connect panel shall have an enclosure manufactured of aluminum and painted ANSI 61 gray or Grade 316 stainless steel.
- .2 The quick connect panel enclosure dimensions shall be 24" wide x 32" high x 11" deep.
- .3 The quick connect panel shall include four (4) integral mounting tabs for wall mounting.
- .4 The quick connect panel shall be divided into an upper termination chamber and a lower wiring chamber.
- .5 The upper termination chamber shall have a dead front panel covering all exposed electrical parts.
- .6 The lower chamber shall have individual cable holes to restrict access and reducing the possibility of theft.
- .7 The cable access holes shall have a hinged cover held closed by springs inherently resistant to corrosion in order to securely cover the cable access holes when the temporary cables are not installed.

- .5 The quick connect panel shall have an additional cable lock plate to reduce risk of cable theft. This lock plate will also serve to lock the hinged cable access door(s) when the temporary power cables are not installed.
- .6 The quick connect panel shall have an outer single hinged access door restricting access to both wiring chambers for safety and security.
- .7 The outer access door shall have a padlock hasp preventing unauthorized entry.

2.2 1200 and 1600 Amp Models

- .1 The quick connect panel shall have an enclosure manufactured of 12 gauge galvanized steel painted ANSI 61 gray or 316 stainless steel..
- .2 The quick connect panel enclosure dimensions shall be 35" wide x 56" high x 28" deep.
- .3 The quick connect panel shall include four (4) feet for floor or concrete pad mounting. Holes in the bottom of the feet shall be available for anchoring the enclosure to the floor or pad.
- .4 The quick connect panel shall be divided into an upper termination chamber and a lower wiring chamber.
- .5 The upper termination chamber shall have a key lock handle door covering all exposed electrical parts.
- .6 The lower chamber main door shall have a key lock handle main door covering all exposed camlock connectors.
 - .1 The lower chamber main door shall have a smaller trap door for cable egress. This trap door shall have a key lock handle to preventing unauthorized entry.

2.3 2000A-4000A Amp Models

- .1 The quick connect power panel shall have an enclosure manufactured of aluminum or 316 stainless steel.
- .2 The quick connect panel shall not have enclosure dimensions that exceed 39.00" H x 31.00" W x 50.00"D for 2000A and 39.00" H x 48.00" W x 50.00"D for 2400A and above.
- .3 The quick connect panel shall be able to accommodate rear, side and bottom cable entry.
- .4 Multiple Chamber style design to isolate permanent connections and camlock connections.
- .5 Pad-lockable tamper resistant door preventing access to temporary connections while unit is in use.
- .6 Trap door for cable egress.
 - .1 45 degree camlocks for hassle free connection eliminating stress on cables during operation.
- .7 Provisions for Trap Key interlock prevent access to temporary connections while cables are energized.
- .8 Slotted fingers to restrict cable access reducing theft.

2.4 ELECTRICAL

- .1 The quick connect panel shall be have input and output connections rated up to 600 VAC, as specified in the contract documents.
 - .1 Input Panels - Recessed male connectors
 - .2 Output Panels - Female connectors with flip covers.
- .2 All electrical connectors shall be cam type single pole connectors compatible with Maringo or Leviton 16 Series CAM Locks™ and available color coded as per industry standard practice:
 - .1 240V and below: phase 1 = black, phase 2 = red, phase 3 = blue (if required).
 - .2 440 to 480V: phase 1 = brown, phase 2 = orange, phase 3 = yellow.
 - .3 Ground shall always be green.
 - .4 Neutral shall always be white.

2.5 Up to 800 Amp Models

- .1 The upper termination chamber shall be provided with lug terminals for the permanently installed conductors.
- .2 The lower chamber shall have the cam type single pole connectors as specified above:
 - .1 For 400A models, there shall be one (1) row of up to five (5) series single pole connections.
 - .2 For 800A models, there shall be two (2) rows of up to five (5) single pole connections.
- .3 Withstand Current Rating (WCR) shall be no less than 10kA verified by testing supervised by a Nationally Recognized Testing Laboratory, not by calculation.

2.6 1200-1600A Amp Models

- .1 The upper termination chamber shall have copper buss bars:
 - .1 Designed for a current density not to exceed 725 amps per square inch cross sectional area
 - .2 With holes to accommodate standard ½" hardware drilled on 1.95" centers.
- .2 The lower chamber shall have the cam type single pole connectors as specified above:
 - .1 For 1200A, there shall be three (3) rows of up to 5 single pole connections.
 - .2 For 1600A, there shall be four (4) rows of up to 5 single pole connections.
- .3 Withstand Current Rating (WCR) shall be no less than 22kA verified by testing supervised by a Nationally Recognized Testing Laboratory, not by calculation.

2.7 2000A-4000A Amp Models

- .1 The rear chamber which houses the permanent connections will have mechanical lugs.

- .1 For 2000A, there shall be six (6) single (#2 AWG to 600 MCM) mechanical lugs.
- .2 For 2400A, there shall be eight (8) single (#2 AWG to 600 MCM) mechanical lugs.
- .3 For 2800A, there shall be nine (9) single (#2 AWG to 600 MCM) mechanical lugs.
- .4 For 3200A, there shall be ten (10) single (#2 AWG to 600 MCM) mechanical lugs.
- .5 For 3600A, there shall be eleven (11) single (#2 AWG to 600 MCM) mechanical lugs.
- .6 For 4000A, there shall be twelve (12) single (#2 AWG to 600 MCM) mechanical lugs.
- .2 The front of the panel shall have the cam type single pole connectors as specified above:
 - .1 For 2000A, there shall be three (5) rows of up to 5 single pole connections.
 - .2 For 2400A, there shall be four (6) rows of up to 5 single pole connections.
 - .3 For 2800A, there shall be three (7) rows of up to 5 single pole connections.
 - .4 For 3200A, there shall be four (8) rows of up to 5 single pole connections.
 - .5 For 3600A, there shall be three (9) rows of up to 5 single pole connections.
 - .6 For 4000A, there shall be four (10) rows of up to 5 single pole connections.
- .3 Withstand Current Rating (WCR) shall be no less than 100kA verified by testing supervised by a Nationally Recognized Testing Laboratory, not by calculation.
- .4 Phase Rotation Monitor
- .5 Two wire auto start

2.8 COMPLIANCE

- .1 The 400-4000 Amp quick connect Input panel must be listed to UL 1008 under Annex J as a Transfer Switch Accessory. Output Panel must be listed to UL 891 for Panelboards.
- .2 "Built to the standard" shall not be allowed: the quick connect panels shall be tested in accordance with and listed to UL 1008 or UL 891 standards.
- .3 UL 50 Listed enclosures may be used but only listed to UL 50 shall not be acceptable.

Part 3 Execution

3.1 INSTALLATION OF ENCLOSED SWITCHES (DISCONNECTS)

- .1 Provide disconnects:
 - .1 Wherever shown on the drawings and/or specified herein.

- .2 Wherever required by starter schedule drawings:
 - .3 For motorized equipment which cannot be seen from the motor starter location or is more than 10m away from the starter location.
 - .4 For all "packaged" equipment supplied by other Divisions and fed from a motor starter panel.
- .2 Enclosures mounted indoors and not exposed to the weather shall be NEMA 1 type.
 - .3 Enclosures mounted outdoors or in locations exposed to the weather shall be NEMA 3 type.
 - .4 Where the enclosed switch is for use on a variable frequency drive application, wire the normally closed contact on the switch to the stop circuit on the variable frequency drive.

3.2 Warranty & Service

- .1 The Quick Connect panel shall come with a warranty of no less than 24 months from date of shipment.
- .2 The Quick Connect Power Panel provider shall maintain a national service organization of company-employed personnel located throughout the contiguous United States.
- .3 The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide contactors, to suit application, complete with all accessories for a complete installation, as required by the contract documents.

1.3 SUBMITTALS

- .1 Submit shop drawings of contactors.

1.4 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers are: Schneider Canada, Eaton (Cutler Hammer) and Siemens.

Part 2 Products

2.1 AC CONTACTORS

- .1 Provide magnetic full voltage contactors, Series A201 non-reversing type for heating and motor loads and Series A202 for lighting loads. Each contactor shall be suitable in all respects for the application.
- .2 Mount each contactor in a NEMA enclosure, complete with the necessary accessories including pilot light in cover.
- .3 The amperes rating, number of poles, etc., for contactors shall be as noted on the drawings.

Part 3 Execution

3.1 INSTALLATION

- .1 Install contactors as shown on drawings.
- .2 Comply with manufacturer's installation requirements.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 REQUIREMENTS OF REGULATORY AGENCIES

- .1 The electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.
- .2 All components shall be CSA and/or ULC approved listed and labelled. The complete assembly to comply with CSA 282 Emergency Power Supply for Buildings.
- .3 The generator set must be pre-certified to meet Ministry of the Environment (MOE) emission and sound requirements for stationary standby. On-site emission testing & certification will not be acceptable for standby applications.
- .4 Provide necessary information to allow the client to and prepare the appropriate documentation, make application to and obtain Ministry of Environment (MOE) certification for emissions and noise levels for the generator installation.

1.3 WORK INCLUDED

- .1 Provide, install, and acceptance test a complete and operable Emergency / Standby electric generating system, including all devices and equipment specified herein, as shown on the drawings, or required for the service. Equipment shall be new, factory tested, and delivered ready for installation.
- .2 Provide standby power system(s) capacity as per drawings to supply electrical power at voltage as indicated on the drawings, 60 Hertz 3 Phase, 4 wire. . The generator(s) shall consist of a liquid cooled spark-ignited engine, a synchronous AC alternator, system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.
- .3 The generator shall be applied at the listed ambient and elevation. Bidders to submit the generators rated power output at 35 degree C ambient and suitable for installation in Toronto.
- .4 Bidders are to submit the generator sound level in dBA at 23 ft based on the configuration specified.
- .5 The on-site gas pressure is between 11 and 15 inches of water column.

1.4 SUBMITTALS

- .1 Submit the following information for review:
 - .1 Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
 - .2 Manufacturer's certification of prototype testing.
 - .3 Manufacturer's published warranty documents
 - .4 Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.

- .5 Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
- .6 Manufacturer's installation instructions.
- .7 Three (3) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

1.5 WARRANTY

- .1 The standby electric generating system components, complete generator set and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of two (2) years. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge for parts, labor and travel.
- .2 The warranty period shall commence at the substantial completion date. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

1.6 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers are: Genrep (Seneca Generators) Crothers (Caterpillar) Ltd, Gal Power and Paramount (Kohler).

Part 2 Products

2.1 ENGINE

- .1 Engine rating and performance
 - .1 The prime mover shall be a liquid cooled, spark-ignited, 4-cycle engine. It will have adequate horsepower to achieve rated kW output.
 - .2 The engine shall support a 100% load step.
 - .3 The system shall be sized and sequenced to allow emergency system loads as defined by CAN/CSA 282 to be transferred onto the generator(s) within 15 seconds. Non-emergency system loads will be sequenced onto the generator(s) as generator capacity comes on-line.
 - .4 The generator shall accept a load step of 100% of rated kW with a maximum frequency dip of 12 Hz.
- .2 Engine oil system
 - .1 Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter(s) with internal bypass and replaceable element(s).
 - .2 The engine shall operate on mineral based oil. Synthetic oils shall not be required.
- .3 Engine cooling system

- .1 The engine is to be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system. The coolant system shall include a coolant fill box which will provide visual means to determine if the system has adequate coolant level. The radiator shall be designed for operation in 122 degrees F, (50 degrees C) ambient temperature.
- .2 The engine shall have (a) unit mounted, thermostatically controlled water jacket heater(s) to aid in quick starting. The wattage shall be as recommended by the manufacturer.
- .3 Engine coolant and oil drain extensions, equipped with pipe plugs and shut-off valves, must be provided to the outside of the mounting base for cleaner and more convenient engine servicing.
- .4 A radiator fan guard must be installed for personnel safety that meets UL and OSHA safety requirements.
- .4 Engine starting system
 - .1 Starting shall be by a solenoid shift, DC starting system.
 - .2 The engine's cranking batteries shall be lead acid. The batteries shall be sized per the manufacturer's recommendations. The batteries supplied shall meet CAN/CSA 282 cranking requirements of 90 seconds of total crank time. Battery specifications (type, amp-hour rating, cold cranking amps) to be provided in the submittal.
 - .3 The generator shall have an engine driven, battery charging alternator with integrated voltage regulation.
 - .4 The generator shall have an automatic dual rate, float equalize, 10 amp battery charger. The charger must be protected against a reverse polarity connection. The chargers charging current shall be monitored within the generator controller to support remote monitoring and diagnostics. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.
- .5 Engine fuel system
 - .1 The engine shall be configured to operate on pipe line grade natural gas.
 - .2 The engine shall utilize a fuel system inclusive of carburetor, gas regulator, low gas pressure switch, and fuel shut-off solenoid. Generators larger than 80 kW are to include air-fuel-ratio control.
 - .3 The engines internal fuel connections shall be terminated to the generator frame via an NPT fitting for easy installation.
- .6 Engine controls
 - .1 Engine speed shall be controlled with an integrated isochronous governor function with no change in alternator frequency from no load to full load. Steady state regulation is to be 0.25%.
 - .2 Generator(s) shall incorporate an active air-fuel-ratio controller. The air-fuel-ratio controller shall be integrated into the generator controller to ensure security of settings and to support monitoring and remote diagnostics. External air-fuel-ratio controllers are not acceptable.
 - .3 Engine sensors used for monitoring and control are to be conditioned to a 4-20ma signal level to enhance noise immunity.

- .4 All engine sensor connections shall be sealed to prevent corrosion and improve reliability.
- .7 Engine exhaust & intake
 - .1 The engine exhaust emissions shall meet the MOE emission requirements for standby power generation.
 - .2 Generators engine will incorporate a 3-way catalytic convertor to meet MOE emission requirements.
 - .3 The manufacturer shall supply its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system. A rain cap will terminate the exhaust pipe after the silencer. All components must be properly sized to assure operation without excessive back pressure when installed.
 - .4 The muffler/silencer shall be HOSPITAL grade and shall be accompanied with a 24-inch flex connector linking the exhaust manifold with the muffler/silencer.
 - .5 Provide silencers as manufactured by SMS Silencers Inc., hospital grade, Model SM4 or approved equal. Approval is subject to acoustic engineers review.
 - .6 All exhaust piping from the turbo-charger discharge to the silencer shall be thermally wrapped to minimize heat dissipation inside the room.
 - .7 The engine intake air is to be filtered with engine mounted, replaceable, dry element filters.

2.2 ALTERNATOR

- .1 The alternator shall be the voltage and phase configuration as specified on the drawings.
- .2 The alternator shall be a 4-pole, revolving field, stationary armature, synchronous machine. The excitation system shall utilize a brushless exciter with a three phase full wave rectifier assembly protected against abnormal transient conditions by a surge protector. Photo-sensitive components will not be permitted in the rotating exciter.
- .3 The alternator shall include a permanent magnet generator (PMG) for excitation support. The system shall supply a minimum short circuit support current of 300% of the rating for 10 seconds.
- .4 The alternator shall support .8 pf of rated kilowatt delivery with a maximum voltage dip as per CAN/CSA C282.
- .5 Three phase alternators shall be 12 lead, broad range capable of supporting voltage reconnection. All leads must be extended into a NEMA 1 connection box for easy termination. A fully rated, isolated neutral connection must be included by the generator set manufacturer.
- .6 The alternator shall use a single, sealed bearing design. The rotor shall be connected to the engine flywheel using flexible drive disks. The stator shall be direct connected to the engine to ensure permanent alignment.
- .7 The alternator shall meet temperature rise standards of UL2200 (120 degrees C). The insulation system material shall be class "H" capable of withstanding 150 degrees C temperature rise.

- .8 The alternator shall be protected against overloads and short circuit conditions by advanced control panel protective functions. The control panel is to provide a time current algorithm that protects the alternator against short circuits. To ensure precision protection and repeatable trip characteristics, these functions must be implemented electronically in the generator control panel -- thermal magnetic breaker implementation are not acceptable.
- .9 An alternator strip heater shall be installed to prevent moisture condensation from forming on the alternator windings. A tropical coating shall also be applied to the alternator windings to provide additional protection against the entrance of moisture.

2.3 CONTROLS AND OPERATING SEQUENCE

- .1 Generator controller
 - .1 The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators meeting all requirements of CAN/CSA 282.
 - .2 The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation, synchronizing, load-sharing (real and reactive) and all related generator operations.
 - .3 Communications shall be supported with building automation via the Modbus protocol without network cards. Optional internet and intranet connectivity shall be available.
 - .4 The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.
 - .5 Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.
 - .6 A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.
 - .7 Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, callout capabilities, support for multi-channel digital strip chart functionality and .2 msec data logging capabilities.
 - .8 In addition to standard CAN/CSA 282 alarms, the application loads should also be protected through instantaneous and steady state protective settings on system voltage, frequency, and power levels.
 - .9 The control system shall provide pre-wired customer use I/O: 4 relay outputs (user definable functions), 4 contact inputs, 2 analog inputs,

communications support via RS232, and RS485. Additional I/O must be an available option.

- .10 Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. In addition, custom ladder logic functionality inside the generator controller shall be supported to provide application support flexibility. The ladder logic function shall have access to all the controller inputs and customer assignable outputs.
- .11 The control panel shall include a touch screen to display all user pertinent unit parameters including: engine and alternator operating conditions; oil pressure and optional oil temperature; coolant temperature and level alarm; fuel level (where applicable); engine speed; DC battery voltage; run time hours; generator voltages, amps, frequency, kilowatts, and power factor; alarm status and current alarm(s) condition per CAN/CSA 282.

2.4 TYPICAL/NORMAL OPERATING SEQUENCE

- .1 Upon the failure of utility power, the automatic transfer switch(es) (ATS) provides a two-wire start signal to the system controller. The system controller sends a start command to the generators via RS485 communication.
- .2 The emergency system transfer switch shall transfer first.
- .3 The “non-life safety system” transfer switch shall transfer once the generator has stabilized and has adequate generator capacity.
- .4 Once utility power has returned, the two-wire start signal will be removed. The generator will run in a cool down mode, and then generator shuts down.
- .5 Transfer switches supplied shall be capable of being inhibited from transferring with a contact from the system controller. The transfer switches supplied shall also be able to shed load via trip-to-neutral feature -- the load is shed and does not re-close to a utility that may have a fault present. For applications in which load shedding with the transfer switch is not feasible, load shedding requirements will be evaluated and accommodated as necessary.

2.5 ENGINE/ALTERNATOR PACKAGING

- .1 The engine/alternator shall be mounted with internal vibration isolation onto a welded steel base. These units shall not need external vibration isolation for normal pad mounted applications.
- .2 A mainline, thermal magnetic circuit breaker carrying the UL mark shall be factory installed. The breaker shall be rated between 100 to 125% of the rated ampacity of the generator. The line side connections are to feed from the alternator, and the load side of the breaker shall feed a paralleling switch. The breaker is to have aux contact and shunt trip. The breaker will function as a redundant tripping device in the system. If the paralleling switch fails to open, the generator breaker will be shunt tripped.
- .3 The generator shall include a unit mounted 120 volt convenience outlet.

2.6 REMOTE ANNUNCIATOR

- .1 Provide and install a 20-light LED remote alarm annunciator with horn, located in the CACF.
- .2 The remote annunciator shall provide all the audible and visual alarms called for by CAN/CSA 282 including indications for high battery voltage, low battery voltage, loss of normal power to the charger.
- .3 Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator.
- .4 Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided.
- .5 Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements.
- .6 Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared.

2.7 ENCLOSURE

- .1 Generator Enclosure: Provide an outdoor weather-protective, acoustically insulated housing consisting of:
 - .1 Acoustically insulated housing to meet UL 94 HF1 flammable classification, with maximum sound pressure of 75 dB(A) at 7m.
 - .2 Insulated to maintain an inside temperature of 10°C based on outside design condition of -25°C.
 - .3 Hinged doors for access to both sides of the engine and alternator, and the control equipment including the distribution panel as noted. Key-locking and padlockable door latches shall be provided for all doors. Door hinges shall be stainless steel.
 - .4 Exhaust muffler internal to the enclosure, size and type as specified.
 - .5 Insulated motorized discharge dampers and intake dampers, angled to reduce noise levels.
 - .6 All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color. All surfaces If all metal parts shall be primed and painted grey.
 - .7 Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.
 - .8 Provide emergency battery light pack, 2 x 150W incandescent lamps and fixtures, 15A duplex GFI receptacle, properly sized unit heater w/ fan, thermo stat, and 8 circuit load centre to accommodate these items. Provide a 60 amp -120/2308 volt 3-phase service c/w feeder from the building service room to the enclosure to power the load centre.

2.8 LOOSE ITEMS

- .1 Supplier to itemize loose parts that require site mounting and installation.

- .2 Flexible fuel hose for use in gas piping installation.
- .3 Spare Parts:
 - .1 Fuses: One spare set
 - .2 Filters One spare set (air, fuel, oil)

2.9 ADDITIONAL PROJECT REQUIREMENTS

- .1 Factory Testing
 - .1 Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:
 - .1 Verify voltage & frequency stability.
 - .2 Verify transient voltage & frequency dip response.
 - .3 Load test the generator for 60 minutes.

Part 3 Execution

3.1 INSTALLATION OF ENGINE - GENERATOR SET

- .1 Mount the assembly on vibration isolators secured to a concrete pad. Check engine generator alignment when installation is complete. If necessary, re-align in accordance with the manufacturer's recommendations.
- .2 Install the complete electrical generating system including all external fuel connections in accordance with requirements of CAN/CSA 282, and the manufacturer's recommendations as reviewed by the Engineer.
- .3 Provide adequate starting batteries with a charger rack, jumper cables, etc., and connect to the engine. Connect battery low voltage alarm signal wiring into the fire alarm system.
- .4 Check the specific gravity of engine coolant. Add glycol and/or water, if required.
- .5 Supply suitable fuel piping connections and install as required. Retain the services of the appropriate trade to complete the installation.
- .6 Provide flexible and rigid exhaust piping and an exhaust silencer as specified. Retain the services of the appropriate trade to complete the installation.
- .7 The muffler and associated piping shall be suspended from the ceiling with 1" deflection hangers such as Mason 30N isolators as per acoustic report recommendations.
- .8 Mount the control panel where shown and connect complete. Check all control panel functions.
- .9 Prepare and submit to the Engineer's approval, all necessary design, erection and layout drawings, wiring, piping and control diagrams, details and samples as required for proper execution and completion of the work.
- .10 Supply all materials for equipment touch-up painting and finishing after installation is complete.
- .11 Provide all required supervision by the manufacturer's personnel of the initial operation of the unit at the job site.

3.2 TESTING

- .1 Before acceptance, the manufacturer shall conduct tests at his premises to be witnessed by the Owner's representative and the electrical trade. All tests shall meet the requirements of CSA C282. These tests shall include:
 - .1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.
 - .2 Unit start and shut down on "Manual" control.
 - .3 Unit start and transfer on "Test" control.
 - .4 Unit start on "Engine start" control.
 - .5 Operation of manual bypass switch.
 - .6 Operation of automatic alarms and shut down devices.
 - .7 Run unit on load for minimum period of 4h to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.
 - .8 At end of test run check battery voltage to demonstrate battery charger has returned battery to fully charged state.
 - .9 Demonstration of voltage and frequency regulation from no load to full load and with loads suddenly applied and dropped up to full load. Performance shall be recorded on a Esterline Angus Special Service Recorder.
 - .10 All equipment shall function precisely in accordance with these specifications during the runs and demonstrations listed above.
 - .11 The electrical loads used for testing shall be controllable and adjustable. The loading device shall provide a steady load free from fluctuation.
 - .12 Provide factory test data for the generator, exciter and voltage regulator.
 - .13 All shop tests specified shall be repeated on site and demonstrated at time of substantial completion to the Owner and Consultant.
 - .14 Fuel for all tests shall be provided by this Sub Contractor.
 - .15 Provide an on site portable dry load banks to indicate full rating of unit with incremental loading.

3.3 STARTUP AND COMMISSIONING

- .1 The supplier shall provide factory trained technicians to check-out the completed installation and to perform an initial startup inspection at site to include:
 - .1 Ensuring the engine starts (both hot and cold) within the specified time.
 - .2 Verification of engine parameters within specification.
 - .3 Verify no load frequency and voltage, adjusting if required.
 - .4 Test all automatic shutdowns of the engine-generator.
 - .5 Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using building load.

3.4 TRAINING

- .1 Training is to be supplied by the start-up technician for the end-user during commissioning. The training should cover basic generator operation and common generator issues that can be managed by the end-user.
- .2 Training is to include manual operation of system.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.

1.2 WORK INCLUDED

- .1 Provide automatic transfer switches complete with all necessary auxiliaries required for a complete installation as per the contract requirements.

1.3 SUBMITTALS

- .1 Submit complete shop drawings.

1.4 ACCEPTABLE MANUFACTURERS

- .1 The specifications are based on Asco Electric.

Part 2 Products

2.1 EMERGENCY POWER TRANSFER AND BYPASS ISOLATION SWITCH

- .1 Provide transfer and bypass isolation switches of ampere capacity indicated on the drawings. The transfer and bypass isolation switches shall be 3-pole double throw for use on a 600/347V 3-phase, 4-wire, 60 Hertz system and shall be Asco 7000 Series. The transfer and bypass isolation switches shall be capable of withstanding without damage a short circuit of 200,000 amperes symmetrical when used in conjunction with current limiting fuses.
- .2 The automatic transfer switch shall be electrically operated, mechanically held and shall be rated for full load continuous duty on both tungsten filament and re-active loads. The switch shall be equipped with arc chutes and magnetic blow out coils.
- .3 In the event of a failure in any coil, the switch shall not be permitted to switch to a neutral position but shall always be maintained in a closed position. Failure of any continuously energized coil on the normal supply will cause the switch to automatically transfer to the emergency supply.
- .4 The switch shall contain an auxiliary contact which will close the automatic starting circuit of the emergency generator set on a normal power failure or if the normal voltage is reduced to 70% of the nominal rating or any phase.
- .5 The switch shall be equipped with the following feature:

Type 1	Time delay to override momentary normal source outages and delay all transfer switches and engine starting signals, adjustable from 0.5 to 6 seconds. Factory set at 3 seconds.
Type 2B	Transfer to emergency time delay. Adjustable from 0 to 1 minute for controlled timing of load transfer to emergency, factory set at 5 seconds.

Type 2E	Unloaded running time delay for emergency engine generator cool-down. Adjustable from 0 to 5 minutes factory set at 5 minutes.
Type 3A	Retransfer to normal time delay. Time delay is automatically bypassed if emergency source fails and normal source is available. Adjustable from 0 to 30 minutes. Factory set at 5 minutes.
Type 5A	Test switch to momentarily simulate normal source failure. Installed and connected on enclosure door.
Type 9A & 9B	Pilot lights to indicate switch positions. Green for connected to normal source and red connected to emergency source.
Type 14A & 14B	Auxiliary contacts, two contacts closed when the switch is in the normal position and 2 contacts closed when the switch is in the emergency position. The contacts should be rated 10 Amps and 600V.
Type 22	Fully rated solid neutral bar complete with lugs.
Type 27	In-phase monitor to ensure that on transfer and re-transfer motor load inrush currents do not exceed normal starting current.
Type 31	Elevator pre and post transfer signals.

- .6 The switch shall be mounted in NEMA 1 enclosure, complete with drip hoods.

Part 3 Execution

3.1 INSTALLATION OF EMERGENCY POWER TRANSFER SWITCH

- .1 Mount the switch where shown in accordance with the manufacturer's recommendations and connect complete as shown and detailed.
- .2 Provide from transfer switches, signal circuits to the elevator machine room controllers for pre-transfer signals (both directions); refer also to Section 26 05 16.
- .3 Provide from the transfer switch a signal circuit to the fire alarm control panel to annunciate "Failure to start - generator".
- .4 Provide from each transfer switch (including fire pump transfer switch provided by others) a signal circuit to the generator control panel to initiate generator start up in the event of a normal power failure.
- .5 Obtain services from transfer switch manufacturer to commission each transfer switch.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Electrical General Requirements and all documents referred to therein.
- .2 Comply with Section 25 56 26, Integrated Lighting System Controls.

1.2 WORK INCLUDED

- .1 Provide all fixtures, poles and auxiliary equipment as required for a complete installation.
- .2 This Contractor is responsible for releasing orders and coordinating deliveries of the light fixtures from the suppliers in order to adhere to the Construction schedule. This Contractor is responsible for receiving, handling and storing all light fixtures until ready for installation.
- .3 Inspect deliveries to ensure they are complete.
- .4 Install all electrical light fixtures as per architects reflected ceiling plans.
- .5 Coordinate with Mechanical and BAS sub-trades to ensure all proposed luminaires are fully compatible with the proposed integrated lighting controls system. Refer to Section 25 56 26, Integrated Lighting System Controls for details.

1.3 SUBMITTALS

- .1 Submittals:
 - .1 Submit information in accordance with Section 26 05 01.
 - .2 Submit shop drawings for all products as follows:
 - .1 Provide complete, fully dimensioned detail drawings including all major components and details fabrication of each fixture type.
 - .2 Provide requisite schematics and plans indicating assembly and installation of components.

1.4 QUALITY ASSURANCE

- .1 All components to be approved/listed and labelled by an approved agency.

1.5 SOURCE QUALITY CONTROL

- .1 The Manufacturer of all products specified herein must have been engaged in the fabrication of the equipment for at least the past 5 years.
- .2 The light fixtures listed in the light fixture schedule are pre-approved and are the standard of acceptance to be met through quality, performance, and architectural design.

1.6 DELIVERY AND STORAGE

- .1 All lighting equipment shall be individually packaged with sufficient, protective padding for the selected method of transport. All handling and shipping shall be performed in accordance with the equipment manufacturer's recommendations. Unopened containers shall be stored in a protected location.

1.7 WARRANTY

- .1 Provide Contractor warranties as well as factory warranties. All equipment and labor in this Contract shall be free from defects in products or workmanship for 24 months after substantial completion.

1.8 ACCEPTABLE MANUFACTURERS

- .1 Acceptable fixture manufacturers are as listed in the fixture schedules.

Part 2 Products

2.1 GENERAL

- .1 Provide new lighting fixtures complete with mounting accessories, junction boxes, trims, and lamps.
- .2 All products of a specified type are to be from the same manufacturer.
- .3 Fixture type catalogue numbers do not necessarily denote required mounting equipment or accessories. Provide complete mounting accessories appropriate for each mounting condition.
- .4 All fixtures shall be installed with a frame or canopy that is compatible with the ceiling type specified by the Consultant.
- .5 Provide appropriate accessories for proper mounting of all fixtures. Include plaster frames for plaster ceiling and firestop protection for fixtures in rated ceiling. For fixtures suspended from ceiling, provide pendants or aircraft cables complete with accessories to complete the installation as indicated on the drawings.
- .6 Where light fixture or light fixture suspension apparatus penetrates metal pan or sheet metal ceiling or canopies, an approved copy of the shop drawings of those fixtures shall be provided to the ceiling manufacturer. Apertures in the ceiling or openings for suspension cables shall be pre-cut by the ceiling manufacturer to suit light fixtures. Instruct the manufacturer accordingly.
- .7 If the words "equivalent" or "approved equal" are not indicated after light fixture manufacturer and catalog number in the fixture schedule, no other manufacturer will be acceptable for that particular type.

2.2 LAMPS

- .1 All fixtures shall be provided with proper, new, and operable lamps. Provide lamps indicated on the Fixture Schedule, or, if not indicated, as recommended by the fixture manufacturer. Lamps shall be compatible with the respective fixture in all cases.

2.3 LAMP HOLDERS

- .1 Lamp holders shall hold lamps securely to prevent damage caused by normal vibrations and maintenance handling.

2.4 FIXTURE CONSTRUCTION

- .1 General:

- .1 All fixtures shall be free of inappropriate light leaks.
- .2 Fixtures in non-accessible ceilings and in the columns shall have accessible junction boxes, drivers, and transformers through fixture apertures.
- .3 No metal clips, screws, angles, etc. shall be visible when the fixture is viewed from below.
- .4 All mounting frames installed in damp locations or in plaster ceiling shall be galvanized.
- .5 Extruded fixture housings shall have a minimum thickness of 2.3 ($\frac{3}{32}$ ") mm and be smooth and free of tooling lines. Die-cast end plates and joiner sections shall have a minimum thickness of 2 ($\frac{3}{32}$ ") mm thickness and concealed fasteners.
- .6 Die-casts shall be smooth, free of pits, grooves, and imperfections.
- .7 Spinning shall be smooth and clean with finished edges, and free of spinning lines.
- .8 Sheet metal fixture housings shall be of welded construction with seams filled and ground smooth. Any exceptions shall be noted under individual fixture types.
- .9 All adjustable fixtures shall have locking rotation and tilt devices.
- .10 Pendant-mounted fixtures shall have stems with ball swivels or be cable-mounted to allow 45 degrees swing in any direction from vertical.
- .11 Ball swivels and cables end hardware shall be concealed with sleeve.
- .2 Fixture utilizing both 120 volt services and 347 volt services or utilizing more than one 120 volt service or more than one 347 volt service shall have wiring sections and separate wiring connections and labelling as necessary to satisfy all Code and local inspection requirements.
- .3 Reflector Cones:
 - .1 Provide 45 Degrees lamp image cut-off when viewed from below unless indicated otherwise.
 - .2 Reflector cones shall have a minimum thickness of 0.8 (0.03125") mm and be manufactured of uniform gauge Alcoa 3002 alloy, free of spin marks, or other manufacturing defects. The use of plastic for cones or trim rings is not acceptable.
 - .3 Reflector finish shall be semi specular by means of an Alzak process. Reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of no less than 80% on clear specular finish unless otherwise noted.
 - .4 Cone flange shall be formed as an integral part of cone and shall have identical appearance as inner cone unless otherwise indicated. Flange overlap shall have a perpendicular orientation to cone and shall have adequate width to cover ceiling opening with no visible light leaks.
 - .5 Fixtures with Alzak reflector cones shall all be furnished by the same manufacturer, unless otherwise indicated. All reflector cones shall have iridescent suppressant finish for linear and HID fixtures unless otherwise specified.
- .4 Parabolic Louvre Assemblies:

- .1 Louvre assemblies shall be shipped and stored in plastic bags and shall not be installed until construction has progressed to a suitably clean stage. Single piece peel-off seal on bottom of louvre is not acceptable. No construction dust or paint shall be allowed to accumulate on the louvres at any time. Louvres shall be constructed with minimum 0.6 (0.0235") mm Alcoa licensed process Coilzak semi-specular iridescent suppressant anodized aluminium. All louvre blades shall have parabolic designed curvature. All cell sizes shall be equal unless otherwise specified.
- .5 Unless otherwise noted, lenses for use with linear fixtures shall be of minimum 3.175mm (0.125") thickness.
 - .1 Material shall be light-stable 100% virgin acrylic with minimum 98% transmittance unless otherwise indicated. Acrylic shall conform to minimum standards of IES-NEMA-SPI, and have a minimum thickness of 3mm. Material shall perform as applied for a period of 20 years with no greater than 5% transmission loss.
- .6 Parabolic Baffles: All parabolic baffles shall be straight and paralleled with equal cell sizes. Baffles placed end to end shall have no visible break in appearance. Baffles shall be constructed with minimum 0.6mm (0.0235") Alcoa licensed process Coilzak semi-specular iridescent suppressant anodized aluminium unless otherwise specified.

2.5 LINEAR FIXTURES

- .1 The fixture housing pressure fit construction or utilizing rivets shall not be accepted and, when applicable, shall have lenses in hinged frame utilizing hidden release mechanisms of a heavy duty standard (i.e., visible frame releases will not be accepted). Lenses shall be securely retained in the frame assembly utilizing the equivalent of stainless steel spring clips.
- .2 Fixture reflectors, unless specifically designed using specular metal, shall have a complete coverage of white alkyd reflecting enamel. Enamel shall have a minimum 85% reflectivity, applied by either an electrostatically charged spray or dip process then baked in a temperature controlled oven until paint is thoroughly cured. Prior to applying enamel, each metallic surface shall be prepared using a five stage hot zinc phosphatizing process.
- .3 All fixtures shall have the following wording stencilled above each lamp and visible only when the lamp is removed: "RE-LAMP ONLY WITH (...TYPE) LAMPS". Type shall include colour, temperature and lamp series.
- .4 All painting to be done after cutting.

2.6 FIXTURE FINISHES

- .1 Painted fixtures shall have synthetic enamel, with acrylic, alkyd, epoxy, polyester or polyurethane base applied after the fixture is completely constructed. Paint shall be light stabilized, baked on at minimum 180 Degrees C, and catalytically or photochemically polymerized after application.
- .2 All metal parts shall be cleaned and treated with phosphate or chromate bonding process after fabrication for maximum paint adhesion.

- .3 All polished decorative metals, (brass, chrome, etc.), shall have a clear protective finish, baked-on lacquer or air-cured urethane.
- .4 All custom colour finishes are to be approved by the Consultant.
- .5 All fixtures, lenses, diffusers and fittings to have a flame spread rating of less than 250.

2.7 LIGHTING FIXTURE SCHEDULE

- .1 Catalogue numbers in the Lighting Fixture Schedule are shown to indicate approved manufacturer and fixture quality requirements. The numbers may or may not include variations or special light fixture features as specified in the associated fixtures carried in his bid include all features as specified in the Schedule.

2.8 EXTERIOR LIGHTING

- .1 Supply and install exterior lighting as indicated in the FIXTURE SCHEDULE and as shown on the Drawings complete with poles, arms, light fixtures, lamps, anchor bolts and setting template, nut covers and other accessories necessary for proper installation. Finish all metal surfaces with zinc chromate primer, and finish paint as directed by the Consultant.

2.9 WIRE GUARDS

- .1 Provide wire guards to all fixtures that are mounted so that any part of the fixture is less than 2400mm (8'-0") above adjacent floor, unless noted otherwise in the fixture schedules.
- .2 All fixtures in storage rooms and services rooms shall have wire guards.

Part 3 Execution

3.1 VERIFICATION OF CONDITIONS

- .1 Confirm all ceiling depths against final architectural ceiling plans and sections to ensure that recessed fixtures can be installed in all ceiling conditions and advise the Consultant immediately of any discrepancies prior to ordering of the fixtures or proceeding with the Work.

3.2 INSTALLATION – GENERAL

- .1 Lighting fixtures shall be installed as indicated on architectural reflected ceiling plans, Electrical Drawings and per approved shop drawings.
- .2 Lighting fixtures are indicated in the Lighting Fixture Schedule by means of type letters, which correspond to similar letters on the plans.
- .3 Lighting fixtures shall be installed in accordance with fixture manufacturers written instructions, applicable requirements of the consultant, applicable authorities, and with recognized industry practices.
- .4 Verify locations and spacings of lighting fixtures with reflected ceiling plans and notify Consultant of any variance or conflict between the plans and field conditions. Do not proceed until conflict has been resolved.

- .5 Work shall be co-ordinated with other trades. Lighting fixture locations shall have priority over location of ducts, diffusers, sprinklers, smoke detectors and other non-structural obstructions.
- .6 All fixtures shall be supported directly from the building structural members or from bridging attached to the structural members by rod hangers and inserts. Provide all necessary hardware and blocking to ensure that fixtures hang true, square, plumb, and in proper alignment.
- .7 Fixtures installed in suspended T-bar ceiling shall be equipped with suspension chains, securely fastened to fixture and slab above. The light fixture shall be centred in the ceiling grid opening. Provide a minimum of two chains, one each on diagonal opposite corners, and provide more chains if required by local authority having jurisdiction.
- .8 Provide every light outlet in the building with a lighting fixture as instructed complete with lamps and other accessories necessary for its proper installation and operation. If a fixture type is not designed for any particular outlet, obtain the necessary details from the Consultants prior to submission of tender. Alternatively, supply a suitable fixture for the outlet involved as directed by the Consultants.
- .9 For exact location of ceiling mounted lighting fixtures, refer to Architectural reflected ceiling plan.
- .10 Install lighting fixtures true to the surface in or to which they are mounted, and except where otherwise indicated on the Drawings, align correctly with building or room walls as the case directs. Mount wall fixtures at elevations specified or as shown on Architectural or Electrical Drawings. Where no elevation is shown, confirm mounting height with the Consultant prior to rough-in.
- .11 Where lighting fixtures are stem hung from 'ball and socket' swivels at the ceiling, use stranded wire, #16 AWG (19 x 29) minimum size from outlet box to the fixture.
- .12 Where lighting fixtures are chain-suspended, use solid conductor in armoured cable or flexible conduit and secure to chain with white or clear nylon cable ties.
- .13 Provide lamicoid plate (white letters on blue background) with inscription "UPS" or "EMERG" and fasten to T-bar or fixture frame for all lighting fixtures connected to the UPS or emergency system.
- .14 All parts of all linear and high intensity discharge lighting fixtures shall be securely fastened and if necessary fitted with neoprene spacers to minimize ballast noise amplification.
- .15 All fixtures shall be installed with the bottom of the fixture housing aligned with the finished ceiling line unless otherwise noted in manufacturers installation instructions.
- .16 Ceiling insulation shall be a minimum of 75 (3") mm away from fixture.
- .17 Support recessed linear fixtures by four hangers per fixture minimum independent of ceiling structure or tee bars unless ceiling system is designed to carry the fixtures. In this case, provide seismic restraints only.
- .18 Support recessed fixtures by one hanger per fixture minimum independent of ceiling structure or tee bars.

- .19 Provide wiring channel for mounting fixtures and wiring in between fixtures, suspended below mechanical piping, ductwork, etc., as directed on 15mm (0.6") rigid conduit or 10mm (0.4") galvanized rod hangers, on 2440mm (8 ft.) centres.
- .20 Nominal size of channels 70 x 70, 10mm (0.4") steel minimum, baked white enamel finish, complete with channel connectors, and closure pieces, coverpieces, mounting hickies, fixture connectors, etc., with jointer pieces 300mm (12") in length minimum to form a rigid assembly.

3.3 INSTALLATION OF RECESSED FIXTURES

- .1 Holes shall be cut to exact fixture size so that no gaps will be present when trims or cones are installed.
- .2 Round holes in acoustical tile ceilings shall be cut using adjustable diameter cutter on slow speed drill press.
- .3 Holes in metal pan and/or sheet metal ceiling and/or ceiling canopy shall be precut by ceiling manufacturer based on approved shop drawings of the light fixtures located in these areas. Electrical contractor shall be responsible for co-ordination between Division 26 and metal ceiling manufacturer(s) of light fixture installation in areas with metal ceilings.
- .4 Provide plaster frames or plaster trim as required and turn same over to the ceiling section for installation.
- .5 Installation of trims shall be tight with no gaps or light leaks. Reflector cones, baffles, aperture plates and decorative elements shall be installed after completion of plastering, ceiling tile work painting, and general clean-up in areas. Caulking or sealing fixture trim cones to ceiling to eliminate light leaks or gaps shall not be acceptable.
- .6 Where fixtures are recessed into non-accessible ceiling and the fixtures specified are not pre-wired, wire to an outlet box adjacent to each fixture and visible only when the fixture is removed, connect to the fixture with suitable high-temperature wire in at least 1200mm (48") of flexible conduit. Install fixtures so that they may be readily removed to gain access to these outlet boxes.
- .7 Provide insulated housings on all recessed lighting fixtures installed in ceilings where thermal insulation is installed.

3.4 INSTALLATION OF LINEAR FIXTURES

- .1 Linear fixtures, surface mounted or suspended, shall not have more than 6mm (1/4") variation in alignment for any 5 metre (17 feet) run.
- .2 In spaces with metal pan or sheet metal ceiling installation of linear fixtures shall be co-ordinated with ceiling supplier and installer. Refer to mounting details on Electrical, Architectural, Interior Design drawings and manufacturer recommendation.

3.5 INSTALLATION OF TRACK LIGHTING

- .1 In spaces with parallel rows of track, all track shall be installed such that neutral conductors and feeds have the same orientation.

3.6 INSTALLATION OF LAMPS AND auxiliary equipment

- .1 At the time of occupancy of any area, all lamps within that area shall be in proper place and working order.
- .2 In the event the Contractor request and receive approval to use the new permanent lighting fixture system for construction purposes (i.e. temporary lighting) and the use of the permanent fixtures is in excess of sixty (60) days prior to occupancy or substantial completion (whichever is first), the Contractor shall supply replacement lamps as follows:

3.7 FIELD QUALITY CONTROL

- .1 Operate each fixture after installation and connection. Each fixture shall be inspected for proper connection and operation.
- .2 Perform testing of operation of temporary or emergency power systems.
- .3 Verify that all lenses, louvres, baffles, fixture trim cones, diffusers and other parts are thoroughly cleaned in a manner recommended by the manufacturer.

3.8 LUMINAIRE WIRING

- .1 Connect recessed luminaires to outlet boxes with 10mm (0.4") flexible conduit and 90 Degrees C wire.

3.9 CONTROL AND CIRCUITING

- .1 Where no switching is shown, lighting shall be panel switched. Panel circuit breakers shall be suitable for switching duty marked "SWD".
- .2 Where circuiting is not specified, provide sufficient 15A - 1P breakers and wiring to limit loading to 1200 watts per circuit or to code whichever is the most restrictive.

3.10 FIXTURES IN SERVICE ROOMS

- .1 Before mounting any fixture in mechanical, electrical or other service room obtain written approval of layout to be used. Layout must suit equipment limitations in the room and must be installed clear of mechanical equipment.

3.11 ADJUSTMENTS

- .1 All adjustable fixtures shall be aimed as instructed by the Consultant. Personnel, lifts, and ladders shall be provided as required.
- .2 Adjust exit sign directional arrows, if required.

3.12 CLEANING

- .1 Remove all plastic bags from parabolic fixtures after construction is finished and prior to final acceptance.
- .2 All unnecessary equipment, materials, wiring, and fixtures shall be removed from those areas affected by the construction. Materials that are not part of the lighting or electrical distribution system shall be removed from the Site.
- .3 All lighting fixtures shall be cleaned in a manner approved by the manufacturer and shall be free of dirt and debris upon completion of installation.

3.13 DEMONSTRATION

- .1 Building personnel shall be trained to operate lighting control system. Building personnel shall be advised on relamping procedures and be given a list of lamps required for the fixtures on the Project.

3.14 PROTECTION

- .1 Lighting fixtures, once installed, shall be protected from damage during the remainder of construction period.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Section 26 05 00, Common Work Results for Electrical and all documents referred to therein.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Provide Electric Vehicle Chargers as specified.
 - .2 Provide concrete bases to mount the EVC;s accordingly;
 - .3 Provide local stainless steel NEMA 3R disconnect switches ahead of each unit per NEC requirements.

1.3 SUBMITTALS

- .1 Submit shop drawings in accordance with Division 01 "General Requirements" and Section 26 05 01 Shop Drawings, Product Data and Samples.

Part 2 Products

2.1 MANUFACTURERS

- .1 Manufacturers: Basis of Design is Clipper Creek Share2 HCS-40 units. Alternate manufactures shall be submit to the Consultant for review prior to close of pricing.

2.2 FEATURES

- .1 Commercial grade plug units with the following features:
 - .1 25' SAE-J1772 cord with cable management;
 - .2 NEMA 4X enclosure
 - .3 Total max KW rating of 7 KW
 - .4 Protect units with 40amp breakers 2 pole breakers (208 volt – single phase, 2wire + grounding).
 - .5 Electrical protection – Overvoltage, Undervoltage, Surge, Ground Fault, Short Circuit, Over Current and Over Temperature.
- .2 The unit shall share power over 2 units in the private garages, allowing 100% of charge when only one car is plugged in and share 50/50 when 2 car are plugged in.

Part 3 Execution

3.1 INSTALLATION

- .1 Install units on bases or wall as shown. Coordinate rough-in details with structural consultant.
- .2 Provide empty conduit from each unit back to the building for IT Room for communication conduits.

END OF SECTION

Appendix A

YRND – Lighting Standards

Lighting Standard

Version	Date	Description of Revisions
1	December 1, 2009	
2	January 7, 2011	Last sentence of section 2 added
3	January 27, 2011	Updates to controls requirements and new illuminance requirement for active vehicle storage and maintenance
4	June 23, 2011	Various changes
5	October 9, 2012	Section 2.1.4 updated.
6	March 24, 2014	Several updates.
7	November 20, 2014	T5 lamps removed from section 2.2.1. Section 2.2.3 modified to include more exclusions. Re-numbering of sections.
8	March 17, 2015	Section 2.3.3 added regarding exterior lighting control.
9	August 16, 2016 Draft for Consideration	Section 2.2.3 added regarding exterior lighting and maximum colour temperature

1 General:

1.1 Scope:

- .1 The objective of this section is to provide guidance to the User for the purpose of designing Lighting systems.
- .2 It is applicable to the design of new facilities, upgrades and expansions of existing facilities, and leasehold improvement projects.
- .3 This section should be read in conjunction with the Program Specific Requirements.
- .4 Where Program Specific Requirements, Ontario Building Code and/or this Building and Facilities Design Standard (the Standard) conflict, the most stringent requirement shall apply.
- .5 Provide interior and exterior lighting photometric calculations including floor plans showing illuminance levels at the work plane for both full lighting and night lighting.

2 Design Requirements:

2.1 Lighting Power Density:

- .1 Target lighting power density shall be 40% less than the maximum allowed by ASHRAE 90.1-2010 while delivering maintained illuminance levels indicated in this Facilities Design Standard. Where the Standard does not address maintained illuminance levels for a specific space type, illuminance levels should target the lower end of the range recommended in the Illuminating Engineering Society (IES) *Lighting Handbook*, latest edition.

2.2 Light Sources:

- .1 Primary indoor illumination shall be LED luminaires with lamps having 4100K colour temperature and minimum 85 color rendering index. Initial system efficacy shall be at least 94 lumens per watt for T8. This includes task lighting, garage areas and other industrial-type spaces.
- .2 Primary exterior lighting shall be LED with minimum warranty of 5 years for LED + driver and minimum L70 of 70,000 hours when tested to IESNA LM79 standard at ambient temperature of 25 degrees C.
- .3 For sites that are adjacent to residential areas and where there is potential for light trespass into adjacent properties, exterior lighting shall have a maximum colour temperature of 3000K.
- .4 Incandescent, halogen, compact fluorescent, T5 or T8 fluorescent, high pressure sodium, low pressure sodium, metal halide and induction light sources light

-
- sources shall not be used..5 Exit signs shall be LED with maximum input power of 2 watts.
- 6 4-lamp recessed or troffer luminaires should not be used as this usually results in over-illumination directly under the luminaire.
- 7 The will be of the following options for lighting sources;
- 7.1 LED Flat panel lighting, which will have the following features:
- Capable of accepting 120V to 347V incoming power source
 - 0-10VDC Dimming controls
 - -The ability to switch colour temperature and watt out put using dip switches on unit
 - Available in 1'x4', 2'x2, 2'x4' sizes
- 7.2 LED Flat panel Pot lighting, which will have the following features:
- Capable of accepting 120V to 347V incoming power source
 - 0-10VDC Dimming controls
 - Available in 4", 6" and 8" Round sizes
- 7.3 LED tubes (for retro fits only), which will have the following features:
- Capable of being used for with electronic ballasts
 - Dimmable
 - Availble in 2700K, 3500K, 4000K and 5000K color temperatures
- 2.3 Distributed Lighting Controls:
- .1 Except for exit and emergency lighting, circuit breakers shall not be used to switch lighting circuits.
- .2 Provide interior whole building automatic lighting shutoff per ASHRAE 90.1-2010, section 9.4.1.1.
- .3 Exterior lighting shall be controlled by a photocell to automatically turn off lighting when sufficient daylight is available. Between midnight and 6 a.m., façade and landscape lighting shall be automatically shut off, and other exterior lighting shall be reduced by at least 30%.

-
- .4 Provide controls for individual spaces per ASHRAE 90.1-2010, section 9.4.1.2, including multi-level lighting and occupancy/vacancy sensors. Avoid unnecessary after-hours lit areas and associated energy use (via overrides) through appropriate zoning of controls.
 - .5 Provide automatic control devices with manual-off capability in addition to automatic off with the exception of washrooms and court rooms.
 - .6 Public restrooms, corridors and stairwells to be provided with occupancy sensors with automatic ON controls.
 - .7 In addition to ASHRAE 90.1-2010 requirements, provide vacancy sensors for the following spaces including recommended time out durations with the exception that mechanical and electrical rooms shall time out after one hour:
 - Mechanical rooms
 - Electrical rooms
 - Utility rooms
 - Janitor rooms
 - .8 Provide automatic daylighting controls per ASHRAE 90.1-2010, section 9.4.1.4 (sidelighting) and 9.4.1.5 (toplighting) as modified by the Ontario Building Code (Supplemental Standards SB-10, Division 2, Chapter 2, 1.1.1.7.(2) and (3). Daylighting controls shall be dimming rather than step for regularly occupied spaces such as offices and lobbies.
 - .9 Functional testing of lighting controls shall comply with ASHRAE 90.1-2013, section 9.4.3.
 - .10 Large spaces such as garages and industrial-type spaces shall have multiple overlapping levels of lighting control and /or Lighting Automation System

2.4 Centralized Lighting Controls:

- .1 Consider Digital Addressable LightingControl system in Region owned office buildings and/or where multiple lighting levels including day-lighting can provide significant energy savings. A tie-in to the Building Automation System (BAS) is preferred. During the initial design the Region shall supply the lighting controls contractor a range of BACnet addresses the Lighting Control System (LCS) will run on. The LCS network will have a BACnet over IP interface to interface with the BAS. All BAS points will be network visible so that other BACnet systems can auto discover them. Contractor shall consult with York Region Project Manager during the development of addresses.
- .2 Lighting zoning shall be coordinated with HVAC design to ensure HVAC and lighting zones can share zone after hours over-rides.

2.5 Illuminance:

- .1 Design illuminance shall be in accordance with the following table.

Table 1 – Recommended Maintained Illuminance

AREA USE	AVERAGE ILLUMINANCE IN FOOTCANDLES (LUX)	WORK-PLANE HEIGHT
General Office / Private office	30 – 50 fc (320 – 540 lux) Task lighting can be used to provide part of the requirement. Illuminance ratio not to exceed 3:1 (maximum: minimum).	30" (760 mm)
Lunchroom / Cafeteria	30 – 50 fc (320 – 540 lux) Illuminance ratio not to exceed 3:1 (maximum: minimum).	30" (760 mm)
Corridors / Stairs / Elevators	5 – 15 fc (60 – 160 lux)	0" (0 mm)
Washrooms (General)	10 – 20 fc (110 – 220 lux)	0" (0 mm)
Washrooms (Mirror)	30 – 50 fc (320 – 540 lux)	30" (760 mm)
Conference / Meeting Rooms	30 – 70 fc (320 – 750 lux) A low-level illuminance shall also be provided for presentations.	30" (760 mm)
Storage	10 – 20 fc (110 – 220 lux)	0" (0 mm)
Equipment Rooms (Mechanical / Electrical / Janitorial)	30 – 50 fc (320 – 540 lux)	0" (0 mm)
Covered Parking	5 fc (60 lux) Illuminance ratio not to exceed 4:1 (average: minimum).	0" (0 mm)
Outdoor Parking	1 fc (10 lux) Minimum 0.2 fc, illuminance ratio not to exceed 5:1 average: minimum and 20:1 maximum: minimum.	0" (0 mm)
Vehicle Maintenance	35 – 50 fc (350 – 500 lux) Illuminance ratio not to exceed 4:1 (average: minimum).	0" (0 mm)
Vehicle Storage	20 – 30 fc (200 – 300 lux) Illuminance ratio not to exceed 4:1 (average: minimum).	0" (0 mm)

END OF SECTION

Appendix B

YRND – Receptacle and Circuit Labelling Standard

Receptacle and Circuit Labelling Standard

Version	Date	Description of Revisions	Reason for Revisions
1	March 14, 2014		

NOTE:

This Guideline does not override any governing codes, by-laws or municipal standards. When conflict exists, the most stringent requirements will govern.

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

Notice: This Document hardcopy must be used for reference purpose only.

The on-line copy is the current version of the document.

Any deviation from this document shall be approved by the Region Project Manager prior to proceeding.

1 General

1.1 SCOPE / SUMMARY

1.1.1 Provide labelling of electrical power outlets and receptacles throughout the entire building to provide identification of electrical circuit.

1.1.2 Provide circuit identification on electrical drawings.

1.2 APPLICABILITY

1.2.1 This Building & Facilities Design Standard and Guideline shall apply to:

1.2.1.1 All Region owned and leased buildings where electrical work is required.

1.3 RELATED SECTIONS

1.3.1 01 91 00 Commissioning

1.4 REFERENCE STANDARDS

1.4.1 Not applicable

2 Design Requirements / Products

2.1 RECEPTACLE LABELLING

2.1.1 Provide labelling as per photograph below and as follows:

2.1.1.1 Labels for circuits on normal power shall be in black lettering.

2.1.1.2 Labels for circuits on emergency power shall be red lettering.

2.1.1.3 Each label shall contain the distribution panel identification number and circuit number.

- 2.1.1.4 All project/construction drawings and as-built drawings shall show the distribution panel identification number and circuit number at each receptacle location.
- 2.1.2 Renovation projects that involve adding, replacing, deleting or moving receptacles shall follow the same requirements of 2.1.1.
- 2.1.3 Base building electrical drawings shall be updated as part of any renovation project to include the changes made to lighting or receptacles. Updates to include new location of light fixtures, receptacles and light switches; and the distribution panel and circuit number identification number at each receptacle and light switch.
- 2.1.4 Photograph of typical receptacle labelling:



END OF SECTION

Appendix C

YRND – Electrical Power Monitoring Standard

Electrical Power Monitoring Standard

Version	Date	Description of Revisions	Reason for Revisions
1	June 6, 2014	Original	
2	July 14, 2021	Various changes	

NOTE:

This Guideline does not override any governing codes, by-laws or municipal standards. When conflict exists, the most stringent requirements will govern.

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

Notice: This Document hardcopy must be used for reference purpose only.

The on-line copy is the current version of the document.

Any deviation from this document shall be approved by the Region Project Manager prior to proceeding.

1 General

1.1 SCOPE / SUMMARY

- 1.1.1 Provide all metering equipment required to measure and trend electrical consumption and demand by end use.

1.2 APPLICABILITY

- 1.2.1 This Building & Facilities Design Standard and Guideline shall apply to:
 - 1.2.1.1 All construction and major renovation of Region owned and leased buildings and facilities greater than or equal to 500m².

1.3 RELATED SECTIONS

- 1.3.1 Commissioning
- 1.3.2 Instrumentation and Controls for Plumbing
- 1.3.3 Instrumentation and Control Devices for HVAC
- 1.3.4 Electricity Meter Installation/Startup Verification Form
- 1.3.5 Corporate ITS Cabling & Wiring Standard

1.4 REFERENCE STANDARDS

- 1.4.1 Not applicable

2 Design Requirements / Products

2.1 DESIGN

- 2.1.1 Optimize electrical distribution to allow reduction in number of meters by grouping similar/like end use loads.
- 2.1.2 Provide metering basis of design with schematic design submission for review and comment by the Region

- 2.1.3 Provide schematic diagrams showing metering intent and outline specifications with design development submission for review and comment by the Region
- 2.1.4 Provide full schematics and specifications for metering system with construction documents submission for review and comment by the Region
- 2.1.5 Design electrical distribution that separates end uses identified in 2.2.1. End uses comprising less than 10% of the primary end use metered may be combined with other uses

2.2 END USES TO BE MONITORED

- 2.2.1 Provide electrical meters for each separate end use type, including:
 - 2.2.1.1 Facility incoming electricity
 - 2.2.1.2 Interior Lighting
 - 2.2.1.3 Exterior Lighting
 - 2.2.1.4 Ventilation Fans
 - 2.2.1.5 Pumps
 - 2.2.1.6 Space Cooling
 - 2.2.1.7 Process electricity (e.g. compressors)
 - 2.2.1.8 Elevators
 - 2.2.1.9 Data centres
 - 2.2.1.10 Plug loads
 - 2.2.1.11 Electric heating where it is the primary source of building heating

2.2.1.12 Any other load 40 kW (50 hp for motors) or greater (submeter individually except where multiple similar pieces of equipment serve a similar load)

2.2.1.13 Generation used as part of demand response systems

2.2.2 Exception: 2.2.1.2 to 2.2.1.13 need not apply to:

2.2.2.1 Leased buildings or spaces where the Region's anticipated occupancy is less than five years; or

2.2.2.2 Buildings less than 2322m²

2.2.3 End uses in spaces leased to tenants, spaces with significantly differing occupancy schedules or spaces with significantly differing facility use are to be metered separately.

2.2.3.1 Exception: Spaces leased to tenants less than 929m² need not be metered separately from other areas.

2.3 METERING EQUIPMENT

2.3.1 Electricity Meters

2.3.1.1 Internet Protocol (IP) based meter complete with:

2.3.1.1.1 Built-in web server.

2.3.1.1.2 Capable of operating with a dedicated IP address (to be provided by the Region).

2.3.1.1.3 Communications Protocols:

2.3.1.1.3.1 HTTP/Post capable of pushing data to 3rd party applications/databases.

2.3.1.1.3.2 Modbus TCP

2.3.1.1.4 Built-in real-time and historic graphics accessible with any HTML 5 internet

browser (computer, tablet, phone) on the Region's network. Data to be displayed in local time, adjusted for daylight savings time. All meter functions to be accessible via the browser.

2.3.1.1.5 Real-time clock with battery backup and email alert for battery end of life.

2.3.1.1.6 Time-Stamp:

2.3.1.1.6.1 Represent date and time

2.3.1.1.6.2 In UTC time or offset from a specified UTC time

2.3.1.1.6.3 Resolution: Minimum 1 second

2.3.1.1.7 Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets. Time-stamps to be exported as a single field with a numeric (non-text) value in local time.

2.3.1.1.8 Published application programming interface (API) allowing data to be retrieved from the meter via non-proprietary means, such as JavaScript Object Notation (JSON).

2.3.1.1.9 Built-in trending and data storage:

2.3.1.1.9.1 2 years of consumption data (kWh) at 1 minute intervals with time-stamp; and

- 2.3.1.1.9.2 10 years of consumption data (kWh) at 1 hour intervals with time-stamp.
 - 2.3.1.1.9.3 Stored in non-volatile memory.
 - 2.3.1.1.10 Security:
 - 2.3.1.1.10.1 Unrestricted access to data and graphics over the Region's network.
 - 2.3.1.1.10.2 Password protection for access to setup, changing settings/parameters and deleting data.
 - 2.3.1.1.11 Ability to measure, store and trend the following data at 1 minute intervals complete with time-stamp:
 - 2.3.1.1.11.1 Accumulated energy per phase (kWh)
 - 2.3.1.1.11.2 Accumulated total energy (kWh)
 - 2.3.1.1.11.3 Active power per phase (kW)
 - 2.3.1.1.11.4 Active total power (kW)
 - 2.3.1.1.11.5 RMS voltage per phase
 - 2.3.1.1.11.6 RMS current per phase
 - 2.3.1.1.11.7 Power factor per phase
 - 2.3.1.1.11.8 Total power factor.

2.3.1.1.11.9 Line frequency

2.3.1.2 Acceptable product: z3 Controls Inc. NetMeter or equivalent

2.3.2 Current Transformers

2.3.2.1 Compatible with electricity meter input without the use of transformers or other devices.

2.3.2.2 Linear accuracy +/-1% of reading.

2.3.2.3 Accuracy at 10% to 130% of rated current.

2.3.2.4 Unburdened current transformers shall not be permitted.

2.3.3 Data Cabling

2.3.3.1 Follow Corporate ITS Cabling & Wiring Standard for data cable requirements.

2.3.3.2 Colour: Green

3 Execution

3.1 INSTALLATION REQUIREMENTS

3.1.1 Install meter in a painted, hinged NEMA 1 (or better) enclosure complete with modular terminal blocks, finger safe fuse holders, fuses and power supply. Label front of enclosure with meter name, IP address and load(s) measured.

3.1.2 Provide disconnect at panel board for voltage reference.

3.1.3 All communication cables to be continuous. No splicing is allowed.

3.1.4 Affix York Region Property Services Branch Asset ID tag (to be provided by the Region) to meter prior to installation.

- 3.1.5 Sensor and network configuration to be done in consultation with the Region's Property Services Branch.
- 3.1.6 Connect meter to the Region's IT network.
- 3.1.7 Commission meter:
 - 3.1.7.1 Ensure latest available firmware version is installed in meter
 - 3.1.7.2 Obtain Network information from York Region project manager and program into meter, including IP address, subnet mask, default gateway, primary and secondary DNS addresses.
 - 3.1.7.3 Set meter clock to current local time.
 - 3.1.7.4 Set up email alerts as specified and/or requested by the Region's project manager.
 - 3.1.7.5 Set up trend logging as specified and/or requested by the Region's project manager. At minimum, set up trend logging per 2.3.1.1.9 and 2.3.1.1.11 above.
 - 3.1.7.6 Set default homepage to display real-time demand graphs and consumption statistics.
 - 3.1.7.7 Verify CT rating is correctly entered in meter setup.
 - 3.1.7.8 Confirm each voltage and current reading displayed on meter software using voltmeter and clamp-on ammeter. Where circuits do not have a load at time of commissioning, induce a load to ensure readings are obtainable.
 - 3.1.7.9 Verify CT's are wired to corresponding voltage reference and that CT's are installed in correct orientation.

- 3.1.7.10 Verify meter information is viewable through a web browser on a device on the Region's network.
- 3.1.7.11 Complete and submit Energy Meter Installation/Startup Verification Form.
- 3.1.7.12 Provide training on meter software use to Region staff including Facilities Operations and Maintenance and Climate Change and Energy Conservation.
- 3.1.7.13 Provide meter manufacturer's calibration certificate(s), installation, operations and maintenance manuals and recommended meter recalibration interval(s).

END OF SECTION

ELECTRICITY METER INSTALLATION/STARTUP VERIFICATION FORM

Project Name:		Project Number:	
Installing Contractor:		Form Completed By (Name):	
Telephone No.:		Date (MM/DD/YY):	

Purpose: The following form is intended to ensure energy meters are correctly and completely set up prior to commissioning verification. Refer to *York Region Building and Facilities Design Standards and Guidelines–Electrical Power Monitoring Standard* for additional requirements.

1. General Information

Manufacturer:	
Model:	
Serial Number:	
Meter location (eg. room number):	

2. Physical Installation

26 09 13 Reference	Requirement	Confirm Compliance	Notes
3.1.1	Is the meter in a painted, hinged NEMA 1 (or better) enclosure complete with modular terminal blocks, finger safe fuse holders, fuses and power supply?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3.1.1	Is the front of the enclosure labelled with meter name, load measured and IP address?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3.1.2	Has a disconnect been provided for the voltage reference at the panel board?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3.1.3	Are communication cables continuous (i.e. not spliced)?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3.1.4	Has a York Region Property Services Branch Asset ID Tag been affixed to the meter?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3.1.6	Has the meter been connected to the Region's IT network?	<input type="checkbox"/> Yes <input type="checkbox"/> No	

3. Network Configuration (Note 1 indicates the data is to be provided by the Region's Project Manager)

MAC Address:				
DHCP Disabled?	<input type="checkbox"/> Yes	<input type="checkbox"/> No		
IP Address: ¹				
Gateway: ¹				
Subnet Mask: ¹				
Primary DNS: ¹				
Secondary DNS: ¹				
26 09 13 Reference	Requirement	Confirm Compliance		Notes
3.1.7.2	Has the meter's Network information been obtained from the Region's Project Manager?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.10	Is the meter viewable through a web browser on a device connected to the Region's network?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	

4. Access

Administrator User Name:	
Administrator Password:	

5. Meter Configuration (Note 1 indicates the data is to be provided by the Region's Project Manager)

CT Setup:	<input type="checkbox"/> Single Phase (120 or 347V)	<input type="checkbox"/> Split Phase (240V)	<input type="checkbox"/> Three Phase (208 or 600V)	
CT Rating:	_____ A			
Voltage Multipliers:	General: _____	Phase A: _____	Phase B: _____	
Current Multipliers:	General: _____	Phase A: _____	Phase B: _____	
Meter Name: ¹				
Meter Description/Load Served:				
26 09 13 Reference	Requirement	Confirm Compliance		Notes
3.1.7.1	Has the latest firmware been installed in the meter?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.3	Has the meter's internal clock been set to current local time?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.4	Have email alerts been set up as specified?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.5	Has trend logging been set up as specified?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.6	Has the meter's web based home screen been set to display real-time demand graph and consumption statistics?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.7	Has CT rating been correctly entered into meter setup?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.9	Have CT's been wired to corresponding voltage reference?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.9	Have CT's been installed with correct orientation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	

6. Meter Data Verification

Complete the following Table with meter readings and voltmeter/ammeter reading to verify correct setup:

	Input 1		Input 2		Input 3		Input 4		Input 5		Input 6		Input 7		Input 8	
Measured Load: (ex. LP-1A)																
Parameter	Meter	Voltmeter/ Ammeter	Meter	Voltmeter/ Ammeter	Meter	Voltmeter/ Ammeter	Meter	Voltmeter/ Ammeter	Meter	Voltmeter/ Ammeter	Meter	Voltmeter/ Ammeter	Meter	Voltmeter/ Ammeter	Meter	Voltmeter/ Ammeter
V _{A-N}																
V _{B-N}																
V _{C-N}																
I _A																
I _B																
I _C																

26 09 13 Reference	Requirement	Confirm Compliance		Notes
3.1.7.8	Has each voltage and current reading displayed on meter software been verified using voltmeter and clamp-on ammeter?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	

7. Training

26 09 13 Reference	Requirement	Confirm Compliance		Notes
3.1.7.12	Has training been provided to Region staff?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
3.1.7.13	Have meter manufacturer's calibration certificate(s), installation, operations and maintenance manuals and recommended meter recalibration interval(s) been provided to the Region's Project Manager?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	

Appendix D

YRND – Electrical & ICAT Works Proposed Phasing

23137 YRND Operations Centre - Electrical Works Proposed Phasing R1

SCENARIO 2 - STEP 1

EXTERIOR

- 1 PROVIDE NEW POWER AND LOW VOLTAGE DUCT BANKS FOR NEW INCOMING SERVICES FROM BASELINE RD TO NEW PROPOSED ELECTRICAL ROOM AND IT ROOM LOCATION.
- 2 PROVIDE NEW POWER AND LOW VOLTAGE CONDUITS FROM EXISTING GATE TO NEW PROPOSED ELECTRICAL ROOM AND IT ROOM LOCATION.
- 3 PROVIDE NEW ELECTRICAL PROVISIONS FROM EXISTING SITE BUILDINGS AND EQUIPMENT TO NEW PROPOSED ELECTRICAL ROOM LOCATION. CONDUITS AND WIRING SHALL BE PROTECTED AND KEPT SAFE FOR FUTURE TERMINATIONS.
- 4 PROVIDE NEW ELECTRICAL PROVISIONS FROM PROPOSED RELOCATED CONTRACTOR TRAILERS LOCATION TO NEW PROPOSED ELECTRICAL ROOM LOCATION. CONDUITS AND WIRING SHALL BE PROTECTED AND KEPT SAFE FOR FUTURE TERMINATIONS.
- 5 PROVIDE NEW ELECTRICAL & ICAT SYSTEMS AND EQUIPMENT WITHIN CONSTRUCTION AREA.
- 6 PROVIDE TEMPORARY POWER AND ICAT SYSTEMS AND EQUIPMENT FOR TEMPORARY OFFICE/LOCKER RELOCATION.
- 7 EXISTING ELECTRICAL & ICAT INCOMING SERVICES, SYSTEMS, AND EQUIPMENT REQUIRED TO MAINTAIN FACILITY OPERATIONS SHALL BE PROTECTED AND REMAIN.

INTERIOR

- 1 EXISTING ELECTRICAL ROOM AND ALL ELECTRICAL & ICAT SYSTEMS AND EQUIPMENT REQUIRED TO MAINTAIN FACILITY OPERATIONS SHALL BE PROTECTED AND REMAIN.

SCENARIO 2 - STEP 2

EXTERIOR

- 1 EXISTING ELECTRICAL & ICAT INCOMING SERVICES, SYSTEMS, AND EQUIPMENT REQUIRED TO MAINTAIN FACILITY OPERATIONS SHALL BE PROTECTED AND REMAIN.
- 2 PULL PRIMARY AND SECONDARY POWER CABLES. PROTECT, KEEP SAFE, AND PREPARE CABLES FOR FUTURE TERMINATIONS.
- 3 PROVIDE TEMPORARY EQUIPMENT AND DEVICES, SUCH AS POWER FEEDS, SECURITY CAMERAS, DATA CONNECTIONS, ETC. REQUIRED ORDER TO MAINTAIN EXISTING FACILITY OPERATIONS.

INTERIOR

- 1 EXISTING ELECTRICAL ROOM AND ALL ELECTRICAL & ICAT SYSTEMS AND EQUIPMENT REQUIRED TO MAINTAIN FACILITY OPERATIONS SHALL BE PROTECTED AND REMAIN. ALL OTHER EXISTING ELECTRICAL AND ICAT DEVICES AND EQUIPMENT SHALL BE DEMOLISHED.
- 2 PROVIDE NEW ELECTRICAL AND ICAT DEVICES AND EQUIPMENT IN RENOVATION AREAS AND ADDITION BUILDING.
- 3 PROVIDE TEMPORARY EQUIPMENT AND DEVICES, SUCH AS POWER FEEDS, SECURITY CAMERAS, DATA CONNECTIONS, ETC. REQUIRED ORDER TO MAINTAIN EXISTING FACILITY OPERATIONS.

SCENARIO 2 - STEP 3

EXTERIOR

- 1 DEMOLISH AND REMOVE TEMPORARY POWER AND ICAT SYSTEMS AND EQUIPMENT FOR TEMPORARY OFFICE/LOCKER RELOCATION.
- 2 PROVIDE NEW PROPOSED SITE LIGHTING, BLOCK HEATER RECEPTACLES, EV CHARGING STATION PROVISIONS, AND ALL OTHER EXTERIOR DEVICES AND EQUIPMENT.
- 3 DEMOLISH EXISTING ELECTRICAL AND ICAT DEVICES AND EQUIPMENT.
- 4 DEMOLISH TEMPORARY EQUIPMENT AND DEVICES, SUCH AS POWER FEEDS, SECURITY CAMERAS, DATA CONNECTIONS, ETC. REQUIRED ORDER TO MAINTAIN EXISTING FACILITY OPERATIONS.

INTERIOR

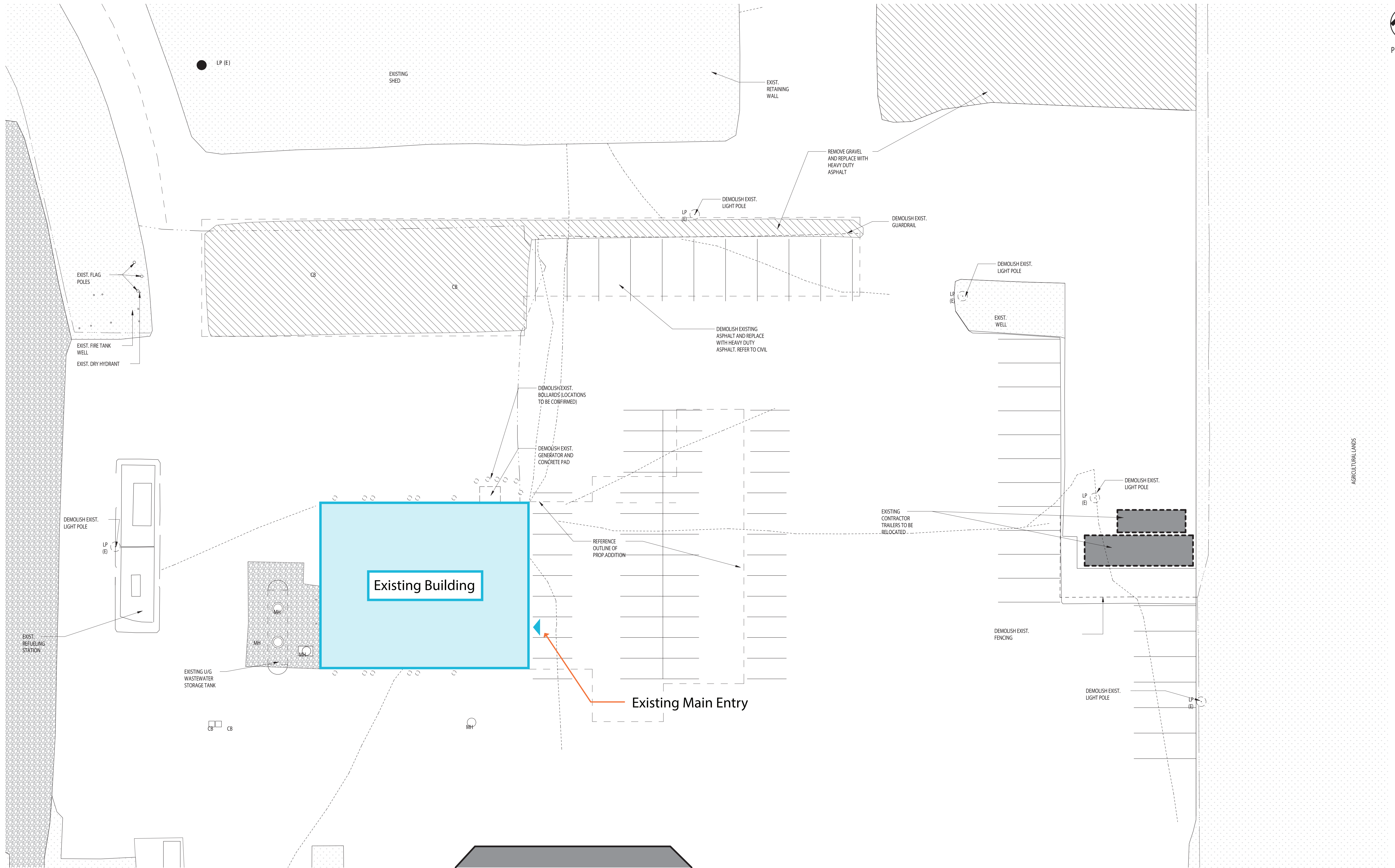
- 1 PROVIDE NEW ELECTRICAL AND ICAT DEVICES AND EQUIPMENT IN RENOVATION AREAS AND ADDITION BUILDING.
- 2 ARRANGE ESA INSPECTIONS, COMMISSION, AND ENERGIZE ALL ELECTRICAL AND ICAT SYSTEMS.
- 3 CHANGEOVER ELECTRICAL AND ICAT SERVICES FROM EXISTING SYSTEMS TO NEW SYSTEMS.
- 4 DEMOLISH TEMPORARY EQUIPMENT AND DEVICES, SUCH AS POWER FEEDS, SECURITY CAMERAS, DATA CONNECTIONS, ETC. REQUIRED ORDER TO MAINTAIN EXISTING FACILITY OPERATIONS.

NOTES:

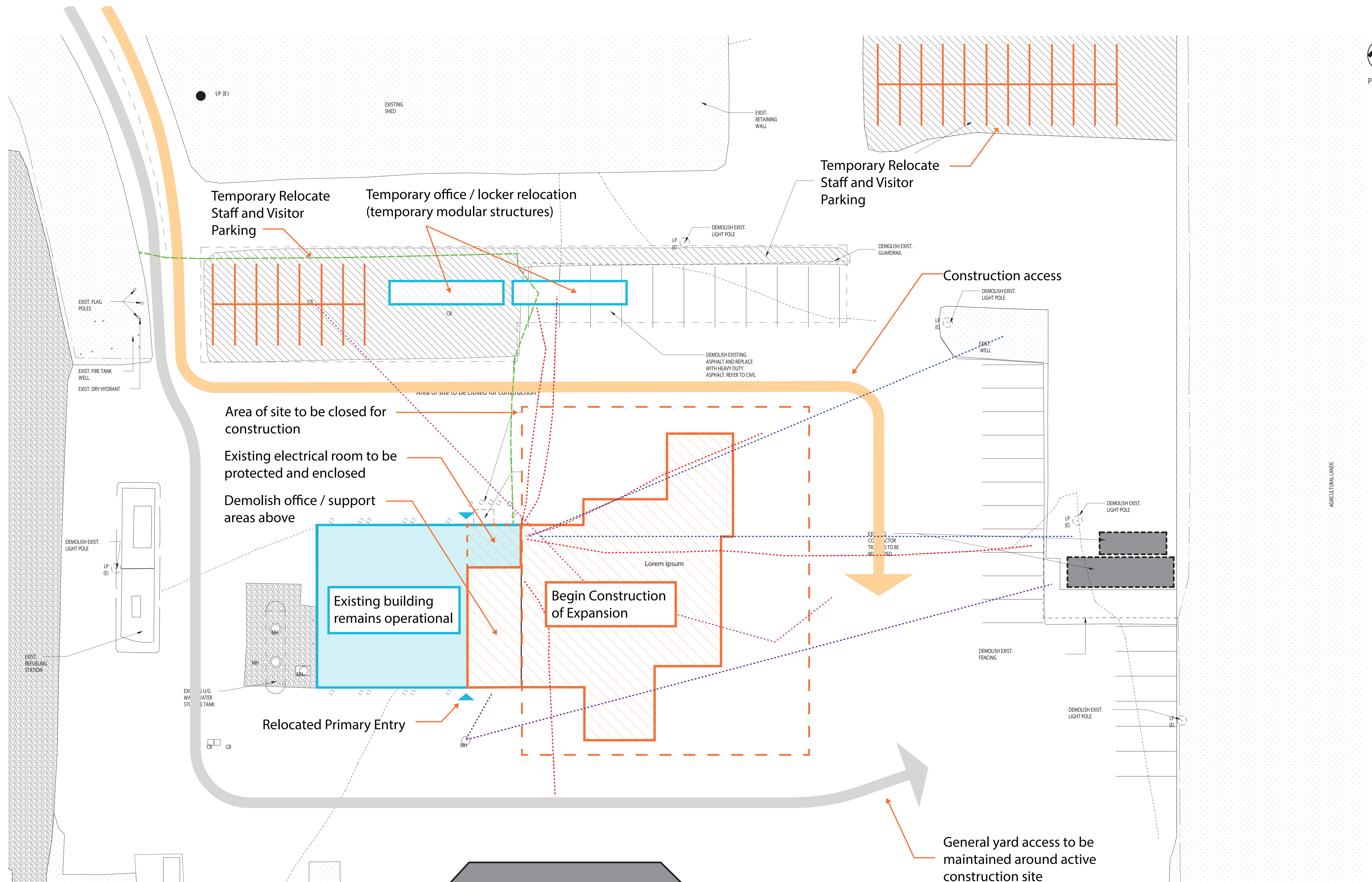
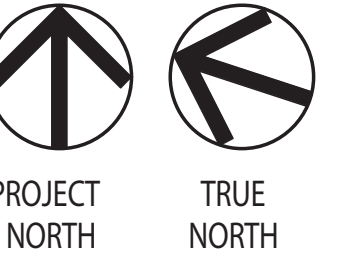
- 1 THE ABOVE PROPOSED PHASING PLAN IS PROVIDED FOR REFERENCE ONLY. THE CONTRACTOR SHALL PROPOSE NEW/REVISE TO SUIT SITE CONDITIONS AND CONSTRUCTION SCHEDULE.

Appendix E

YRND – Proposed Phasing



Start - Spring 2025 (Tender)

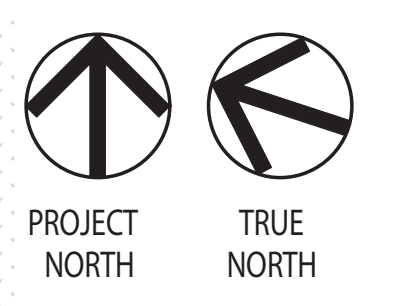
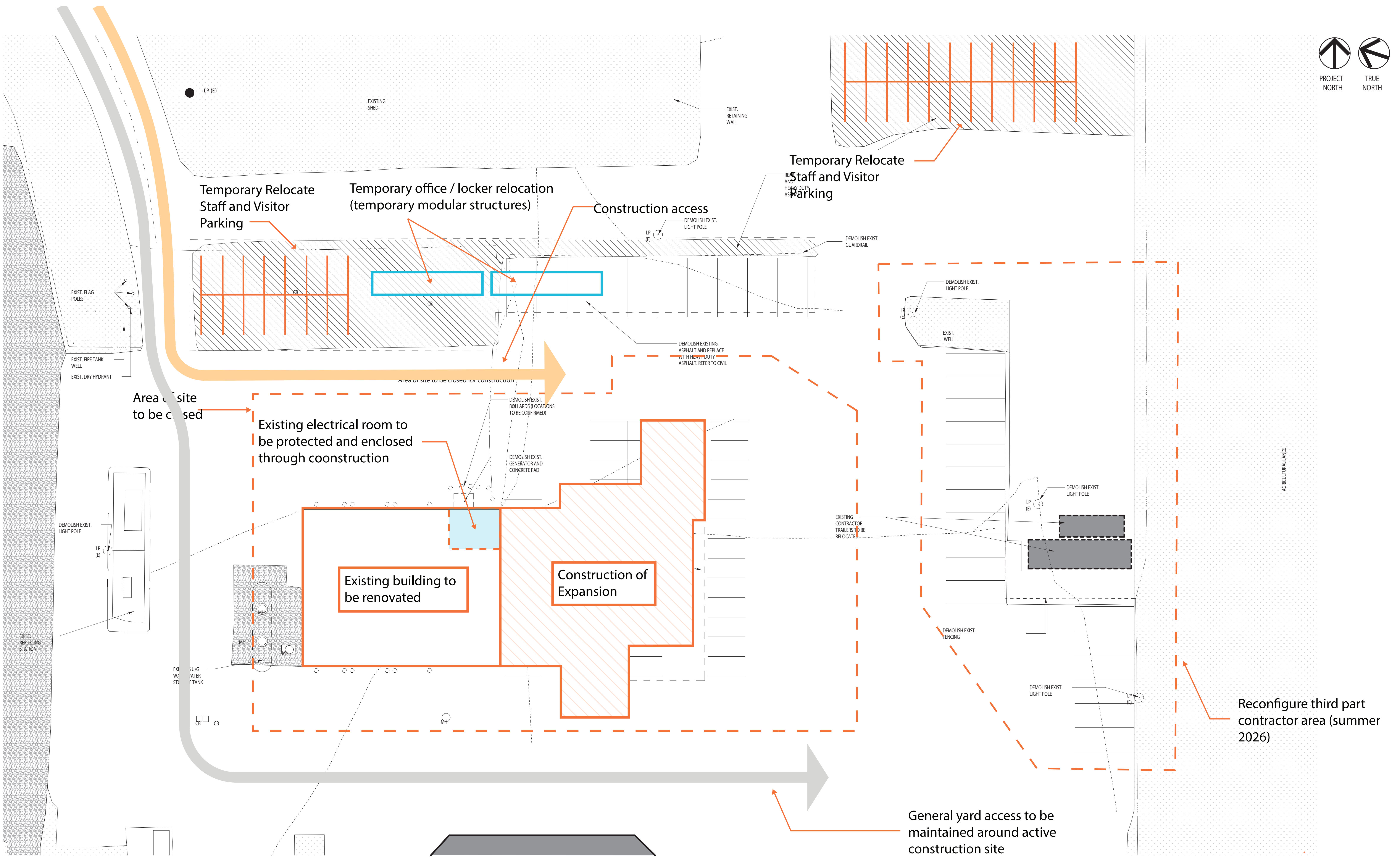


Scenario 2 - Step 1

Start - Late Summer / Fall 2025

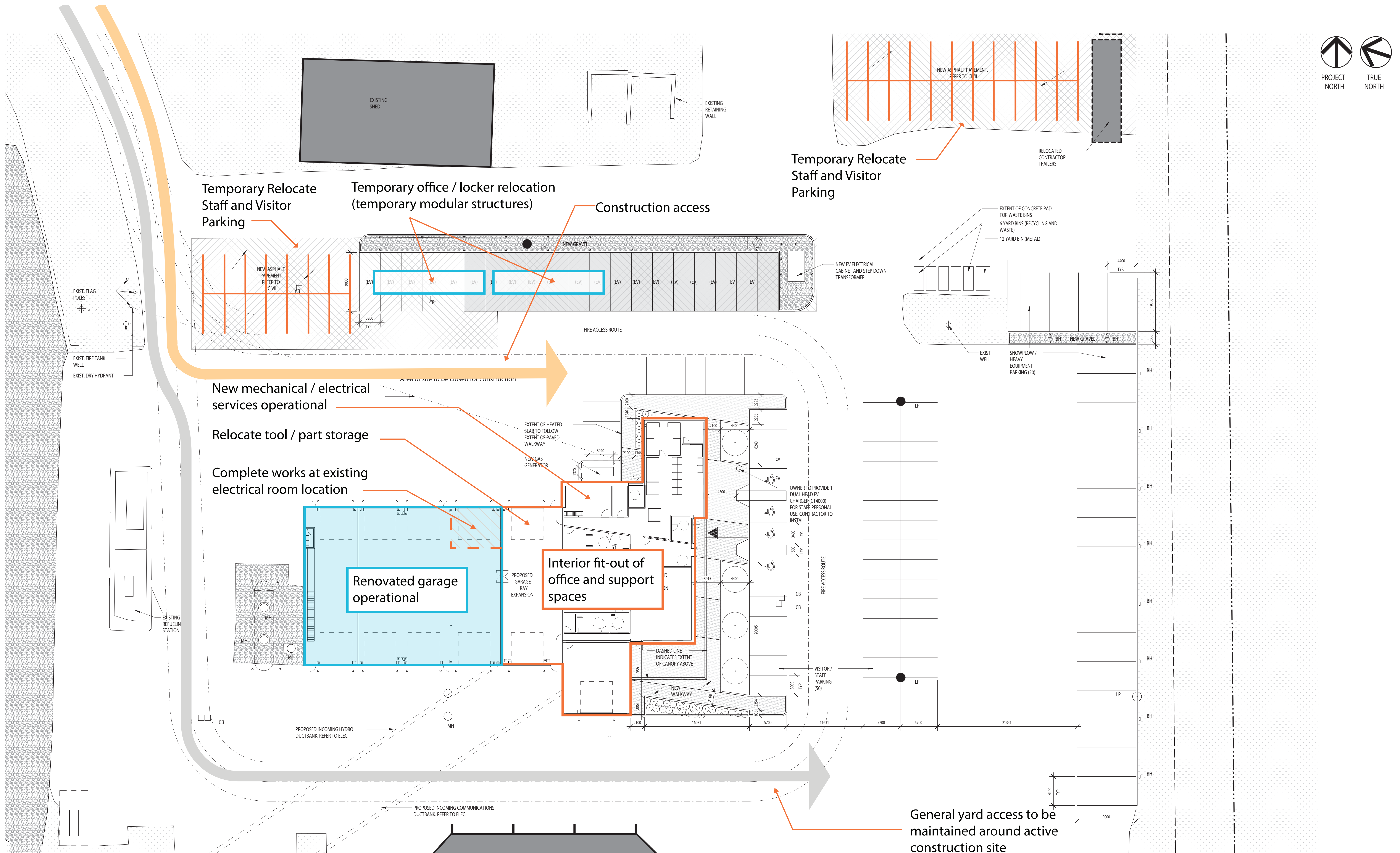
Finish - April 1, 2026

- Gas line to be maintained through construction
- ... Denotes hydro line to be relocated
- ... Denotes water main to be relocated
- ... Denotes sanitary line to be relocated
- ... Denotes storm line to be relocated



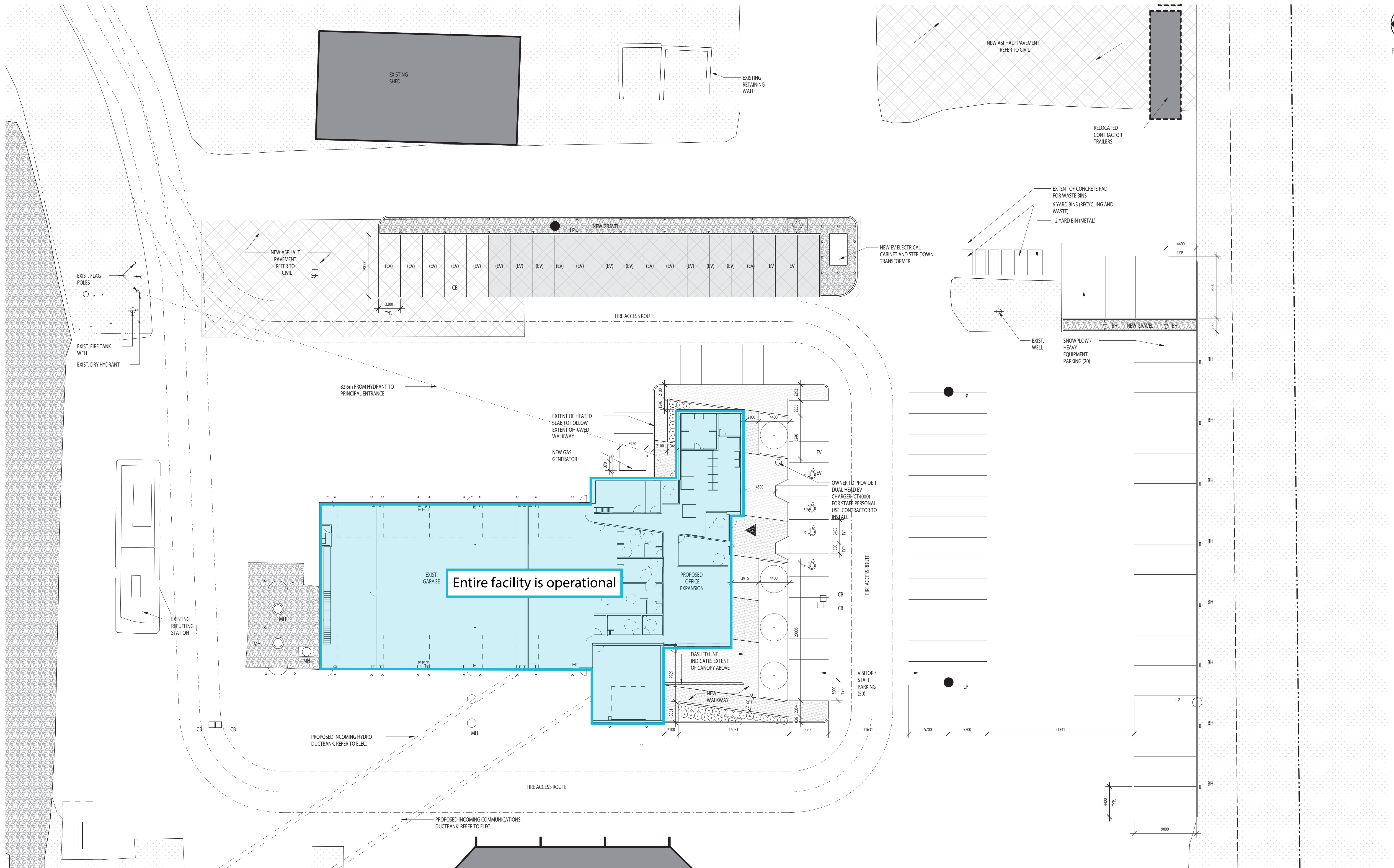
Scenario 2 - Step 2

Start - April , 2026
Finish - Fall 2026










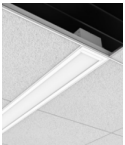




Scenario 2 - Step 3




Start - Before Nov. 1, 2026





Finish - Early 2027

TYPE		DESCRIPTION					BALLAST / DRIVER		CRI	MANUFACTURER CAT. NO. (BASE)	ALTERNATE MANUFACTURERS	IMAGE (REFERENCE ONLY)	COMMENTS / USE (SEE DRAWINGS)
			WATTS	LUMENS	TYPE	COLOR TEMP	VOLTS	TYPE					
C 1		4" RECESSED ROUND LED DOWNLIGHT, 45° BEAM ANGLE MEDIUM DISTRIBUTION, SELF FLANGED SPUN ALUMUNIUM REFLECTOR WITH SEMI-SPECULAR CLEAR FINISH, RATED 50,000 HRS @L70, TRIM SUITED FOR INSTALLATION IN EXTERIOR SOFFIT, IP64 RATED, WET LOCATION RATED, ARCHITECT TO CONFIRM FINISH.	17W	1500	LED	4000K	120	0-10V	70+	COOPER LIGHTING PORTFOLIO LD4C15D010 EX4C159040 MD1H	APPROVED EQUAL		EXTERIOR CANOPY
C 2		4" RECESSED ROUND LED DOWNLIGHT, 60° BEAM ANGLE MEDIUM DISTRIBUTION, GALVANIZED STEEL PLASTER FRAME, SELF FLANGED SPUN ALUMUNIUM REFLECTOR WITH SPECULAR CLEAR FINISH, RATED 50,000 HRS @L70, IP64 RATED, DAMP LOCATION RATED, ARCHITECT TO CONFIRM FINISH.	15W	1500	LED	4000K	120	0-10V	85+	COOPER LIGHTING HALO COMMERCIAL HC410D010-HM40525940- 41MDC	APPROVED EQUAL		CHANGE ROOM WASHROOM CORRIDOR
C 3		4" RECESSED ROUND LED SHOWER DOWNLIGHT, CANLESS MODULAR CONSTRUCTION, REGRESSED FLAT ACRYLIC LENS, RATED 50,000 HRS @L70, IP64 RATED, WET LOCATION RATED, ARCHITECT TO CONFIRM FINISH.	13W	1200	LED	4000K	120	0-10V	85+	COOPER LIGHTING HALO LCR412RD9FSE010MW	APPROVED EQUAL		CHANGE ROOM SHOWER
C 4		4" PENDANT CYLINDER LED DOWNLIGHT, 61° BEAM ANGLE MEDIUM DISTRIBUTION, SPUN ALUMINUM HOUSING, SELF-FLANGED SPUN ALUMINUM CONICAL REFLECTOR WITH SPECULAR-CLEAR FINISH, RATED 50,000 HRS @L70, DAMP LOCATION RATED, C/W PENDANT MOUNTING KIT TO SUIT APPLICATION, ARCHITECT TO CONFIRM FINISH.	10W	1000	LED	4000K	120	0-10V	85+	COOPER LIGHTING HALO COMMERCIAL HCC4S10D010SL- HCC8P36SL-HM40525940- 41WDC	APPROVED EQUAL		CORRIDOR
C 5		2" SUSPENDED SHALLOW ROUND CYLINDER LED DOWNLIGHT, 40° BEAM ANGLE FLOOD DISTRIBUTION, SPUN ALUMINUM RIMLESS REFLECTOR WITH SPECULAR CLEAR FINISH, SELF-FLANGED SPUN ALUMINUM REFLECTOR, RATED 50,000 HRS @L70, DAMP LOCATION RATED, C/W AIRCRAFT SUSPENSION CABLE TO SUIT APPLICATION, COORDINATE EXACT SUSPENSION LENGTH ON SITE, ARCHITECT TO CONFIRM FINISH.	11W	1000	LED	4000K	120	0-10V	85+	COOPER LIGHTING PORTFOLIO LSR2B10WFL559040D010 2LBD LI	APPROVED EQUAL		ENTRY CORRIDOR
E 1		DIE-CAST ALUMINUM EDGE-LIT EXIT SIGN, CSA APPROVED, UNIVERSAL MOUNT, UNIVERSAL DIE-CAST BACKBOX FOR SURFACE/SEMI- RECESSED MOUNTING, FIXTURES, SINGLE OR DOUBLE FACE GREEN RUNNING MAN PICTOGRAM AND DIRECTIONAL INDICATOR TO SUIT APPLICATION, ARCHITECT TO CONFIRM FINISH.	2.5W	N/A	LED	N/A	120	N/A	N/A	EMERGI-LITE EDE SERIES	APPROVED EQUAL		CORRIDORS VESTIBULES OPEN OFFICE SPACE CHANGE ROOMS
E 2		WET LOCATION RATED EXIT SIGN, CSA APPROVED, UNIVERSAL MOUNT, SINGLE OR DOUBLE FACE GREEN RUNNING MAN PICTOGRAM AND DIRECTIONAL INDICATOR TO SUIT APPLICATION, SEALED VANDAL- RESISTANT POLYCARBONATE FACEPLATE, FULLY GASKETED NEMA-4X RATED POLYMERIC ENCLOSURE, ARCHITECT TO CONFIRM FINISH.	2.5W	N/A	LED	N/A	120	N/A	N/A	EMERGI-LITE SURVIVE ALL EN SERIES	APPROVED EQUAL		EXTERIOR DOORS GARAGES

TYPE		DESCRIPTION					BALLAST / DRIVER		CRI	MANUFACTURER CAT. NO. (BASE)	ALTERNATE MANUFACTURERS	IMAGE (REFERENCE ONLY)	COMMENTS / USE (SEE DRAWINGS)
			WATTS	LUMENS	TYPE	COLOR TEMP	VOLTS	TYPE					
F 1		4" WIDE CUSTOM LENGTH RECESSED LED LINEAR, CUSTOMIZABLE RUN LENGTHS TO THE NEAREST 1", ALUMINUM HOUSING, FLUSH SATIN LENS, COLD-ROLLED STEEL REFLECTOR, SUITABLE FOR INSTALLATIONS IN DRYWALL CEILING, RATED 400,000 HRS @L70, DAMP LOCATION RATED, ARCHITECT TO CONFIRM FINISH.	7W/ft	750lm/ft	LED	4000K	120	0-10V	85+	COOPER LIGHTING SQ4R SQ4R-F-075D-940-1-UNV-STD-W-4	APPROVED EQUAL		LUNCH ROOM MEETING ROOM OFFICE
F 2		4' LONG SUSPENDED/SURFACE MOUNTED FLAT LED STRIPLIGHT, DIE-FORMED COLD ROLLED STEEL HOUSING, FROSTED DIFFUSED ACRYLIC LENS, RATED 60,000 HOURS AT L70, DAMP LOCATED RATED, C/W SUSPENSION CABLE KIT AND WIRE GUARD WHERE REQUIRED TO SUIT APPLICATION, ARCHITECT TO CONFIRM FINISH.	26W	4100lm	LED	4000K	120	0-10V	85+	COOPER LIGHTING SNX LENSED 4SNX-41SL-FDL-UNV-L940-CD	APPROVED EQUAL		ELECTRICAL ROOM MECHANICAL ROOM IT ROOM FIRST AID ROOM JANITOR ROOM
F 3A		4' LONG SUSPENDED VAPOUR TIGHT LED LINEAR, IMPACT PROTECTED FIBERGLASS HOUSING, WATERTIGHT USING POLYURETHANE GASKETING, FULL METAL FIXTURE LINER, FROSTED LENS WITH 15% DR HIGH IMPACT ADDITIVE FOR IMPACT RESISTANCE, RATED 60,000 HOURS AT L90, WET LOCATION RATED, IK06 RATED LENS AND HOUSING, C/W CHAIN SUSPENSION KIT TO SUIT APPLICATION, ARCHITECT TO CONFIRM FINISH.	58W	8000	LED	4000K	120	0-10V	85+	COOPER LIGHTING VAPORLITE LED 4VT2-LD5-8-FR50-UNV-L840-CD1-WL-U	APPROVED EQUAL		SIGN GARAGE GARAGE WASH BAY
F 3B		4' LONG WALL/SURFACE MOUNTED VAPOUR TIGHT LED LINEAR, IMPACT PROTECTED FIBERGLASS HOUSING, WATERTIGHT USING POLYURETHANE GASKETING, FULL METAL FIXTURE LINER, FROSTED LENS WITH 15% DR HIGH IMPACT ADDITIVE FOR IMPACT RESISTANCE, RATED 60,000 HOURS AT L90, WET LOCATION RATED, IK06 RATED LENS AND HOUSING, ARCHITECT TO CONFIRM FINISH.	58W	8000	LED	4000K	120	0-10V	85+	COOPER LIGHTING VAPORLITE LED 4VT2-LD5-8-FR50-UNV-L840-CD1-WL-U	APPROVED EQUAL		GARAGE WASH BAY
S 1A		22" LENGTH X 22" WIDTH, SINGLE HEAD EXTERIOR AREA POLE LIGHT, DIE-CAST ALUMINUM HOUSING, ALUMINUM POLE MOUNT ARM SUITABLE FOR INSTALLATION ON SQUARE POLE, TYPE IV FORWARD THROW DISTRIBUTION, 5 YEAR WARRANTY, WET LOCATION RATED, DARK SKY COMPLIANT, ARCHITECT TO CONFIRM FINISH. LIGHT HEAD SHALL BE INSTALLED ON A 8m (24') LONG, BLACK PAINTED, SQUARE GALVANIZED STEEL POLE TO MATCH EXISTING LIGHT POLES (DYNAPOLE SSS4-24 OR APPROVED EQUAL). LIGHT POLES SHALL BE INSTALLED ON A PRECAST CONCRETE BASE MINIMUM 900mm (3') HIGH, 600mm DIAMETER, C/W STEEL ANCHOR BOLTS AND WASHERS AS REQUIRED BY YORK REGION STANDARDS.	213W	27750	LED	4000K	120	0-10V	70+	COOPER LIGHTING SOLUTIONS GALN-SA4C-740-U-T4FT	APPROVED EQUAL		EXTERIOR SITE

TYPE		DESCRIPTION					BALLAST / DRIVER		CRI	MANUFACTURER CAT. NO. (BASE)	ALTERNATE MANUFACTURERS	IMAGE (REFERENCE ONLY)	COMMENTS / USE (SEE DRAWINGS)
			WATTS	LUMENS	TYPE	COLOR TEMP	VOLTS	TYPE					
S	1B	22" LENGTH X 22" WIDTH, DOUBLE HEAD EXTERIOR AREA POLE LIGHT, DIE-CAST ALUMINUM HOUSING, ALUMINUM POLE MOUNT ARM SUITABLE FOR INSTALLATION ON SQUARE POLE, TYPE IV FORWARD THROW DISTRIBUTION, 5 YEAR WARRANTY, WET LOCATION RATED, DARK SKY COMPLIANT, ARCHITECT TO CONFIRM FINISH. LIGHT HEAD SHALL BE INSTALLED ON A 8m (24') LONG, BLACK PAINTED, SQUARE GALVANIZED STEEL POLE TO MATCH EXISTING LIGHT POLES (DYNAPOLE SSS4-24 OR APPROVED EQUAL). LIGHT POLES SHALL BE INSTALLED ON A PRECAST CONCRETE BASE MINIMUM 900mm (3') HIGH, 600mm DIAMETER, C/W STEEL ANCHOR BOLTS AND WASHERS AS REQUIRED BY YORK REGION STANDARDS.	426W	55500	LED	4000K	120	0-10V	70+	COOPER LIGHTING SOLUTIONS GALN-SA4C-740-U-T4FT	APPROVED EQUAL		EXTERIOR SITE
	S 2A	22" LENGTH X 22" WIDTH, SINGLE HEAD EXTERIOR AREA POLE LIGHT, DIE-CAST ALUMINUM HOUSING, ALUMINUM POLE MOUNT ARM SUITABLE FOR INSTALLATION ON SQUARE POLE, TYPE IV FORWARD THROW DISTRIBUTION, 5 YEAR WARRANTY, WET LOCATION RATED, DARK SKY COMPLIANT, C/W BACKLIGHT SHIELDING, ARCHITECT TO CONFIRM FINISH. LIGHT HEAD SHALL BE INSTALLED ON A 8m (24') LONG, BLACK PAINTED, SQUARE GALVANIZED STEEL POLE TO MATCH EXISTING LIGHT POLES (DYNAPOLE SSS4-24 OR APPROVED EQUAL). LIGHT POLES SHALL BE INSTALLED ON A PRECAST CONCRETE BASE MINIMUM 900mm (3') HIGH, 600mm DIAMETER, C/W STEEL ANCHOR BOLTS AND WASHERS AS REQUIRED BY YORK REGION STANDARDS.	213W	20030	LED	4000K	120	0-10V	70+	COOPER LIGHTING SOLUTIONS GALN-SA4C-740-U-T4FT-HSS	APPROVED EQUAL		EXTERIOR SITE
	S 3A	22" LENGTH X 22" WIDTH, SINGLE HEAD EXTERIOR AREA POLE LIGHT, DIE-CAST ALUMINUM HOUSING, ALUMINUM POLE MOUNT ARM SUITABLE FOR INSTALLATION ON SQUARE POLE, TYPE 3 DISTRIBUTION, 5 YEAR WARRANTY, WET LOCATION RATED, DARK SKY COMPLIANT, C/W BACKLIGHT SHIELDING, ARCHITECT TO CONFIRM FINISH. LIGHT HEAD SHALL BE INSTALLED ON A 8m (24') LONG, BLACK PAINTED, SQUARE GALVANIZED STEEL POLE TO MATCH EXISTING LIGHT POLES (DYNAPOLE SSS4-24 OR APPROVED EQUAL). LIGHT POLES SHALL BE INSTALLED ON A PRECAST CONCRETE BASE MINIMUM 900mm (3') HIGH, 600mm DIAMETER, C/W STEEL ANCHOR BOLTS AND WASHERS AS REQUIRED BY YORK REGION STANDARDS.	213W	20420	LED	4000K	120	0-10V	70+	COOPER LIGHTING SOLUTIONS GALN-SA4C-740-U-T3-HSS	APPROVED EQUAL		EXTERIOR SITE

TYPE		DESCRIPTION					BALLAST / DRIVER		CRI	MANUFACTURER CAT. NO. (BASE)	ALTERNATE MANUFACTURERS	IMAGE (REFERENCE ONLY)	COMMENTS / USE (SEE DRAWINGS)
			WATTS	LUMENS	TYPE	COLOR TEMP	VOLTS	TYPE					
S	4B	22" LENGTH X 22" WIDTH, DOUBLE HEAD EXTERIOR AREA POLE LIGHT, DIE-CAST ALUMINUM HOUSING, ALUMINUM POLE MOUNT ARM SUITABLE FOR INSTALLATION ON SQUARE POLE, TYPE V SQUARE WIDE DISTRIBUTION, 5 YEAR WARRANTY, WET LOCATION RATED, DARK SKY COMPLIANT, ARCHITECT TO CONFIRM FINISH	426W	58340	LED	4000K	120	0-10V	70+	COOPER LIGHTING SOLUTIONS GALN-SA4C-740-U-5WQ	APPROVED EQUAL		EXTERIOR SITE
		LIGHT HEAD SHALL BE INSTALLED ON A 8m (24') LONG, BLACK PAINTED, SQUARE GALVANIZED STEEL POLE TO MATCH EXISTING LIGHT POLES (DYNAPOLE SSS4-24 OR APPROVED EQUAL).											
		LIGHT POLES SHALL BE INSTALLED ON A PRECAST CONCRETE BASE MINIMUM 900mm (3') HIGH, 600mm DIAMETER, C/W STEEL ANCHOR BOLTS AND WASHERS AS REQUIRED BY YORK REGION STANDARDS.											
W	1	7" LENGTH X 4" DEPTH X 8" HEIGHT, EXTERIOR WALL PACK LIGHT, DIE-CAST ALUMINUM HOUSING, ONE-PIECE SILICONE GASKET FOR WATER TIGHT SEAL, ANODIZED RELECTOR, IMPACT-RESISTANT TEMPERED GLASS LENS, RATED 72,000 HOURS AT L90, WET LOCATION RATED, DARK SKY COMPLIANT, ARCHITECT TO CONFIRM FINISH.	38W	1020	LED	4000K	120	0-10V	70+	COOPER LIGHTING SOLUTIONS XTOR4B-W	APPROVED EQUAL		EXTERIOR SITE

Notes:	<div>1. Submit photometric calculations for alternate manufacturers. Div 26 to carry all additional related costs to meet performance of based manufacturer.</div> <div>2. Coordinate housing requirements for each recessed installation, and provide appropriate housing.</div> <div>3. Provide insulated housing where the fixture may become in contact with insulation.</div> <div>4. All lensed LED fixtures shall have hinged frames.</div> <div>5. Except RUNNING MAN signs, all LED fixtures shall be tested to IESNA LM79-2008 & LM80. Lifetime shall be based on L70.</div> <div>6. All exterior luminaires shall be Dark Sky Friendly.</div>
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INFORMATION, COMMUNICATIONS, AUTOMATION & TECHNOLOGY (ICAT) SPECIFICATIONS

FOR

YORK REGION

NORTH ROADS OPERATIONS CENTRE

TO

GEC ARCHITECTURE

DATED

MAY 23, 2025

REISSUED FOR TENDER

Contact Person: Desmond Lau
Phone: 647-968-0637
Email: dlau@mcw.com

MCW Project No. 23137

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END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 In case of discrepancy of the specifications details, the Owner's standards and requirements attached in the Appendices shall take precedence.**
- .2 Comply with the requirements of Division 1 and all documents referred to therein.
- .3 Work related to telecommunications system shall be installed by a Structured Cabling System (SCS) manufacturers (CommScope, Belden, Panduit, Hubbell, Leviton or approved equal) authorized and certified trained installer and supervised an SCS manufacturers authorized and certified SCS Engineer. Owner reserves the right to review and approves any personnel assigned to this project in a supervisory or managerial role.
- .4 SCS contractor shall have had at least 10 years of comparable experience with telecommunications projects. As part of the proposal, SCS installer shall submit at least three (3) comparable Project reference descriptions with reference contacts. Comparable projects shall equal or exceed size and complexity of work on drawings.
- .5 SCS contractor shall assign RCDD certified Project Manager as the main contact for the project.
- .6 The Contractor shall propose alternate product at no additional cost to the Owner, if the design-based product has been discontinued or obsoleted. The proposed alternate product shall have equal or better performance than the original design-based product.

1.2 APPLICATION

- .1 This Section applies to and is a part of all Sections of Division 27.

1.3 ABBREVIATIONS, ACRONYMS AND DEFINITIONS

ACD	Automatic Call Distribution
AFF	Above Finished Floor
AWG	American Wire Gauge
BICSI	Building Industry Consulting Services International
CAT5	Category 5 Copper Cable
CAT5e	Category 5e Copper Cable
CAT6	Category 6 Copper Cable
CAT6A	Category 6A Copper Cable
CDDI	Copper Distributed Data Interface
CMP	Communications Multipurpose Plenum
CMR	Communications Multipurpose Riser
EIA	Electronic Industries Association
ELFEXT	Equal-Level Far-End Crosstalk
FEXT	Far End Crosstalk
Gbps	Gigabits per second
HSM	High Speed Migration
HVAC	Heating, Ventilation, and Air Conditioning
IDF	Intermediate Distribution
IEEE	Institute of Electrical and Electronics Engineers

IM	Information Management
ISDN	Integrated Services Digital Network
LAN	Local Area Network
Mbps	Megabits per second
MDF	Main Distribution Frame
MMF	Multi-mode fiber optics
MUTOA	Multi-User Telecommunications Outlet Assembly
NEXT	Near End Cross Talk
NRTL	Nationally Recognized Testing Laboratories
OSHA	Occupational Safety and Health Act
PBX-	Private Branch Exchange: telephone switch
PDS	Premises Distribution Systems
PoE	Power over Ethernet
POP	Point of Presence
PSACR	Power Sum Attenuation-to-Crosstalk Ratio
PSAFEXT	Power Sum Alien Far-End Crosstalk
PSAELFEXT	Power Sum Alien Equal Level Far-End Crosstalk
PSANEXT	Power Sum Alien Near-End Crosstalk
PSELFEXT	Power Sum Equal Level Far-End Crosstalk
PSNEXT	Power Sum Near-End Crosstalk
SCC	Security Command Center
SCS	Structured Cabling System
SFF	Small Form Factor
SMF	Single-mode fiber optics
TC	Telecommunications Closet
TE	Telecommunications Enclosure
TEF	Telecommunications Entrance Facility
TIA	Telecommunications Industry Association
TR	Telecommunications Room
TO	Telecommunications Outlet
UPS	Uninterruptible Power Supply
UTP	Unshielded Twisted Pair
VoIP	Voice over Internet Protocol
WAO	Work Area Outlet
WAN	Wide Area Network

- .1 Access Floor - A floor system that has removable floor panels.
- .2 Building Backbone Cabling – Cabling used to connect Floor Distributors (FD) or other local collection points to the Building Distributor (BD). Building backbone cabling typically carries aggregate traffic and, as such, impacts multiple network devices and users. Building backbone cabling may include either fiber optic or copper cabling or both.
- .3 Building Distributor (BD) – Termination point from which all building backbone cabling emanates and interconnection point for the network backbone. Commonly referred to as BDF in Americas, Main Comm Rooms in EMEA and Communication Room, IT Lab or IT Room in AsiaPac. Referred to as BD in international and European industry standards and Intermediate Cross-connect (IC) in American industry standards. There is one BD for each building and it feeds all FD's in the same building. The BD should be located so that all FD's served are within 300 cable meters (984 cable feet).

- .4 Campus Backbone Cabling – Cabling used to connect Building Distributors (BD) or other key network segments to the Campus Distributor (CD). With rare exceptions, campus backbone cabling carries aggregate traffic and typically impacts entire buildings worth of network devices and users and, as such, link redundancy with diverse routing is highly recommended. Campus backbone cabling almost exclusively consists of fiber optic cabling. Copper cabling may be used in short-distance (< 90m) applications. In such cases, lightning protection will usually be required by code.
- .5 Campus Distributor (CD) – Termination point from which all campus backbone cabling emanates and highest-level interconnection point for the network backbone. Commonly referred to as NOC in Americas and Main Comm Rooms in EMEA. Referred to as CD in international and European industry standards and Main Cross-connect (MC) in American industry standards. On smaller campuses, there is one CD for the campus. On larger campuses, there might be several CD's with each CD serving several buildings. Besides linking to each of the BD's it serves, the CD is also the network interconnection point for data center links and links to service providers.
- .6 Category 3 (Cat 3) – A category of transmission performance, defined in TIA standards, that specifies electrical properties up to 10 MHz. Cat 3 is the minimum performance grade permissible and is used typically for analog voice distribution.
- .7 Category 5e (Cat 5e) / Class D – A category/class of transmission performance that specifies electrical properties up to 155.5 MHz. Capable of supporting copper-based, four-pair Gigabit Ethernet (IEEE 802.3ab 1000BASE-T) applications. Category 5e is defined in TIA-568-C standard. Class D is defined in the ISO 11801 standard.
- .8 Category 6 (Cat 6) / Class E – A category/class of transmission performance that specifies electrical properties up to 250 MHz. Refer to the TIA- 568-C family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class E requirements. Also, refer to CENELEC EN50173.
- .9 Category 6A (Cat 6) / Class EA– A category/class of transmission performance that specifies electrical properties up to 500 MHz and capable of supporting data applications operating at 10Gbps. Refer to the TIA-568-C family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class EA requirements.
- .10 Category 7 – backward compatible with Class D/Category 5e and Class E/Category 6. Class F features even stricter specifications for crosstalk and system noise than Class E. To achieve this, shielding has been added for individual wire pairs and the cable as a whole.
- .11 Category 8 – ratified by the TR43 working group under ANSI/TIA 568-C.2-1. It is defined up 2000 MHz and only for distances from 30 to 36m depending on the patch cords used. ISO is expected to ratify the equivalent in 2018 but will have 2 options: Class I channel, Category 8.1 cable and Class II channel, Category 8.2 cable. Category 8 is designed only for data centers where distances between switches and servers is short. It is not intended for general office cabling.
- .12 Certification – The testing and documentation of the transmission performance (e.g., Category 5e / Class D) of a permanent link or channel, based on sweep frequency (where applicable) testing of numerous parameters with results

compared to a range of acceptable values. This project requires 100% certification (with documentation) of all permanent link cabling at the time of installation. Channel certification is optional and is the responsibility of the group using the channel.

- .13 Channel – The entire physical pathway between active equipment ports, inclusive of all patch cords, patch panels, jacks and cabling segments.
- .14 Class C – A category of transmission performance, defined in ISO and EN standards, that specifies electrical properties up to 16 MHz
- .15 Conduit - A raceway of circular cross-section.
- .16 Entrance Facility (EF) – Termination point of service provider cables that have entered the building and location of service demarcation point (MPOE) and interconnection point to the network. Commonly referred to as Telco Room in Americas, POP Room in EMEA and Building Entrance in AsiaPac. Referred to as Building Entrance Facility in international and European industry standards and Entrance Facility (EF) in American industry standards. The EF is linked to the CD, where present, or to the BD.
- .17 Floor Distributor (FD) – Termination point for horizontal cabling and interconnection point for network access. Commonly referred to as IDF. Referred to as Floor Distributor (FD) in international and European industry standards and Horizontal Cross-connect (HC) - FD quantities and locations are determined by building size and geometry so that all points served are within 90 cable meters (295 cable feet) of an FD. The FD feeds all Telecommunications Outlets (TO's) in its service zone. All FD's in a building are linked to the building's Building Distributor (BD) via backbone cabling.
- .18 Horizontal Cabling – Cabling used to connect individual work area outlets to local Floor Distributors (FD) or other collection points. Unlike backbone cabling, horizontal cabling does not typically carry aggregate traffic and, as such, impacts only single network devices or users. In buildings, horizontal cabling almost exclusively consists of copper cabling. Fiber optic cabling may be used where situations dictate but, unlike horizontal copper cabling, horizontal fiber optic cabling is not installed in advance as default building facilities. At this writing, horizontal copper cabling in many networks is capable of supporting Gigabit (1Gb/s) Ethernet applications as well as other applications of similar bandwidth.
- .19 Permanent Link – A stationary cabling segment, consisting of the permanently installed cable and the permanently affixed jack at both ends (typically at the outlet faceplate and closet patch panel, or on a patch panel on both ends). The concept assumes that, while patch cords might be disconnected or moved over time, the permanent cable and jacks will not be disturbed and the electrical characteristics of the permanent link will remain unaltered.
- .20 Plenum - A space within the building designed for the movement of environmental air; i.e., a space above a suspended ceiling or below an access floor.
- .21 Raceway - Any channel designed for holding wires or cables; i.e. conduit, electrical metal tubing, busways, wireways, ventilated flexible cableway.
- .22 Spine – also called a backbone, the main communications cables in an IDF.

1.4 DEFINITIONS & REFERENCE STANDARDS

- .1 Wherever the term "This Sub-Contractor" is used in the Division 27 Drawings and Specifications, it means the firm having a subcontract with the "Contractor" to perform, supervise and co-ordinate all work of this Division.
- .2 Wherever the term "install" (and tenses of "install") is used in the Division 27 Drawings and Specifications, it means install and connect complete.
- .3 Wherever the term "supply" is used in the Division 27 Drawings and Specifications, it means supply only.
- .4 Wherever the term "Provide" or "Provision of" are used in relationship to equipment and other materials specified for the Work of Division 27 it means "Supply, Install and Connect". Wherever the terms "Provide" or "Provision of" are used in connection with services such as testing, start-up and commissioning for any part of the Work of Division 27, it means procure, supervise, take responsibility and pay for these services.
- .5 Whenever "Drawings and Specifications" are referred to herein, it means "the Contract Documents".
- .6 Wherever the terms "Authorities" or "Authorities having jurisdiction" are used in the Division 27, Drawings and Specifications, it shall mean any and all current laws and/or by-laws of any federal, provincial or local authorized agencies having jurisdiction over the sum total or parts of the work including, but not restricted to the Municipal Planning and Building Department, Municipal Fire Department, The Construction Safety Act, Municipal Public Works Department, Federal and/or Provincial Fire Marshall, the Ontario Electrical Safety Code and the Ontario Building Code.
- .7 Wherever the term "Work" is used in the Division 27 Drawings and Specifications, it means all equipment, permits, materials and labour to provide a complete communications installation as required and detailed in the Drawings and Specifications.
- .8 Wherever the term "Acceptable" is used in the Division 27 Drawings and Specifications it means acceptable to the Consultant.
- .9 Reference Standards:
 - Ontario Building Code
 - Ontario Electrical Safety Code
 - Telecommunications Industry Association (TIA)
 - ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises
 - ANSI/TIA-568.1-E Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 - ANSI/TIA-568.3-D Optical Fiber Cabling and Components Standard
 - ANSI/TIA-568.4-D Coaxial Components
 - ANSI/TIA-569-E, Telecommunications Pathways and Spaces.
 - ANSI/TIA-526-7-A, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - ANSI/TIA-526-14-C, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

ANSI/TIA-606-C, Administration Standard for Commercial Telecommunications Infrastructure.

ANSI/TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

ANSI/TIA-758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard

ANSI/TIA TSB-162-B Telecommunications Cabling Guidelines for Wireless Access Points

ANSI/TIA-862-B, Structured Cabling Infrastructure Standard For Intelligent Building Systems

ANSI/TIA-942-B, Data Center Cabling

ANSI/TIA-1005-A, Telecommunications Infrastructure Standard for Industrial Premises

ANSI/TIA-1152-A, Requirements for Field Test Instruments and Measurements for Balanced Twisted Pair Cabling

ANSI/TIA-5017, Telecommunications Physical Network Security Standard

ANSI/TIA-5018, Distributed Antenna Systems (DAS)

TIA TSB-184-A Power Delivery (4-pair)

BICSI

Telecommunications Distribution Methods Manual (TDMM), 14th Edition
Information Technology Systems Installation Methods Manual (ITSIMM), 7th Edition

ANSI/BICSI 002-2019- Data Center Design and Implementation Best Practices

ANSI/BICSI 001-2017, Information and Communication Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities

ANSI/BICSI 004-2018, Communication Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities

ANSI/BICSI 006-2020, Distributed Antenna System (DAS) Design and Implementation

ANSI/BICSI 007-2017- Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises

ANSI/BICSI 008-2018 - Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices

ANSI/BICSI N1-2019: Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure

ANSI/BICSI N2-17: Installation of Telecommunications and ICT Cabling to Support Remote Power Applications

ANSI/BICSI N3-20: Planning and Installation Methods for the Bonding and Grounding of Telecommunications and ICT Systems and Infrastructure

BICSI G1-17, ICT Outside Plant Construction and Installation: General Practices

1.5 WORK INCLUDED

- .1 Sections of Division 27 are not intended to delegate functions nor to delegate work and supply to any specific trade and the Work shall include all labour, materials, equipment and tools required for a complete and working installation as described, but not necessarily limited to all the sections in the specifications.

1.6 PERMITS, FEES AND INSPECTIONS

- .1 Apply for, obtain, and pay for all permits, licenses, inspections, examinations and fees required for Work of Division 27. If the municipality is structured as a "single permit jurisdiction", the Contractor will apply, pay for and obtain the municipal building permit. In this case, the Division 27 contractor has no financial obligation for permit application except for permits not covered in the "single permit".
- .2 Arrange for inspection of all Work by the Authorities having jurisdiction over the Work. On completion of the Work, present to the Consultant the final unconditional certificate of approval of the inspecting Authorities.
- .3 Comply with the requirements of the latest edition of the applicable CSA standards, the requirements of the Authorities, Federal, Provincial and Municipal Codes, the applicable standards of the Underwriters' Association and all other Authorities having jurisdiction. These codes and regulations constitute an integral part of these specifications.
- .4 In case of conflict, the codes take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the drawings and specifications by applying any of the codes referred to herein.
- .5 Before starting any work, submit the required number of copies of drawings and specifications to the Authorities for their approval and comments. Comply with any changes requested as part of the contract, but notify the Consultant immediately of such changes. Prepare and furnish any additional drawings, details or information as may be required.

1.7 CONTRACT DRAWINGS

- .1 The Drawings for Communications work are performance drawings, diagrammatic, intended to convey the scope of work and indicate general arrangement and approximate location of apparatus, fixtures and conduit runs. The Drawings do not intend to show architectural and structural details.
- .2 Do not scale Drawings. Obtain information involving accurate dimensions from dimensions shown on Architectural and Structural drawings, and by site measurement.
- .3 Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (conduits around beams, columns, etc.)
- .4 Alter, at no additional cost, the locations of materials and/or equipment as directed, that do not necessitate additional material.
- .5 Install ceiling mounted components in accordance with reflected ceiling drawings.
- .6 Confirm on the site the exact location and mounting elevation of outlets and fixtures as related to Architectural and Structural details.

1.8 EXAMINATION OF SITE AND DOCUMENTATIONS

- .1 Prior to submitting tender, carefully examine conditions at the site which could affect the Work. Refer to and examine all contract documents.

- .2 Be responsible for any damage done to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.
- .3 Refer to room finish schedules to determine finished, partially finished and unfinished areas of the building.
- .4 Ensure that materials and equipment are delivered to the site at the proper time and in such assemblies and sizes so as to enter into the building and to be moved into the spaces where they are to be located without difficulty. Be responsible for any cutting and patching involved in getting assemblies into place.

1.9 CO-ORDINATION DRAWINGS

- .1 Prepare drawings in conjunction with all trades concerned, showing sleeves and openings for passage through structure, and all inserts, equipment bases, and supports, and relate these to suitable grid lines and elevation datum.
- .2 When requested, provide weights of major items of equipment.
- .3 Prepare interference and co-ordination drawings for all areas where the work of this Division could conflict with and/or obstruct the work of other trades and/or other Sections of this Division. Submit drawings for review by the Consultant.

1.10 RECORD DRAWINGS

- .1 The drawings for this Project have been prepared using AutoCAD. For the purpose of producing record (as-built) drawings, copies of contract drawings may be purchased from the Consultant based on the following rates plus HST. In using the drawings from the Consultant to produce record drawings, the Contractor is deemed to have agreed to take full responsibility for any and all information on the drawings.
- .2 The drawings for this Project have been prepared using Revit/BIM 360. For the purpose of exchanging model and producing record (as-built) drawings, a model file will be made available to the trade for a cost of \$850 plus HST. In using the model from the Consultant to produce record drawings, the Contractor is deemed to have agreed to take full responsibility for any and all information on the drawings.

For 1 to 10 files	\$550.00
For 11 to 20 files	\$650.00
For 21 to 50 files	\$850.00
For 51 to 100 files	\$1,350.00
For greater than 100 files, charge	\$10.00 per file + \$350.00.
- .3 Obtain a set of white prints as the job progresses, mark this set to accurately indicate installed work. Show location by dimension from walls or columns for all buried services as well as invert depths. Have these white prints available for inspection at the site at all times, and present for scrutiny at each job meeting.
- .4 At completion of the project, transfer all information from the white prints to the CAD files, and provide one CD with updated CAD files, to the Consultant as part of the close out documents.

- .5 The contractor is responsible for all cost associated with the production and services required, such as recreating, plotting and printing to produce “as-built” drawings.

1.11 PRODUCT STANDARDS AND ALTERNATIVES

- .1 Provide new material and equipment as specified and to the acceptance of the Consultant. Manufacturer's names are listed to set a standard of quality, performance, capacity, appearance and serviceability. Other acceptable manufacturers are also listed, and their names may be used in the submission of the Communications List of Manufacturers, Subtrades and Separate and Unit Prices Tender subject to conditions stipulated in paragraph .3 of this article.
- .2 Where no other acceptable manufacturers are indicated, provide the exact make specified. Requests for acceptance of manufacturers not listed must be submitted not less than seven working days prior to closing date of the tender and submissions must bear proof of acceptance by the Consultant if used in the tender. No exceptions. Requests for substitutions shall be considered not approved unless approval is issued in writing by the Consultant.
- .3 Assume full responsibility for ensuring that when providing other acceptable and approved manufacturers, system performance shall be equal or better than the base system. Provide clause-by-clause specifications comparison between the base system and the alternate substituted system. Provide system performance study as required by the Consultant and to the satisfaction of the Consultant.

1.12 PATENTS

- .1 Pay all royalties and licence fees, and defend all suits or claims for infringement of any patent rights, and save the Owner and Consultant harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters, patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters, patent or rights.

1.13 RIGHTS RESERVED

- .1 Rights are reserved to furnish any additional detail drawings, which in the judgement of the Consultant may be necessary to clarify the work, and such drawings shall form a part of this contract.

1.14 EQUIPMENT NAMEPLATES

- .1 Provide apparatus with proper nameplates affixed thereto, showing the size, name of equipment, serial number and all information usually provided, which also includes voltage, cycle, phase, horsepower of motors and the name and address of the manufacturer.

1.15 EXPEDITING AND DELIVERY

- .1 Continuously check and expedite delivery of equipment and materials. If necessary, inspect at the source of manufacture.

- .2 Continuously check and expedite the flow of necessary information to and from all parties involved.
- .3 Immediately inform the Consultant in case information is required from him.
- .4 Provide delivery records updated monthly.

1.16 SUPERINTENDENCE

- .1 Maintain at the job site, at all times, qualified personnel and supporting staff, with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.
- .2 The supervising personnel and their qualifications are subject to the approval of the Consultant.

1.17 WORKMANSHIP

- .1 Install equipment, conduit and cables in a workmanlike manner to present a neat appearance to function properly to the satisfaction of the Consultant. Install runs parallel and perpendicular to building lines, in chases, behind furring or above ceilings, where such concealment is possible. In areas where systems are to be exposed install neatly and group to present a tidy appearance.
- .2 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement with due allowance therefore.
- .3 Include in the work all requirements of manufacturers shown on the shop drawings or manufacturers installation instructions.
- .4 Replace work unsatisfactory to the Consultant without extra cost.
- .5 Make provision to accommodate future plant and equipment indicated on drawings.
- .6 Protect from damage all equipment delivered to the site and during installation. Any damage or marking of finished surfaces shall be made good to the satisfaction of the Consultant.

1.18 TRIAL USAGE AND TESTS

- .1 The Owner has the privilege of the trial usage of Communications Systems or parts thereof for the purpose of testing and learning the operational procedures.
- .2 Assist in trial usage over a length of time as deemed reasonable by the Consultant at no extra cost and do not waive any responsibility because of trial usage.
- .3 Trial usage shall not be construed as Substantial Completion of the Work, or acceptance by the Owner.
- .4 Provide and pay for all testing required on the system components where, in the opinion of the Consultant, manufacturers ratings or specified performance is not being achieved.

1.19 CLEANING

- .1 Remove all debris, surplus material and all tools.

- .2 Carry out additional cleaning operating of systems as specified in other sections of the specification.

1.20 COMPLETION

- .1 Leave communications work in specified working order.

1.21 WARRANTIES

- .1 A Manufacturers Limited Lifetime Product and Performance Warranty shall be obtained by the Contractor on behalf of the Owner covering all applicable structured cabling components of the installed system. It is the responsibility of the contractor to provide all forms/documents necessary to obtain the system warranty. Evidence of such warranty will be provided by Contractor as part of their contractual obligation and final retainage payments are contingent upon delivery to Owner of Manufacturers site warranty certificate.
- .2 Provide warranty certificates, wherever given or required, in excess of the normal warranty period showing the name of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.
- .3 Contractor warranty: Provide all services, materials and equipment necessary for successful operation of entire telecommunications system and SCS system for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, wiring, accessories, software, hardware, installation, programming, and configuration required to maintain a complete and operable system. Provide manufacturer's published recommended preventative maintenance procedures during warranty period. This shall apply to all items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty.
- .4 At end of warranty period, transfer manufacturers' equipment and material warranties still in force to Owner.
- .5 If warranty work problems cannot be corrected immediately to Owner's satisfaction, advise Owner in writing, describing efforts to correct situation, and provide analysis of cause for problem. If necessary to resolve problem, provide at no cost services of manufacturer's engineering and technical staff at site in a timely manner to analyze warranty issues, and develop recommendations for correction, for review and approval by Owner.

1.22 INSTRUCTION TO OWNERS

- .1 Instruct the Owner's representatives in all aspects of the operation of systems and equipment.

- .2 Arrange for and pay for services of service engineers and other manufacturers' representatives required for instruction on specialized portions of the installation.
- .3 Submit to the Consultant at the time of final inspection a complete list of systems stating for each system:
 - .1 Date instructions were given to the Owner's staff.
 - .2 Duration of instruction.
 - .3 Name of persons instructed.
 - .4 Other parties present (manufacturer's representative, consultants, etc.).
- .4 Signatures of the Owner's staff stating that they properly understood the system installation, operation and maintenance requirements.

1.23 DOCUMENTATION AND SYSTEMS ACCEPTANCE

- .1 Assemble three (3) copies of operating and instruction manuals in three ring binders with index tabs each and searchable PDF in flash drive, containing this subcontractor's and suppliers names and telephone numbers.
- .2 Each manual shall contain the following data:
 - .1 A set of as-built prints.
 - .2 Letters of Owner's Instructions
 - .3 A copy of each "reviewed" shop drawing.
 - .4 Complete explanation of operation principles and sequences.
 - .5 Complete part lists with numbers.
 - .6 Recommended maintenance practices and precautions.
 - .7 Complete wiring and connections diagrams.
 - .8 Certificate of warranty.
- .3 Ensure that operating and maintenance instructions are specific and apply to the models and types of equipment provided.

1.24 OWNER'S RIGHT TO RELOCATE COMMUNICATIONS ITEMS

- .1 The Owner reserves the right to relocate telecom outlets at a later date, but prior to installation, without cost, assuming that the relocation per outlet does not exceed 3000 mm from the original location. No credits shall be anticipated where relocation per outlet of up to and including 3000 mm reduces materials, products and labour.
- .2 Should relocations per outlet exceed 3000 mm from the original location the Contract Price will be adjusted accordingly.
- .3 Necessary changes, due to lack of co-ordination, and as required and when approved, shall be made at no additional cost, to accommodate structural and building conditions. The location of conduits and other equipment shall be altered without charge to the Owner, if approved, provided the change is made before installation.

1.25 COMMUNICATIONS LIST OF MANUFACTURERS, SUBTRADES AND PRICES

- .1 At the time of tender closing, list the names of manufacturers or subtrades carried (one per item), the total cost of the Communications Works, any separate, unit and alternative prices where indicated.
- .2 If this Subcontractor neglects to list the specified or acceptable manufacturers or lists more than one manufacturer per item, or lists manufacturers not specified, the Consultant will have the option of making the selection of the manufacturer.
- .3 There will be no substitutions of named manufacturers or subtrades after tender close except as approved by the Consultant.

1.26 PHASING AND SCHEDULING OF WORK

- .1 Refer to Scope of work for a detailed description of the phasing and scheduling of the work. Execute work in accordance with the phasing and construction schedule. Provide all necessary temporary connections and equipment to provide functional, operational systems during construction period when part of the building will be occupied and construction is still continuing in other portions.

1.27 MATERIALS FURNISHED BY OTHERS

- .1 Where materials are furnished by others for installation under this Division, the Sub-Contractor shall notify the supplier of dates he will be ready for delivery as specified in the General Conditions. The Sub-Contractor shall receive, unload, handle, store, protect and insure the material until ready for actual installation. Upon receipt of material furnished by others, the Sub-Contractor shall spot-check or check the entire shipment and promptly advise the Consultant in writing of any damage and/or missing components. Any material which is subsequently lost or damaged due to negligence on the part of the Sub-Contractor shall be promptly replaced (or repaired to the satisfaction of the Owner) at the Sub-Contractor's expense.

1.28 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS.

- .1 Where the Drawings indicated equipment to be furnished by others, provide communications cabling for each unit pursuant to its shop drawings for a complete installation.

1.29 COMMUNICATIONS LEGEND & SCHEDULES

- .1 Refer to Communications Drawings for Legend and Schedules

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 NIL

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 Submit Shop Drawings, Product Data and Samples as specified herein.
- .2 Designate in the Construction Schedule, or in a separate coordination schedule, dates for submission and dates that reviewed Shop Drawings, Product Data and Sample will be required. Give due consideration for review time required by the Consultant, with a minimum of fifteen (15) working days required. The submission will be considered an acceptable submittal schedule.
- .3 All data and dimensions on shop drawings, product data and sample information to be based on units (Imperial or Metric) as shown on the contract documents.
- .4 Shop Drawings with errors or omissions and deviations will be returned "Not Reviewed".
- .5 The Contractor's responsibility for deviations in submission from the requirements of Contract Documents is not relieved by the Consultant's review of submittals, unless a deviation on the submittal is noted as such in writing and has been accepted by the Consultant.
- .6 Keep one (1) reviewed copy of each submission on site.

1.2 SHOP DRAWINGS

- .1 Review and stamp Shop Drawings, Product Data and Samples prior to submission to the Consultant. Confirm that necessary requirements have been determined and verified and that each submittal has been checked and coordinated with requirements of the Work and the Contract Documents. Submittals not stamped, signed, dated and identified as to the specific project, will be returned without being examined and shall be re-submitted when completed.
- .2 Submit drawings in a clear and thorough manner:
 - .1 Identify details by reference to drawing No. and detail, schedule or room numbers as shown on Contract Documents.
 - .2 Minimum sheet size and larger sheets to be multiples of 8½" x 11".
 - .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated. Indicate cross references to design drawings and specification.
 - .4 Adjustments to shop drawings by the Consultant do not change the cost of the work. If adjustments affect the cost of Work, advise through normal channels in writing prior to proceeding with the Work.
 - .5 Make changes in shop drawings as directed by the Consultant. Resubmit and note any revisions other than those requested.
 - .6 If only minor adjustments are made, shop drawings to be returned and fabrication and installation of work to proceed.
- .3 Determine and verify:

- .1 Field measurements.
- .2 Field construction criteria.
- .3 Catalogue numbers and similar data.
- .4 Conformance with Specifications.
- .4 Co-ordinate each submittal with requirements of the Contract documents.
- .5 Each Shop Drawing will be stamped by the Consultant in the following format:

<input type="checkbox"/> NOT REVIEWED	<input type="checkbox"/> REVIEWED
<input type="checkbox"/> RESUBMIT	<input type="checkbox"/> REVIEWED AS MODIFIED
- .6 This review by the Consultant is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which shall remain with this Subcontractor submitting same, and such review shall not relieve this Subcontractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the contract documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication.
- .7 Products not specified by MCW are reviewed to confirm compliance with services provided only. Any changes required between provided services and shop drawing requirements will be identified for coordination between trades.
- .8 Shop drawings shall be accompanied by a complete copy of the attached "Shop Drawing Submittal Sheet" Section 27 05 01, Appendix 'X'.
- .9 Begin no fabrication or work which requires submittals until return of submittals reviewed by Consultant.

1.3 PRODUCT DATA

- .1 Where specified, Manufacturer's standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data is acceptable provided there is conformance with the following:
 - .1 Clearly identify pertinent products or models.
 - .2 Show performance characteristics and capacities.
 - .3 Show dimensions and clearances required.
 - .4 Show wiring or piping diagrams and controls.
- .2 Manufacturer's standard schematic drawings and diagrams may require modifications to drawings and diagrams to provide information applicable to the Work.
- .3 Provide information specifically applicable to the Work.

1.4 SAMPLES

- .1 Samples to be labelled, of sufficient size and quantity to clearly illustrate:
 - .1 Functional characteristics integrally related parts and attachment devices.
 - .2 Full range of colour, texture and pattern.

- .2 Field Samples and mock-ups:
 - .1 Erect, at the project site and in location acceptable to the Consultant.
 - .2 Fabricate each sample and mock-up complete and finished.
 - .3 Remove mock-ups at conclusion of Work or as specified by the Consultant.

1.5 SUBMISSION REQUIREMENTS

- .1 Submit promptly to approved schedule and in sequence to prevent submission delay in the Work.
- .2 Submission requirements:
 - .1 Shop Drawings: Acceptable submissions are: PDF format via e-mail or project shared website. Paper and faxed copies are not acceptable.
 - .2 Product Data: Submit a copy for each O & M Manual.
 - .3 Samples: Submit as specified, or as requested during the shop drawing review period.

1.6 RESUBMISSION REQUIREMENTS

- .1 Make corrections or changes to the submittals noted by the Consultant and resubmit.
- .2 Shop Drawings and Product Data:
 - .1 Revise drawings or data, and resubmit as noted on the initial submittal.
 - .2 Indicate any changes which have been made other than those noted by the Consultant.
- .3 Samples: Submit new samples as required for initial submittal as soon as possible after notification of the rejection of the original submission and mark "resubmitted samples".

1.7 DISTRIBUTION

- .1 Distribute reproductions of Shop Drawings and copies of Product Data which carry the Consultant's stamp to all parties as specified by Division One General Requirements.
 - .1 Job site file
 - .2 Project record document file
 - .3 Other affected contractors
 - .4 Subcontractors
 - .5 Supplier or fabricator (as applicable)
 - .6 Operations Manual

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 NIL

END OF SECTION

SHOP DRAWING SUBMITTAL SHEET

Project: North Roads Operations Centre Date: _____

Project No. 23137 Submittal No. _____

Section: _____

Equipment Description	Quantity	Unit Price	Total Price
1. 1000W Laser Cutter	1	\$1500	\$1500
2. 500W Laser Cutter	2	\$800	\$1600
3. 200W Laser Cutter	3	\$400	\$1200
4. 100W Laser Cutter	4	\$200	\$800
5. 50W Laser Cutter	5	\$100	\$500
6. 25W Laser Cutter	6	\$50	\$300
7. 12.5W Laser Cutter	7	\$25	\$175
8. 6.25W Laser Cutter	8	\$12.5	\$100
9. 3.125W Laser Cutter	9	\$6.25	\$56.25
10. 1.5625W Laser Cutter	10	\$3.125	\$31.25
11. 781.25W Laser Cutter	11	\$1.5625	\$17.1875
12. 390.625W Laser Cutter	12	\$0.78125	\$9.375
13. 195.3125W Laser Cutter	13	\$0.390625	\$5.1875
14. 97.65625W Laser Cutter	14	\$0.1953125	\$2.734375
15. 48.828125W Laser Cutter	15	\$0.09765625	\$1.46453125
16. 24.4140625W Laser Cutter	16	\$0.048828125	\$0.78125
17. 12.20703125W Laser Cutter	17	\$0.0244140625	\$0.4149609375
18. 6.103515625W Laser Cutter	18	\$0.01220703125	\$0.2073828125
19. 3.0517578125W Laser Cutter	19	\$0.006103515625	\$0.10369140625
20. 1.52587890625W Laser Cutter	20	\$0.0030517578125	\$0.051845703125
21. 0.762939453125W Laser Cutter	21	\$0.00152587890625	\$0.0259228515625
22. 0.3814697265625W Laser Cutter	22	\$0.000762939453125	\$0.01296142578125
23. 0.19073486328125W Laser Cutter	23	\$0.0003814697265625	\$0.006480712890625
24. 0.095367431640625W Laser Cutter	24	\$0.00019073486328125	\$0.0032403564453125
25. 0.0476837158203125W Laser Cutter	25	\$0.000095367431640625	\$0.00162017822265625
26. 0.02384185791015625W Laser Cutter	26	\$0.0000476837158203125	\$0.000810089111328125
27. 0.011920928955078125W Laser Cutter	27	\$0.00002384185791015625	\$0.0004050445556640625
28. 0.0059604644775390625W Laser Cutter	28	\$0.000011920928955078125	\$0.00020252227783203125
29. 0.00298023223876953125W Laser Cutter	29	\$0.0000059604644775390625	\$0.000101261138916015625
30. 0.001490116119384765625W Laser Cutter	30	\$0.00000298023223876953125	\$0.0000506305694580078125
31. 0.0007450580596923828125W Laser Cutter	31	\$0.000001490116119384765625	\$0.00002531528472900390625
32. 0.00037252902984619140625W Laser Cutter	32	\$0.0000007450580596923828125	\$0.000012657642364501953125
33. 0.000186264514923095703125W Laser Cutter	33	\$0.00000037252902984619140625	\$0.0000063288211822509765625
34. 0.0000931322574615478515625W Laser Cutter	34	\$0.000000186264514923095703125	\$0.00000316441059112548828125
35. 0.00004656612873077392578125W Laser Cutter	35	\$0.0000000931322574615478515625	\$0.000001582205295562744140625
36. 0.000023283064365386962890625W Laser Cutter	36	\$0.00000004656612873077392578125	\$0.0000007911026477813720703125
37. 0.0000116415321826934814453125W Laser Cutter	37	\$0.000000023283064365386962890625	\$0.00000039555132389068603515625
38. 0.00000582076609134674072265625W Laser Cutter	38	\$0.0000000116415321826934814453125	\$0.000000197775661945343017578125
39. 0.000002910383045673370361328125W Laser Cutter	39	\$0.00000000582076609134674072265625	\$0.0000000988878309726715087890625
40. 0.0000014551915228366851806640625W Laser Cutter	40	\$0.000000002910383045673370361328125	\$0.00000004944391548633575439453125
41. 0.00000072759576141834259033203125W Laser Cutter	41	\$0.0000000014551915228366851806640625	\$0.000000024721957743167877197265625
42. 0.000000363797880709171295166015625W Laser Cutter	42	\$0.00000000072759576141834259033203125	\$0.0000000123609788715839385986328125
43. 0.0000001818989403545856475830078125W Laser Cutter	43	\$0.000000000363797880709171295166015625	\$0.00000000618048943579196929931640625
44. 0.00000009094947017729282379150390625W Laser Cutter	44	\$0.0000000001818989403545856475830078125	\$0.000000003090244717895984649658203125</

Contractor:

Sub-Contractor: _____

Suppliers Name:

Manufacturer:

Catalogue No.:

Variations From Tender Documents

Engineer: MCW Consultants Ltd.
207 Queen's Quay West, Suite 615
Toronto, Ontario
M5J 1A7

SECTION 27 05 01 – APPENDIX 'X'		SHOP DRAWING SUBMITTAL SCHEDULE						Page 1	
PROJECT: North Roads Operations Centre		DIVISION 27 & 28							
PROJECT No: 23137								Date: October 25, 2024.	
SECTION	DESCRIPTION	MANUFACTURER	SHOP DRAWING				DELIVERY		COMMENTS
			SUBMITTED		RETURNED		SCHED	ACTUAL	
			SCHED	ACTUAL	SCHED	ACTUAL			
27 05 26	Grounding and Bonding								
27 05 29	Hangers and Supports								
27 05 32	Firestopping								
27 05 53	Identification								
27 10 00	Testing and Documentation								
27 11 16	Cabinets, Racks, Frames and Enclosures								
27 11 19	Termination Blocks and Patch Panels								
27 13 23	Optical Fiber Backbone Cabling								
27 15 13	Copper Horizontal Cabling								
27 15 43	Copper Jack Information Outlets and Connectors								
27 15 45	Fiber Connectors, Adapters and Adapter Panels								
27 15 49	Work Area Faceplate-Wall Plates and Surface Mount Boxes								
27 16 15	Copper Patch Cords								
27 16 17	Multimode Optical Fiber Cords and Pigtails								
27 16 19	Singlemode Optical Fiber Cords and Pigtails								
28 13 00	Security Systems								
28 15 00	Intercom System								

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for the equipment and cable installations in Telecom Spaces.
- .2 Included in this section are the minimum composition requirements and installation methods for the following:
 - .1 Grounding Electrode System
 - .2 Busbars
 - .3 Bonding accessories

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .2 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .3 Material and work specified herein shall comply with the applicable requirements of the current revision of the following:
 - ANSI/TIA-568 Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-569 Telecommunications Pathways and Spaces
 - ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
 - BICSI – Telecommunications Distribution Methods Manual
 - J-STD-607-A Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - Ontario Electrical Safety Code

1.4 Submittals

- .1 A. Provide product data for the following:
 - .1 Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

Part 2 Products

2.1 Grounding Electrode System

- .1 Grounding Electrode System
 - .1 When required the Grounding Electrode System shall meet the following
 - .1 Active grounding system constantly replenishing moisture into the soil
 - .2 Provide low resistance to ground
 - .3 Provide season to season stability
 - .4 Be maintenance-free for 30 years
 - .5 Contain no hazardous materials or chemicals
 - .2 Approved Manufacturers:

2.2 Wall-mount Busbars

- .1 Telecommunications Main Grounding Busbar (TMGB)
 - .1 Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
 - .2 The busbar shall be 4" (100 mm) high and 20" (510 mm) long and shall have 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
 - .3 The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 27 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
 - .4 The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
 - .5 The busbar shall be UL Listed as grounding and bonding equipment.
- .2 Telecommunications Grounding Busbar (TGB)
 - .1 Telecommunications Grounding Busbar (TGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
 - .2 The busbar shall be 2" (50 mm) high and 12" (300 mm) long and shall have 9 attachment points (one row) for two-hole grounding lugs.
 - .3 The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 6 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
 - .4 The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
 - .5 The busbar shall be UL Listed as grounding and bonding equipment.

2.3 Bonding Accessories

- .1 Two Mounting Hole Ground Terminal Block
 - .1 Ground terminal block shall be made of electroplated tin aluminum extrusion.
 - .2 Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.

- .3 The conductors shall be held in place by two stainless steel set screws.
- .4 Ground terminal block shall have two 1/4" (6.4 mm) holes spaced on 5/8" (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
- .5 Ground terminal block shall be UL Listed as a wire connector.
- .2 Compression Lugs
 - .1 Compression lugs shall be manufactured from electroplated tinned copper.
 - .2 Compression lugs shall have two holes spaced on 5/8" (15.8 mm) or 1" (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
 - .3 Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0, as stated below.
 - .4 Compression lugs shall be UL Listed as wire connectors.
- .3 Antioxidant Joint Compound
 - .1 Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.
- .4 C-Type, Compression Taps
 - .1 Compression taps shall be manufactured from copper alloy.
 - .2 Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation requires a hydraulic crimping tool
 - .3 Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 4/0, as stated below.
 - .4 Compression taps shall be UL Listed.
- .5 Pedestal Clamp with Grounding Connector
 - .1 Pedestal clamp shall be made from electroplated tinned copper or bronze. Installation hardware will be stainless steel.
 - .2 Pedestal clamps shall be sized to fit a specific size conductor, size #6 and/or 2/0, as stated below.
 - .3 Pedestal clamp installation hardware shall be sized to attach to round and/or square raised access floor pedestals that are 1-1/8" to 1-3/4" in diameter, as stated below.
 - .4 Pedestal clamp shall provide straight (in-line) or cross (intersection) support for up to two conductors.
 - .5 Pedestal clamp shall be UL Listed as grounding and bonding equipment.
- .6 Pipe Clamp with Grounding Connector
 - .1 Pipe clamp shall be made from electroplated tinned bronze. Installation hardware will be stainless steel.
 - .2 Pipe clamp shall be sized to fit up to two conductors ranging in size from #6 to 250 MCM; conductors must be the same size.
 - .3 Pipe clamp installation hardware shall be sized to attach to pipes, sizes 1" to 6" (.75" to 6.63" in diameter), as stated below.

- .4 Pipe clamp shall be UL Listed as grounding and bonding equipment.
- .7 Equipment Ground Jumper Kit
 - .1 Kit includes one 24" L insulated ground jumper with a straight two-hole compression lug on one end and an L-shaped two-hole compression lug on the other end, two plated installation screws, an abrasive pad and a .5 ounce tube of antioxidant joint compound.
 - .2 Ground conductor is an insulated green/yellow stripe #6 AWG wire
 - .3 Lugs are made from electroplated tinned copper and have two mounting holes spaces .5" to .625" apart that accept 1/4" screws.
 - .4 Jumper will be made with UL Listed components.

Part 3 Execution

3.1 Installation

- .1 Outdoor grounding and bonding connections.
 - .1 All outdoor grounding and bonding (earthing) connections shall be accomplished using exothermic welding.
- .2 Wall-Mount Busbars
 - .1 Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
 - .2 Conductor connections to the TMGB or TGB shall be made with two-hole bolt- on compression lugs sized to fit the busbar and the conductors.
 - .3 Each lug shall be attached with stainless steel hardware after preparing the bond per manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
 - .4 The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.
- .3 Rack-Mount Busbars and Ground Bars
 - .1 When a rack or cabinet supports active equipment or any type of shielded cable or cable termination device requiring a ground connection, add a rack-mount horizontal or vertical busbar or ground bar to the rack or cabinet. The rack- mount busbar or ground bar provides multiple bonding points on the rack for rack and rack-mount equipment.
 - .2 Attach rack-mount busbars and ground bars to racks or cabinets per the manufacturer's installation instructions.
 - .3 Bond the rack-mount busbar or ground bar to the room's TMGB or TGB with appropriately sized hardware and conductor.
- .4 Ground Terminal Block
 - .1 Every rack and cabinet shall be bonded to the TMGB or TGB.
 - .2 Minimum bonding connection to racks and cabinets shall be made with a rack- mount two-hole ground terminal block sized to fit the conductor and rack and installed per manufacturer recommendations.

- .3 Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.
- .5 Pedestal Clamp
 - .1 At minimum, bond every sixth raised access floor pedestal with a minimum #6 AWG conductor to the TMGB or TGB using a pedestal clamp sized to fit the pedestal and the conductor and installed per the manufacturer's recommendations.
 - .2 If pedestal clamps are used to construct a signal reference grid, bond the signal reference grid to the TMGB or TGB and bond each rack and/or cabinet to the signal reference grid using a compression tap or similar non-reversible bonding component sized to fit both conductors.
 - .3 Remove paint between the pedestal and pedestal clamp, clean surface and use antioxidant between the pedestal and the clamp to help prevent corrosion at the bond.
 - .4 Remove insulation from conductors where wires attach to the pedestal clamp.
- .6 Pipe Clamp
 - .1 Bond metal pipes located inside the data center computer room with a minimum #6 AWG conductor to the TMGB or TGB using a pipe clamp sized to fit the pipe and the conductor and installed per the manufacturer's recommendations.
 - .2 Remove paint between the pipe and pipe clamp, clean surface and use antioxidant between the pipe and the clamp to help prevent corrosion at the bond.
 - .3 Remove insulation from conductors where wires attach to the pipe clamp.
- .7 Equipment Ground Jumper Kit
 - .1 Bond equipment to a vertical rack-mount busbar or ground bar using ground jumper per the manufacturer's recommendations.
 - .2 Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or ground bar to help prevent corrosion at the bond.

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the system of non-continuous cable supports as described in this specification.

1.2 Scope of Work

- .1 This Section includes the minimum requirements for the support structures for the Communications Systems for the project as outlined in the Bid Document.

1.3 Submittals

- .1 A. Submit product data on non-continuous cable support devices, including attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.4 Quality Assurance

- .1 Non-continuous cable supports and cable support assemblies shall be listed by Underwriters Laboratories for both Canadian and US standards (cULus).
- .2 Non-continuous cable supports shall have the manufacturers name and part number stamped on the part for identification.
- .3 Manufacturer: Company specializing in manufacturing products specified in this section with a minimum of five years documented experience in the industry, and certified ISO 9000.

1.5 Coordination

- .1 Coordinate installation of hangers, supports and cables with other trades.

Part 2 Products

2.1 Acceptable Manufacturers

- .1 A. Subject to compliance with these specifications, non-continuous cable supports shall be as manufactured by: Legrand or approved equal.

2.2 References

ANSI/TIA-568 Commercial Building Telecommunications Cabling Standard
ANSI/TIA-569 Telecommunications Pathways and Spaces
ASTM B633 Standard Specification for Electro-Deposited Coatings of Zinc on Iron and Steel
ASTM B 695-90 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A109 Standard Specification for Steel, Strip, Carbon, Cold-Rolled

ASTM A167 Standard Specification for Stainless and heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A480/A480M Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
ASTM A568 Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy Hot-Rolled and Cold-Rolled
A653 G60-Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-coated (Galvannealed) by the Hot-Dip process
ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM A682 Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled, Spring Quality
ASTM A879 Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
ASTM B117 Standard Method of Salt Spray (Fog) Testing
ASTM D610 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
NFPA 70 National Electrical Code®

2.3 Non-continuous Cable Support Systems

- .1 Non-continuous cable supports
 - .1 Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed
 - .2 Non-continuous cable supports shall have flared edges to prevent damage while installing cables
 - .3 Non-continuous cable supports sized 1-5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable
 - .4 retainer strap shall be removable and reusable and be suitable for use in air handling spaces
 - .5 Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments
 - .6 Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply
- .2 Adjustable non-continuous cable support sling
 - .1 Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 5e and higher cable, or optical fiber cable; cULus Listed.
 - .2 Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
 - .3 Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces

- .4 If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.
- .3 Multi-tiered non-continuous cable support assemblies
 - .1 Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; cULus Listed.
 - .2 If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
- .4 Non-continuous cable support assemblies from tee bar
 - .1 Tee bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
 - .2 Enter acceptable products:
- .5 Non-continuous cable support assemblies from drop wire/ceiling
 - .1 Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
 - .2 Acceptable products:
- .6 Non-continuous cable support assemblies from beam, flange
 - .1 Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
 - .2 Enter acceptable products:
- .7 Non-continuous cable support assemblies from C & Z Purlin
 - .1 Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed
 - .2 Enter acceptable products:
- .8 Non-continuous cable support assemblies from wall, concrete, or joist
 - .1 Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed
 - .2 Enter acceptable products:
- .9 Non-continuous cable support assemblies from threaded rod
 - .1 Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed
 - .2 The multi-tiered support bracket shall have a static load limit of 300 lbs.

- .3 U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts
- .4 Enter acceptable products:
- .10 Raised floor non-continuous cable support assemblies
 - .1 Fastener to raised (access) floor pedestal with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments; cULus Listed
 - .2 Enter acceptable products:
- .11 Cantilever-Mounted cable supports
 - .1 U-hook shall be able to be assembled to a wide variety of wall mount brackets.
 - .2 Spacing of individual U-hooks as needed, max of 4' to 5' apart.
 - .3 U-hooks may have the optional attachment of a cable roller for ease in pulling cables
 - .4 Enter acceptable products:
- .12 Installation accessories for non-continuous cable supports
 - .1 Cable Pulley
 - .1 Non-continuous cable supports may be used as an installation tool when a removable pulley assembly is included. The pulley shall be made of plastic and be without sharp edges. The pin and bail assembly must be able to be secured to the J-Hook during cable installation. The pulley must remain secured while cables are being pulled.
 - .2 The pin and roller assembly must be removed after cables are installed.
 - .3 Enter acceptable products:
 - .2 Cable Protector
 - .1 The protective steel tube shall fit over threaded rod and be at least 4" in length.
 - .2 The tube shall prevent damage to cables placed in or pulled through CAT- CMTM U-hooks. The tube shall not inhibit the pulling of cables.
 - .3 Enter acceptable products:

2.4 Finishes

ASTM B633 Standard Specification for Electro-Deposited Coatings of Zinc on Iron and Steel
ASTM B 695 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel

ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

Non-continuous cable supports used where only mildly corrosive conditions apply shall be stainless steel, AISI type 304.

Part 3 Execution

3.1 Installation

- .1 Installation and configuration shall conform to the requirements of the current revision levels of TIA Standards 568 and 569, Ontario Electrical Safety Code, applicable local codes, and to the manufacturer's installation instructions.
- .2 Do not exceed load ratings specified by manufacturer.
- .3 Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- .4 Follow manufacturer's recommendations for allowable fill capacity for each size non- continuous cable support.
- .5 Locate pathways per Telecommunications Drawings.

END OF SECTION

Part 1 General

1.1 Scope

- .1 This SECTION describes the requirements for furnishing and installing firestopping for fire-rated construction. This includes all openings in fire-rated floors, walls and other rated elements of construction, both blank (empty) and those accommodating items such as cables, conduits, pipes, ducts, etc.
- .2 Fireblocking for Concrete Floor or Wall Sleeved Cables.
- .3 Fireblocking for Gypsum Wall Sleeved Cables.
- .4 Fireblocking for Concrete Block Wall Sleeved Cables.

1.2 Related Documents:

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 7 Specification Sections, apply to this Section.
- .2 Cable fill calculations must be included to show the maximum cable fill ratio for each Firestopping System and cable type.

1.3 References:

- .1 Ontario Building Code
- .2 Ontario Electrical Safety Code
- .3 ANSI/TIA 569 - Telecommunications Pathways and Spaces
- .4 ANSI/NFPA 70 – National Electrical Code (NEC)
- .5 ASTM E-814 - Fire Tests of Through-Penetration Fire Stops
- .6 ASTM E-119 - Fire Tests of Building Construction and Materials
- .7 UL 1479 - Fire Tests of Through-Penetration Firestops
- .8 UL Fire Resistance Directory – Penetration Firestops System (XHE2) and Fill, Void or Cavity Materials

1.4 Submittals

- .1 Submit manufacturer's product literature and installation procedures for each type of Firestop material to be installed. Literature shall indicate product characteristics, typical uses, performance and limitation criteria and test data. Submit cured samples of firestop materials.
- .2 Shop drawings: Show typical installation details for the methods of installation. Indicate which firestop materials will be used where and when applications requirements to meet Specific jobsite conditions.
- .3 Product Data: Shall be clearly marked to indicate all technical information which specifies full compliance with requirements of this section and Contract Documents, including the following:
 - .1 Copy of UL illustration of each proposed system indicating manufacturer's approved modifications.

- .2 Each condition requiring penetration seals in proposed UL systems materials, anchorage, methods of installation and actual adjacent construction.
- .4 Applicator's Qualification Statement: Shall include a list of projects indicating required experience.

1.5 Quality Assurance

- .1 Firestopping systems (materials and design) shall conform to both Flame (F) ratings and Time (T) ratings as required by local building code and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire tests in a configuration that is representative of field conditions.
- .2 The work of this section shall be performed by a company which specializes in stalling UL Classified penetration seals required for this Project, with a minimum of five years of documented successful experience and shall be performed by skilled Workmen thoroughly experience in the necessary crafts.
- .3 Deliver material in the manufacturer's original, unopened containers or packages with the manufacturer's name, product identification, lot number, UL label, and mixing and installation instructions as applicable.
- .4 Store materials in the original, unopened containers or packages, and under conditions recommended by the manufacturer.
- .5 All firestop materials shall be installed prior to expiration of shelf life.

1.6 Coordination

- .1 Coordinate layout and installation of Firestopping System with other trades.
- .2 Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.
- .3 Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store devices and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.

Part 2 Products

2.1 Acceptable Manufacturers:

- .1 Materials and products required for work of this section shall not contain asbestos or polychlorinated biphenyls (PCB)
- .2 Manufacturer and Firestopping System must be approved by the local AHJ before purchase or installation

2.2 General

- .1 Provide and install firestopping materials to meet applicable codes and installation requirements for each firestopping application. Products using caulking, putties, wrap
- .2 strips, mortars, composite boards and/or mechanical devices shall be used as appropriate for the specific condition

2.3 Caulking

- .1 When caulking is used, provide and install flexible caulking materials. Cured firestop materials 1/8 thick shall be able around a 1" mandrell without breaking

2.4 Firestop

- .1 Do not use any firestop products which re-emulsify, leach active intumescent ingredients or dissolve when placed in water after curing. Product must withstand the passage of cold smoke, either as inherent property of the system or using a separate product included as part of the UL system or device, and designed to perform this function.

2.5 Penetration Seals

- .1 General:
 - .1 Penetration seals (firestopping material) shall be asbestos-free and capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ASTM E814 and UL 1479.
 - .2 Materials shall meet and be acceptable for use by all three model building codes, Basic/National Building Code, Building Code and Standard Building Code, per National Evaluation Service, Inc. report # NER-243.
 - .3 Materials shall meet requirements of NFPA 101 and NFPA 70.
 - .4 Materials shall be suitable for the firestopping of penetrations made by steel, glass, plastic and insulated pipe, conduit, bus duct, non-insulated pipe and ductwork.
 - .5 On insulated pipe, fire-rating classification must not require removal of insulation.
 - .6 The rating of penetration seals shall not be less than the rating of the time-rated floor or wall assembly.
 - .7 Systems shown below are examples and other equal systems may be approved or required by the AHJ.
- .2 2-hour Rated Concrete Floor:
 - .1 Penetrants: Multiple pipes
 - .2 UL System: No. 93
- .3 2-hour Rated Concrete Floor:
 - .1 Penetrants: Maximum 30" dia. Metal pipe/conduit
 - .2 UL System: No.319
- .4 1-2 –Hour Rated Gypsum Board Wall:
 - .1 Penetrant: Metal pipe/conduit
 - .2 UL System: No. 147
- .5 2-Hour Rated Gypsum Board Wall:
 - .1 Penetrant: Metal pipe/conduit
 - .2 UL System: No. 147
- .6 3-Hour Rated Concrete Wall:

- .1 Penetrant: Metal duct, maximum 2' square and maximum dimension of 30"
- .2 UL System: No. 105
- .7 Walls Below Grace:
 - .1 Penetrants: Pipe sleeves.
 - .2 Seal: Thunderline "Link Seal" casing seal

Part 3 Execution

3.1 Inspection

- .1 Examine the areas and condition where Firestops are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected by the contractor in a manner acceptable to the Architect.

3.2 Conditions Requiring Firestopping

- .1 General – Provide firestopping for conditions specified whether or not firestopping is indicated, and if indicated, whether such material is designed as insulation, safing, or otherwise.
- .2 At any point where a fire rated wall is penetrated with cable or conduit.
- .3 Penetrations
 - .1 Penetrations include conduit, cable wire, pipe, duct or other elements which pass through one or both outer surfaces of a fire rated floor, wall or partition.
 - .2 These requirements for penetrations shall apply whether or not sleeves have been provided, and whether or not penetrations are to be equipped with escutcheons or other trim. If penetrations are sleeved firestop any annular space between the sleeve and wall opening.
- .4 Provide firestopping to fill miscellaneous voids and openings in fire-rated construction as specified herein.

3.3 Installation

- .1 General
 - .1 Installation of Firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
 - .2 Apply Firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
 - .3 Coordinate with plumbing, mechanical, electrical and other trades to assure that all pipe, conduit, cable, and other items which penetrate fire-rated construction have been permanently installed prior to installation of Firestop.
- .2 Field Quality Control

- .1 Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.
 - .2 Follow safety procedures recommended in the Material Safety Data Sheets.
 - .3 Finish surfaces of firestopping which is to remain exposed in the completed work to a uniform and level condition.
 - .4 All areas of work must be accessible until inspection by the applicable Code Authorities.
 - .5 Correct unacceptable firestops and provide additional inspection to verify compliance with this specification at no additional cost.
- .3 Calculate the maximum cable fill ratio for each Firestopping System and cable type. Do not exceed the maximum fill ratio.
 - .4 Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.

3.4 Warranty

- .1 Comply with General Conditions, and include but not be limited to:
 - .1 Repairs and replacement of penetration seals which fail in joint adhesion, cohesion, abrasion, resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability, or appear to deteriorate in any other manner not clearly specified in submitted manufacturer's data as an inherent quality of the material for exposure indicated.

3.5 Cleaning

- .1 Remove spilled and excess materials adjacent to firestopping without damaging adjacent surfaces.
 - .1 Leave finished work in neat, clean condition with no evidence of spillovers or damage to adjacent surfaces.

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 Work covered by this Section shall consist of furnishing labor, equipment and materials necessary for the labeling of the telecommunications infrastructure as described on the Drawings and/or required by these specifications.

1.2 Scope of Work

- .1 This Section includes the minimum requirements for the Identification and labeling of the Communications Systems for the project as outlined in the Bid Document.

1.3 Summary

- .1 Administration of the telecommunications infrastructure includes documentation of cables, termination hardware, patching and cross-connection facilities, conduits, other cable pathways, Telecommunications Rooms, and other telecommunications spaces. All facilities shall apply and maintain a system for documenting and administering the telecommunications infrastructure.
- .2 The owner maintains a standard labeling scheme for voice and data outlets and patch panels.
- .3 Industry Labeling Standards and Conventions shall be used unless otherwise stated in the bid documents or by the Owner's Representative.
- .4 Telecommunications Infrastructure Records must be maintained in a computer spreadsheet, or in a computer database. Paper records are encouraged, but are optional. A cable record is prepared for each backbone cable. The record will show the cable name, and must describe the origin point and destination point of the cable. The cable record will record what services and/or connections are assigned to each cable pair or strand. An equipment record is prepared for services distributed from a certain piece of equipment, such as a router, or a system such as the telephone system PBX.
- .5 Installer shall maintain accurate, up-to-date Installation or Construction Drawings. At a minimum, the Installation Drawings shall show pathway locations and routing, configuration of telecommunications spaces including backboard and equipment rack configurations, and wiring details including identifier assignments.
- .6 Installer shall provide a complete and accurate set of as-built drawings. The as-built drawings shall record the identifiers for major infrastructure components including; the pathways, spaces, and wiring portions of the infrastructure which may each may have separate drawings if warranted by the complexity of the installation, or the scale of the drawings.

1.4 Quality Assurance

- .1 All labels shall be installed in a neat and workmanlike manner. All methods of labeling that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative.

- .2 Labels shall be of the quality and manufacture indicated. The labels and labeling equipment specified are based upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .3 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data labeling.
- .4 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
 - TIA-606-C Administration Standards for Telecommunications Infrastructure TIA-569 Telecommunications Pathway and Spaces
 - TIA-568 Telecommunications Cabling Standard
 - BICSI Telecommunications Distribution Methods Manual
 - UL 969 - UL Standard for Safety for Marking and Labeling Systems

1.5 Submittals

- .1 Provide product data for the following:
- .2 Manufacturers cut sheets, specifications and installation instructions for all products.

1.6 Coordination

- .1 Coordinate installation of labels with other trades.
- .2 Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store materials in original cartons and in a clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.

Part 2 Products

2.1 Manufacturers

2.2 Labels

- .1 Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969
- .2 Shall be preprinted or computer printed type. Hand written labels are not acceptable
- .3 Where insert type labels are used provide clear plastic cover over label
- .4 Outside plant labels shall be totally waterproof even when submerged
- .5 Equipment Room Copper, Fiber, and Coax Backbone Cable Labels
- .6 Equipment Room Copper, Fiber, and Coax Horizontal Cable Labels
- .7 Work Area Copper, Fiber, and Coax Riser Cable Labels
- .8 Patch Panel and Patch Cords Labels

Part 3 Execution

3.1 Identification & Labeling

- .1 The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure.
- .2 Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
- .3 All labels shall be printed or generated by a mechanical device.

3.2 Telecommunication Identifiers

- .1 Outside Plant cabling shall be clearly marked using permanent means. Outside plant shall use the following system of numbering and labeling:
 - .1 Fiber Optic:
 - .1 Identify: far-end building name, building number, fiber-type and strand-count
 - .2 Label at entrance and exit points of tunnel system and at conduit entry points between 12 inches and 36 inches from the conduit or at closet point that is clearly visible and long cable length in tunnel at 200 foot intervals.
 - .3 Label at termination panels at both ends
 - .2 Copper:
 - .1 Identify: far-end building name, building number and strand-count
 - .2 Label at entrance and exit points of tunnel system and at conduit entry points between 12 inches and 36 inches from the conduit or at closet point that is clearly visible and long cable length in tunnel at 200 foot intervals
- .2 Riser cabling shall be clearly marked using permanent means. Riser cabling shall use the following system of numbering and labeling:
 - .1 Fiber Optic:
 - .1 Identify: far-end EF / ER / TR, fiber-type and strand-count.
 - .2 When small facilities are fed from a primary location and treated as an ER, riser shall be labeled similar to Outside Plant Fiber Optic
 - .2 Copper:
 - .1 Identify: far-end EF / ER / TR and pair-count
 - .2 Termination points shall be labeled as to actual pair at every fifth (5th) pair-point.

3.3 Labeling Procedures

- .1 To be consistent with ANSI/TIA standards and industry practices, it is important that both labeling and color coding be applied to all telecommunications infrastructure components. Labeling with the unique identifier will identify a

particular component. Proper color coding will quickly identify how that component is used in the overall telecommunications infrastructure of the facility.

- .2 Visibility and durability:
 - .1 The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure.
 - .2 Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
 - .3 Labels are generally of either the adhesive or insert type. All labels must be legible, resistant to defacement, and maintain adhesion to the application surface.
 - .4 Outside plant labels shall be totally waterproof, even when submerged.
 - .5 Labels applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.
 - .6 Other types of labels, such as tie-on labels, may be used. However, the label must be appropriate for the environment in which it is used, and must be used in the manner intended by the manufacturer.
- .3 Mechanical generation
 - .1 All labels shall be printed or generated by a mechanical device.
 - .2 Handwritten labels are NOT acceptable.

END OF SECTION

Part 1 General

1.1 General Requirements

- .1 Transmission performance of structured cabling varies with length, connecting hardware, cords and total number of connections. The installer must take care to properly install the cabling components. To ensure that the installed structured cabling solution meets or exceeds the required performance it must be 'tested' or 'certified'.
- .2 The requirements for each category of cabling (Cat5e, Cat6, or Cat6A) and optical fiber optics links are located in the ANSI/TIA-568 series standards.
- .3 Test equipment must meet the requirements set forth in the ANSI/TIA-568 series Standard for Field Test Equipment. All Copper testers shall be Level III. All fiber testers shall meet the requirements in ANSI/TIA-568.
- .4 Field Power Meters shall meet the following:

Accuracy	± 0.2 dB
Resolution	0.01 dB
Precision	± 0.15 dB
- .5 The Field light source shall meet the following:

Accuracy	± 0.01 dB
Wavelength	850 ± 30 nm
	1300 ± 50 nm
	1310 ± 30 nm
	1550 ± 30 nm
- .6 The calibration on all test equipment shall be current.
- .7 The software in all test equipment shall be current.

1.2 Manufacturers

The following manufacturer's testers are approved.

- .1 FLUKE
 - .1 OptiFiber OTDR
 - .2 DTX-CLT CertiFiber Optical Loss Test Set
- .2 Ideal
 - .1 LanTEK II
 - .2 LANTEK 6/6A/7G
 - .3 FIBERTEK
- .3 Or other test equipment approved by the Owner

1.3 Systems Testing and Documentation GENERAL REQUIREMENTS

- .1 Provide installation testing of equipment where required by manufacturer's installation instructions.

- .2 Provide complete end to end testing for all copper and fiber optic systems/channels based on latest applicable standards. Document all testing and submit with final as-built submittal package.
- .3 For all controls and operating equipment, submit equipment/systems to at least three complete operational sequences, in which all equipment operations are tested, observed, and verified.
- .4 Prior to substantial completion and project acceptance inspection, submit test reports to indicated scope of startup and operational tests, with results of testing for each specified operation.

1.4 Copper Cabling System Testing

- .1 General: Copper cabling shall be tested and certified after installation as follows and as required for cable manufacturer's warranty. Twisted-pair copper cable channels shall be tested for continuity as specified below, presence of ac/dc voltage, and performance. All cabling shall be tested for conformance to horizontal cable specifications as outlined herein, and shall be tested per test set manufacturer's instructions utilizing latest firmware and software. Testing shall include all electrical parameters as specified under Product. All cables and termination hardware shall be 100 percent tested by installation contractor for defects in installation and to verify cable performance under installed conditions. All conductors of each installed cable shall be verified useable by Contractor prior to system acceptance. All cables shall be tested per contract documents, manufacturer's warranty provisions, and best industry practices. If any of these are in conflict, Contractor shall comply with most stringent requirements. All defects in cabling system installation shall be repaired or replaced to ensure 100 percent useable conductors in all cables installed, at no additional cost to Owner.
- .2 Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by test unit per manufacturers recommended procedures, and referenced to appropriate cable identification number and circuit or pair number. Any faults in wiring shall be corrected and cable re-tested prior to final acceptance.
- .3 Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to maximum distances set forth in ANSI/TIA-568-C standards and all other applicable standards specified under Division 27. Cable lengths shall be recorded, referencing cable identification number and circuit or pair number. For multi-pair cables, shortest pair length shall be recorded as length for cable.
- .4 Factory testing: Every reel of cable shall be tested by cable manufacturer for all characteristics specified for cable type in this section. This testing shall be performed using a sweep test method and include frequencies specified for cable. A test report shall be available electronically, at no additional cost, for a minimum of five (5) years from the date of manufacture. The test report shall include the reel number, the date of the test, the Lot number, and test results for Return Loss (RL), Insertion Loss (Attenuation), Pair-to-Pair NEXT, and Power Sum NEXT Pair-to-Pair ELFEXT and Power Sum ELFEXT. The test report shall show the "Worst Case Margin" for the listed transmission characteristics.

- .5 Test results: Test results shall be automatically evaluated by equipment, using most up- to-date criteria from TIA-568-C standards and all other applicable standards all other applicable standards specified under Division 27, and result shown as pass/fail. Test results shall be printed directly from test unit or from a download file using an application from test equipment manufacturer. The printed test results shall include all tests performed, expected test result and actual test result achieved.
- .6 Test reports: Test reports for all factory testing and field test reports for copper cabling installation shall be submitted to the Owner's Representative and manufacturer prior to commissioning voice and data system and final contract payment. Refer to Submittals in this Section.

1.5 Optical Fiber Cable Testing

- .1 General: Optical fiber cabling shall be tested and certified after installation as described below and as required for cable manufacturer's warranty. Fiber testing shall be performed on all fibers in completed end to end system. Testing shall consist of a bi-directional end to end test in accordance with applicable industry standards, or a bi-directional end to end test performed by TIA-455-53A and all other applicable standards. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode type glass and 1310 and 1550 nanometers for single-mode type glass. These tests shall also include continuity checking of each fiber. For spans greater than 90 meters, each tested span must test to a value less than or equal to value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be less than or equal to 2.0 decibels. The insertion loss for each mated optical fiber connector pair shall not exceed 0.40 decibels.
- .2 Pre-installation testing: Test all optical fiber cable for all fibers prior to installation of cable.
- .3 Performance testing: Where links are combined to complete a circuit between devices, Contractor shall test each link from end to end to ensure performance of system. Only a basic link test is required. Contractor can optionally install patch cords to complete circuit and then test entire channel. The test method shall be same used for test described above. The values for calculating loss shall be those defined in applicable TIA standards: Codes, Standards, and Informative References.
- .4 Attenuation testing: Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach test equipment to cable plant. The light source shall be left in place after calibration and power meter moved to far end to take measurements.
- .5 Loss budget: All fiber cabling shall be tested at both wavelengths 850 nm and 1310 nm for multimode and 1300 nm and 1550 nm for single mode. The link attenuation shall be calculated using:
 - .1 The CommScope Fiber Performance Calculator for CommScope installations or approved equal.
 - .2 The following calculation for other installations:
Link Attenuation Allowance (dB) = Cable Attenuation (dB) + Connector loss (dB) + Splice Insertion Loss (dB)
Where:

Cable attenuation (dB) = Cable attenuation (dB/km) X Length (km)
Connector loss (dB) = Number of Connector pairs X Allowable connector loss (dB)
Splice Insertion Loss (dB) = Number of Splices X Allowable Splice loss (dB)

- .6 Link loss: A mated connector to connector interface shall be considered a single connector. Loss numbers for installed link shall be calculated by taking sum of bi-directional measurements and dividing that sum by two. All links not meeting requirements of standard shall be brought into compliance by Contractor, at no additional cost to Owner.
- .7 Documentation: Following final documentation shall be submitted to the owner's representative prior to commissioning data system and final contract payment according to Submittals in this section.
- .8 Test results: Test results shall be automatically evaluated by equipment, using most up-to-date criteria from all applicable standards specified in 27 02 20.20 and result shown as pass/fail. Test results shall be printed directly from test unit or from a download file using an application from test equipment manufacturer. The printed test results shall include all tests performed, expected test result and actual test result achieved.
- .9 End to End Loss Data: final documentation shall be submitted to the owner's representative.
- .10 As Installed/ As Built Diagrams: Final documentation shall be submitted to the owner's representative.

1.6 Test Documentation

- .1 Electronic Format – if required
 - .1 Certification Test Reports shall be submitted in electronic format using the appropriate software supplied by the test equipment manufacturer. The data format should be that of the test report software (i.e. *.flw files for Fluke). The contractor shall provide any necessary software to view and evaluate the test data.
 - .2 The following list is provided as a reference:
Tester Test Report Software
Fluke LinkWare
Ideal LanTek Reporter
 - .3 One electronic copy of the Test Reports shall be provided.
- .2 Paper Format – if required
 - .1 Provide test documentation in 3-ring binders within 2 weeks after completion of project testing. Binders shall be clearly marked on outside front cover and spine with words Test Results, project name, and date of completion (month and year). Major heading tabs, Horizontal and Backbone, shall divide binder. Each major heading shall be further sectioned by test type. Within horizontal and backbone sections, divide by tabs scanner test results by category, optical fiber attenuation test results, and continuity test results. Present test data within each section in sequence listed in administration records.
 - .2 Provide test equipment by name, manufacturer, model number and last calibration date at the end of document. Unless manufacturer specifies

more frequent calibration cycle, annual calibration cycle shall be required on all test equipment used for this installation.

- .3 Test document shall detail test method used and specific settings of equipment during test. Scanner tests shall be printed on 8 1/2 by 11 inches. Hand written test results (attenuation results and continuity results) shall be documented on a suitable test form.
- .4 When repairs and re-tests are performed, note problem found and corrective action taken, and collocate in binder both failed and passed test data.

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 NIL

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 This document describes the products and execution requirements relating to furnishing and installing Balanced Twisted Pair and Fiber Optic Cabling and Components at the new or remodeled buildings.
- .2 All cables and related terminations, support and grounding hardware should be furnished, installed, wired, tested, labeled, and documented as detailed in this document.
- .3 Products specifications, general design considerations, and installation guidelines are provided in this document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types will be provided as an attachment to this document. If the bid documents are in conflict, this specification should take precedence.
- .4 The successful Vendor shall meet or exceed all requirements for the Balanced Twisted Pair and Fiber Optic Cabling and Components described in this document.

1.2 Regulatory references

- .1 All workmanship and materials shall be in full conformance with applicable building, electrical, and other codes, as determined by the authority having jurisdiction (AHJ).
- .2 All materials should be UL Listed and should be marked as such. If UL has no published standards for a particular item, then other national independent testing standards should apply and such items should bear those labels. Where UL has an applicable system listing and label, the entire system should be so labeled.

1.3 Reference list

- .1 If this document and any of the documents listed above are in conflict, then the more stringent requirement should apply. All documents listed are believed to be the most current releases of the documents. The contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- .2 This document does not replace any code, either partially or wholly. The contractor must be aware of and in compliance with local codes as determined by the authority having jurisdiction (AHJ) that may impact this project.

1.4 Approved Installation

- .1 The bidder must be a certified trained contractor of the Manufacturer. The bidder must have successfully completed all manufacturer design and installation training.

Part 2 Products

2.1 Approved Products

.1 Cabinets & Racks

- .1 Hammond Manufacturing (base design), Belden, Panduit, Hubbell or approved equal
Networking wall-mount cabinets HWC Series
Networking wall-mount low profile cabinets HLP Series (shallow closet application)

Adjustable depth center swing wall rack, HWMR Series (shallow closet application)
Specialized cabinets EN4DH and HDME Series
High-density open-rack 2-Post system DNRRHDW Series (1,500 lb)
High-density open-rack 2-Post system DRZ4 Series (2,000lb)
High-density open-rack 4-Post system DC4R Series
Server cabinets C4RR Series
Multi-media (AV) cabinets RB-AV Series
Data-center network cabinets H1 Series

.2 Power and Monitoring

- .1 Vertical Power Distribution Units (PDU). 208V, 30A, 5kW, L6-30P locked input plug, 30xC13 & 6xC19 receptacles, integral circuit breaker, environmental monitoring port.
Approved Power and Monitoring manufacturer:
Belden 9PB2-361005
Hubbell
Hammond Manufacturing
Eaton
APC
Panduit
Approved equal

.3 Heat Containment

- .1 Hammond Manufacturing (base design), Belden, Panduit, Hubbell or approved equal
Aisle containment TCS Series
Chimney containment CLCH Series

.4 Rack Accessories

- .1 Hammond Manufacturing (base design), Belden, Panduit, Hubbell or approved equal
Mounting hardware 10-32 Mounting, 12-24 Mounting,
Cage Nuts, Clip Nuts, bolt down and ganging kit Hardware
Filler/Blanking panels PBPA Series (aluminum), PBPS Series (steel),
PBFS Series (formed steel), RB-TBP Series (tool free)
2 post = RAS Series (universal rack shelf), DNRMA Series (adjustable),
DNDM Series (center mount), DNRM Series (center mount deep channel),
BRS Series (battery), RSP Series (sliding), RKBM Series (keyboard),
RMS Series (shelf/keyboard/storage combo)

4 post = ADS Series (adjustable), RSUS Series (sliding), RZVS Series (zero U / fixed), RF Series (fixed)
Grounding and bonding accessories RIK Series (isolation kit), GRDKIT Series (bonding kit), GRDBAR Series (horizontal and vertical bus bar), BUSBAR Series (modular, horizontal and vertical)

.5 Security

- .1 Hammond Manufacturing (base design), Belden, Panduit, Hubbell or approved equal
Data-center access system EL SERIES (electronic door locking handles)
Open-rack security door RSDP Series (rail mounting hinged security door), PHPF Series (rack mount locking hinged door panel), RMSC Series (hinged clear security cover)

.6 Cable Management

- .1 Hammond Manufacturing (base design), Belden, Panduit, Hubbell or approved equal
Vertical Management = RB-VCM Series, RRCM Series, FRCM Series, VFM Series,
Horizontal Management = PCMDD Series, RB-HFM Series, RB-HFMD Series, RB-HRM Series, PCMDS Series

.7 Zone Access Ceiling Box Enclosure

- .1 Hubbell ZCB7UA (base design), Belden, Panduit, Hammond or approved equal
Active zone ceiling box, ceiling flush mounted, 24"x24"x12", 7RU, plenum rated, complete with 2x20A 120V duplex receptacles, 2-gang back box, 9 CFM 12V fan and transformer, knob assemblies, fire rated foam kit for cable entries and exits, support brackets, hinged door plate, equipment mounting assemblies, lock kit and key.

2.2 Alternative Products

- .1 Alternative solutions or value-engineering opportunities may be considered. Any alternatives must be submitted in addition to the specified material for comparison purposes with a clear demonstration of how the alternatives will meet the performance, functional, and operational requirements of the solution.

Part 3 Execution

3.1 Lifetime application assurance

- .1 Manufacturer certification provides the assurance that all present and future applications engineered for the performance level of the cabling system used will work for the lifetime of the certified solution.
- .2 Should the manufacturer certified solution fail to support the application(s) designed to operate over it - whether at the time of cutover to the new cabling system, during subsequent use, or after upgrading to a newer supported application – the manufacturer Belden and the Vendor should take prompt corrective action.

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Horizontal and Backbone cable terminations installed in communications equipment rooms (Telecommunications Rooms, Equipment Rooms, or "Telecommunications Closets").
- .2 Included in this section are the minimum composition requirements and installation methods for the following:
Patch Panels

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .2 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .3 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
ANSI/TIA-568 Series Commercial Building Telecommunications Cabling Standard
ANSI/TIA-569 Telecommunications Pathways and Spaces
ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
BICSI - Telecommunications Distribution Methods Manual
CENELEC EN-50173 - Generic cabling systems
ISO/IEC 11801 - Generic cabling for customer premises
J-STD-607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
NFPA 70 National Electric Code

1.4 Submittals

- .1 Provide product data for the following:
 - .1 Manufacturers cut sheets, specifications and installation instructions for all products.

Part 2 Products

2.1 Patch Panels

- .1 Category 5e/Class D Patch Panels
 - .1 General specifications: Patch panel shall be constructed of high strength steel with black powder finish and designed for wall or 19-inch rack mounting.
 - .2 Panels shall be available in 24-port and 48-port configurations, with height of 1 Rack Unit (RU) of 44.5 millimeters (1.75 inches) for each group of 24 ports.
 - .3 The panels shall feature IDC 110-punchdown modules with a cutting ledge directly adjacent to IDCs against which the wires can be directly terminated and cut in one action.
 - .4 Removable rear mounted cable management bar.
 - .5 Accommodation for front and rear identification labels.
 - .6 Panel shall support 1 Gb network line speeds.
 - .7 Panel shall be Category 5 and 3 backward compatible.
 - .8 Panel shall comply with the standards for Category 5e/Class D patch panels listed in the TIA-568 Series Standards and ISO/IEC 11801.
 - .9 Panel shall support IEEE 802.3 1000BASE-T plus other legacy LANs and applications.
 - .10 The patch panel will comply with IEEE 802.3bt (Type 4) Power over Ethernet (PoE+) applications up to 90 watts
 - .11 Contact tines shall be plated with a minimum of 50 microns of gold.
 - .12 The panels shall support both T568A and T568B wiring map.
 - .13 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .2 Category 6/Class E Patch Panels
 - .1 General specifications: Patch panel shall be constructed of high strength steel with satin chrome finish and designed for wall or 19-inch rack mounting.
 - .2 Panels shall be available in 24-port and 48-port configurations, with height of 1 Rack Unit (RU) of 44.5 millimeters (1.75 inches) for each group of 24 ports.
 - .3 Removable rear mounted cable management bar and front and rear identification labels.
 - .4 Patch panels must be capable of connection to the CommScope Intelligent Patching solution or upgradable to connection to the CommScope Intelligent Patching Solution.
 - .5 Patch panels shall support 5 meter cables in 3 and 4 connector channels, 3 meter cables in 2 connector channels and cross connect cords down to 1 meter.
 - .6 Comply with the standards for Category 6/Class E patch panels listed in the TIA- 568 Series Standards and ISO/IEC 11801.

- .7 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .3 Category 6A/Class EA Patch Panels
 - .1 General specifications: Patch panel shall be constructed of high strength steel with satin chrome finish and designed for wall or 19-inch rack mounting.
 - .2 Panels shall be available in 24-port and 48-port configurations, with height of 1 Rack Unit (RU) of 44.5 millimeters (1.75 inches) for each group of 24 ports.
 - .3 The panels shall feature IDC 110-punchdown modules with a cutting ledge directly adjacent to IDCs against which the wires can be directly terminated and cut in one action.
 - .4 Removable rear mounted cable management bar
 - .5 Accommodation for front and rear identification labels.
 - .6 Removable rear mounted cable management bar and front and rear identification labels.
 - .7 Patch panels shall support 5 meter cables in 3 and 4 connector channels, 3 meter cables in 2 connector channels and cross connect cords down to 1 meter.
 - .8 Comply with the standards for Category 6A/Class EA patch panels listed in the TIA-568 Series Standards and ISO/IEC 11801.
 - .9 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .4 High Density Modular Patch Panels
 - .1 General specifications: Patch panel shall be constructed of high strength steel with black powder finish and designed for wall or 19-inch rack mounting.
 - .2 Panels shall be available in a 48-port configuration, with height of 1 Rack Unit (RU) of 44.5 millimeters (1.75 inches).
 - .3 Panel shall be designed for Category 6 and 6A modular snap in information Outlets.
 - .4 Removable rear mounted cable management bar and front and rear identification labels.
 - .5 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .5 Fiber Optic Shelf Panels
 - .1 General specifications: Shelves shall be constructed of high strength steel with black powder finish and designed for wall or 19-inch rack mounting.
 - .2 Shelves shall be available in multi U configurations, with height of 1 Rack Unit (RU) 44.5 mm (1.75 in), to 4 RU 177.8 mm (7 in).
 - .3 Removable rear mounted cable management bar, door or cover and front and rear identification labels.

- .4 Comply with the standards for patch panels listed in the TIA-568 Series Standards and ISO/IEC 11801.
- .5 Fiber Shelf Panels shall accept ST, SC or LC modular adapter panels or pre-terminated MPO cassettes.
- .6 The rack mount optical fiber Enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cable and support either direct connectorization or fusion slicing
- .7 Panel shall incorporate a sliding tray (in 1RU & 2RU) that removes completely from panel for ease of field terminations and splicing
- .8 Approved Manufacturer 1U, 2U and 4U shelves:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .6 Multimedia Patching Systems
 - .1 General specifications: Patch panel shall be constructed of high strength steel with black powder finish and design for wall or 19-inch rack mounting.
 - .2 Patch panels shall allow mix-and-match of shielded, UTP and fiber cassettes in any combination.
 - .3 Patch panels shall be able to hold up to 48 duplex fiber channels or 48 copper ports in a 1RU space.
 - .4 Patch panels shall accept up to 8 copper cassettes or up to 8 single height or 4 double height fiber cassettes.
 - .5 Panels shall be available in 1RU straight or angled configurations.
 - .6 Removable rear mounted cable management bar and front and rear identification labels.
 - .7 Jacks, Outlets and Adapters
 - .1 Unit shall support modular video jacks, 8P8C jacks, and fiber optic type jacks
 - .2 Comply with requirements specified for jacks corresponding to the cable and terminations specified or indicated for the patch panel.
 - .3 Colors shall be specified or selected by the Owner's Representative from the manufacturer's standard colors.
 - .8 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .7 Broadband Community Antenna Television (CATV) patch panel
 - .1 Provides for analog broadband video distribution over horizontal UTP cabling to video adapters located in the work area locations. Horizontal UTP cabling shall be category 6 or higher, as specified or indicated. Video signal transmission distances supported by the system shall be as follows for the operational frequency bandwidth of 5 to 550 megahertz:
 - .1 60 meters: 77 channels for minimum received signal level of 0 decibels referenced to millivolt
 - .2 100 meters: 28 channels for minimum received signal level of 0 decibels referenced to millivolt

- .3 100 meters: 50 channels for minimum received signal level of –10 decibels referenced to millivolt
- .2 Construction: Rack mounted base unit, 1 RU (44 millimeters [1.72 inches])
- .3 Port types:
 - .1 Input: F-type coaxial input connector (female)
 - .2 Output: 8P8C connector jacks rated as Category 6A/Class EA, Category 6/Class EA or Category 6 compliant
- .4 Port quantity: Provide mounting for 16 outlets.
- .5 Standards compliance:
UL, CSA, and IEC 950
FCC Part 76
CISPR 22

2.2 TERMINATION BLOCKS

- .1 Cat 6A 110 Type Cross-Connect Kits:
 - .1 The cross-connect kit shall be a wall-mount Category 6A 110-style wiring kit including block, base, C4 clips and labeling.
 - .2 They shall provide 110 terminations supporting voice, data, video, and Category 6A data applications when used with 4 pair UTP Category 6A rated cabling.
 - .3 The components shall be UL listed and ANSI/TIA-568.2-D compliant.
 - .4 Wall-mount 110 wiring block shall support 64 pair density with provision for ANSI/TIA-606 compliant labeling.
 - .5 The termination block shall comply with the following PoE standards
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts, IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .3 IEEE 802.3bt (Type 4) Power over Ethernet (PoE+) applications up to 90 watts
 - .4 Cisco Universal Power Over Ethernet (UPOE+) applications up to 90 watts
 - .5 Power over HDBaseTTM (POH) applications up to 100 watts
 - .6 Plastic bases and blocks must be made of fire-retardant plastic rated UL 94V-0.
 - .7 Wiring blocks must allow for termination of 22-26 AWG solid copper wire
 - .8 The block must meet Category 6A component requirements.
 - .9 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal
- .2 Cat 6 110 Type Cross-Connect Kits:
 - .1 The cross-connect kits shall be Category 6 110-style wiring kits including blocks, bases, C4 clips and labeling available for wall or rack-mount.

- .2 They shall provide 110 terminations supporting voice, security, and Category 6 data applications when used with 4 pair UTP Category 6 rated cabling.
- .3 The components shall be UL listed and ANSI/TIA-568.2-D compliant.
- .4 Wall-mount 110 wiring blocks shall support 96 and 288 pair densities with provision for ANSI/TIA-606 compliant labeling.
- .5 Rack-mount kits shall support 96 pair densities with provision for ANSI/TIA-606 compliant labeling.
- .6 The termination block shall comply with the following PoE standards
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts, IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .3 IEEE 802.3bt (Type 4) Power over Ethernet (PoE+) applications up to 90 watts
 - .4 Cisco Universal Power Over Ethernet (UPOE+) applications up to 90 watts
 - .5 Power over HDBaseTTM (POH) applications up to 100 watts
- .7 Plastic bases and blocks must be made of fire-retardant plastic rated UL 94V-0.
- .8 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal
- .3 Cat 5e 110 Type Wiring Cross connect Kits:
 - .1 The cross-connect kits shall be Category 5e 110-style wiring kits including blocks, bases, C4 or C5 clips and labeling available for wall or rack-mount.
 - .2 They shall provide 110 terminations supporting voice, security, and Category 5e data applications when used with 4 pair UTP Category 5e rated cabling.
 - .3 The 110 rack-mount panels shall mount to a 19" distribution frame or hinged wall mount bracket.
 - .4 The components shall be UL listed and ANSI/TIA-568.2-D compliant.
 - .5 Wallmount 110 wiring blocks shall support 100 pr density with provision for ANSI/TIA-606-B compliant labeling.
 - .6 Plastic bases and blocks shall be made of fire-retardant plastic rated UL 94V-0.
 - .7 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell or approved equal.

Part 3 Execution

3.1 Installation

- .1 All Patch Panels shall be installed in the racks installed in the telecommunications space.
- .2 Each patch panel shall be attached to the rack using the four (4) rack screws supplied with the panel
- .3 All Patch Panels shall be installed level and plum within the racks.
- .4 Patch Panels shall be installed per the elevation drawings for the Telecommunications space.

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of all Optical Fiber Backbone Cables called for in the Contract Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Optical Fiber Backbone Cables.
- .2 Included in this section are the minimum composition requirements and installation methods for the following:
 - Intra Building Backbone (Inside buildings (ISP))
 - Inter Building Backbone (Between buildings (OSP))

1.3 General Specifications

- .1 Cables shall be designed for Point to Point applications and shall provide a high level of protection for optical fiber installed in building applications.
- .2 Higher optical fiber count cables shall utilize a sub-unitized design with color-coded subunits for easy identification.

1.4 Cable Performance Specifications

- .1 Cables shall comply with the applicable standards per cable type:
 - .1 EN 50173; ISO/IEC 11801
 - .2 ANSI/ICEA S-83-596
 - .3 ANSI/TIA-568.3-D
 - .4 NFPA 130
 - .5 ITU-T G.657.A1 and ITU-T G.652.D compliant for Single-Mode (bend insensitive).
 - .6 ANSI/ICEA S-87-640, Standard for Optical Fiber Outside Plant Communications Cable
 - .7 Telcordia, GR-20-CORE, Generic Requirements for Optical Fiber and Optical Fiber Cable
 - .8 Telcordia, GR-409-CORE, Generic Requirements for Indoor Fiber Optic Cables
 - .9 Telcordia requirements for superior armored cable

1.5 General - Multimode Fiber

- .1 Cable shall support current and next generation LAN, SAN, and WAN applications through laser-optimized 50/125 micrometer optical fibers and shall extend distance of low-cost 850-nanometer vertical cavity surface-emitting laser (VCSEL) based electronics.
- .2 Cable shall support dual speed 1 gigabit per second/10 gigabits per second ports, allowing incremental upgrades of switches and servers with less disruption.

- .3 Optical fibers shall be differential mode delay (DMD) tested using a high-resolution test bench that exceeds fiber optic test procedure (FOTP) 220 standards and independently certified by UL.
- .4 Cable shall also support existing and legacy multi-mode applications that traditionally operate in 850 and 1300 nanometer regions.
- .5 Basis for Design Specifications: CommScope multimode optical (OM3, OM4) or singlemode fiber unless otherwise noted, in strand-count identified on Telecommunications Drawing and/or the Bid Document, and with the appropriate jacket material [OFNR, OFNP, OFN (LS)] for the pathway in which the cable will be routed.

Part 2 Products

2.1 Intra Building Backbone (ISP)

- .1 Indoor Cables - All cable shall be listed for use indoors per the Ontario Electrical Safety Code and shall meet one of the following, per bid document.
 - .1 **Indoor Riser Rated Tight Buffer** - UL-listed OFNR: Tight buffer optical fibers, aramid strength yarn, and riser-rated outer jacket.
 - .2 **Indoor Plenum Rated Tight Buffer** UL-listed OFNP cable: Tight buffer optical fibers, aramid strength yarn, and plenum-rated outer jacket.
 - .3 **Indoor Low Smoke/Zero Halogen Riser Rated Tight Buffer LSZH** cable: Solid copper conductors with non-halogen HDPE insulation and low smoke, zero halogen, compound jacket to achieve LSZH rating.
 - .4 **Indoor Armored Riser Rated Tight Buffer** - UL-listed OFCR: Tight buffer optical fibers, aramid strength yarn, a riser-rated jacket, aluminum interlocking armor with an overall riser-rated sheath jacket to provide additional protection and security.
 - .5 **Indoor Armored Plenum Rated Tight Buffer** UL-listed OFCP cable: Tight buffer optical fibers, aramid strength yarn, a plenum-rated outer jacket, aluminum interlocking armor with an overall plenum-rated sheath jacket to provide additional protection and security.

2.2 Inter Building Stranded Backbone (OSP)

- .1 All cable shall be manufactured and constructed for use in the Outside Plant Environment and shall meet one of the following, per bid document.
 - .1 Outside Plant (OSP) loose tube all dielectric - Dielectric design with MDPE sheath jacket and no metallic elements to provide environmental protection.
 - .2 Outside Plant (OSP) loose tube metallic sheath - Metallic sheath design with MDPE sheath jacket to provide environmental protection. Metallic armor of corrugated polymer coated steel tape to provide added crush protection. Armor shall meet Telcordia requirements for superior armored cable.
- .2 Buffer tubes and optical fibers

- .1 Industry standard buffer tubes stranded around a central strength member and compatible with standard hardware, cable routing, and fan-out kits.
- .2 Optical fibers shall be industry-standard color coded and separated into 12-fiber color-coded binder groups surrounded by plastic core tubes
- .3 Water blocking
 - .1 OSP Fiber Cables are available as either fully dry or dry core with gel in the buffer tubes. The bid document will specify the cable type.
 - .1 Dry water-blocking compound suitable for underground conduit, direct burial, and aerial applications in cable and buffer tubes.
 - .2 Dry water-blocking compound suitable for underground conduit, direct burial, and aerial applications with gel filled buffer tubes.

2.3 Inter Building Central Tube Backbone (OSP)

- .1 All cable shall be manufactured and constructed for use in the Outside Plant Environment and shall meet one of the following, per bid document.
 - .1 **Outside Plant (OSP) Central Tube loose tube all dielectric** - Dielectric design with medium-density polyethylene (MDPE) sheath jacket over a central buffer tube with longitudinal polyester ripcords and no metallic elements to provide environmental protection.
 - .2 **Outside Plant (OSP) loose tube metallic sheath** - Metallic sheath design with medium-density polyethylene (MDPE) sheath jacket over a central buffer tube with longitudinal polyester ripcords and metallic armor of corrugated polymer coated steel tape to provide added crush protection. Armor shall meet Telcordia requirements for superior armored cable.
- .2 Buffer tubes and optical fibers:
 - .1 Central tube of polybutylene terephthalate (PBT) material, containing all optical fibers, with 2 dielectric longitudinal outer strength members extending length of cable.
 - .2 Optical fibers shall be industry-standard color coded and separated into 12-fiber color-coded binder groups and industry-standard color coding.
- .3 Water blocking:
 - .1 OSP Fiber Cables are available as either fully dry or dry core with gel in the buffer tubes. The bid document will specify the cable type.
 - .1 Dry water-blocking compound suitable for underground conduit, direct burial, and aerial applications in cable and buffer tubes.
 - .2 Dry water-blocking compound suitable for underground conduit, direct burial, and aerial applications with gel filled buffer tubes.

2.4 Intra Building Backbone Indoor/outdoor(ISP/OSP)

- .1 Indoor/Outdoor Cables - All cable shall be listed for use indoors per the National Electrical Code (NFPA-70) and shall meet the following, per bid document.
 - .1 **Indoor Plenum Rated Tight Buffer** – UL listed OFNP: Tight buffer optical fibers, aramid strength yarn, and plenum-rated outer jacket.

- .2 **Indoor Riser Rated Tight Buffer** - UL-listed OFNR: Tight buffer optical fibers, aramid strength yarn, and riser-rated outer jacket.
- .3 **Indoor Low Smoke/Zero Halogen Riser Rated Tight Buffer** UL-listed OFN(LS) cable: Solid copper conductors with non-halogen HDPE insulation and low smoke, zero halogen, compound jacket to achieve LSZH rating

2.5 OM4 Multimode Fiber Specification

- .1 The multimode fibers shall fully meet or exceed the OM4 fiber specifications in:
- .2 ANSI/TIA-492AAAD standards
EN 50173-1:2011
ISO/IEC 11801:2010
IEC/EN 60793-2-10 (A1a fiber)
Local/National Codes and Regulations
- .3 The OM4 multimode fiber shall be manufactured with an inside vapor deposition process such as the MCVD (Modified Chemical Vapor Deposition) or PCVD (Plasma Clad Vapor Deposition) processes. Multimode fibers produced with outside vapor deposition processes, such as OVD or VAD, will not be accepted. Inside vapor deposition manufacturing processes results in superior control of Refractive Index Profile required for high bandwidth.
- .4 The OM4 Multimode Fiber SCS shall be capable of supporting, at minimum, the following IEEE Ethernet applications:

802.3j	10BASE-F 10 Mb/s
802.3j	10BASE-FL 10 Mb/s
802.3u	100BASE-FX 100 Mb/s
802.3u	100BASE-SX 100 Mb/s
802.3z	1000BASE-SX 1000 Mb/s
802.3ae	10GBASE-SR 10Gb/s
802.3aq	10GBASE-LRM 10Gb/s with EDC
802.3ba	40GBASE-SR4 40 Gb/s
802.3ba	100GBASE-SR10 100 Gb/s

- .5 Additionally, the OM4 Multimode Fiber SCS shall be capable of supporting the following Fiber Channel Applications Standards, per Technical Committee 11 of INCITS:

1GFC
2GFC
4GFC
8GFC
10GFC
16GFC

- .6 The OM4 multimode fiber shall comply with the following physical specifications:

Cladding Diameter	125 µm
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Cladding Diameter Tolerance	±1.0 µm
Cladding Non-Circularity, maximum	1%
Coating Diameter (Colored)	254 µm
Coating Diameter (Uncolored)	245 µm
Coating Diameter Tolerance (Colored)	±7 µm
Coating Diameter Tolerance (Uncolored)	±10 µm
Coating/Cladding Concentricity Error, maximum	6 µm
Core Diameter	50.0 µm
Core Diameter Tolerance	±2.5 µm
Core/Clad Offset, maximum	1.5 µm
Numerical Aperture	0.200 ± 0.015
Zero dispersion wavelength	1297 - 1316 nm
Zero dispersion slope	≤ 0.105 ps/nm 2-km
Maximum DMD (note: must comply with at least one of the 6 templates specified below 850 nm 1300 nm)	Meets or exceeds TIA-492AAAC-A and IEC 60793-2-10 A1a.2 See attached templates 0.88 ps/m

- .7 The OM4 multimode fiber shall meet the following requirements:

Maximum Fiber Cabled Loss	3.0 dB/km at 850 nm* 1.0 dB/km at 1300 nm*
Minimum Effective Modal Bandwidth	4700 MHz.km at 850 nm (DMD, laser) 500 MHz.km at 1300 nm (DMD, laser)
Minimum overfilled Modal Bandwidth	3500 MHz.km at 850 nm (OFL) 500 MHz.km at 1300 nm (OFL)
Operating Temperature Range (cabled fiber)	-20°C to 50°C (-4°F to 122°F)*
Storage Temperature Range (cabled fiber)	0°C to 50°C (32°F to 122°F) for LSZH -40°C to 65°C (-40°F to 149°F) for others
Maximum Pulling Tension	90 kg
Minimum Tensile Strength	0.7 GPa (100,000 psi)

THIS VALUE REFLECTS CABLED FIBER LOSS. UN-CABLED FIBER VALUES WILL NOT BE ACCEPTED

- .8 The OM4 multimode fibers shall be color coded to facilitate individual fiber identification. Color coding shall follow industry standard TIA-598-C Optical Fiber Cable Color Coding
- .9 The coating shall be mechanically strippable.

- .10 The OM4 fiber shall meet a minimum of one of the DMD templates listed below, accounting for the wider inner and outer mask specifications when compared with TIA 492AAAc and IEC 60793-2-10 standards:
- .11 Differential Mode Delay Testing
The OM4 multimode fiber shall be tested in accordance with: IEC/EN 60793-1-49
TIA-455-220-A
TIA-492AAAC-A
- .12 The following additional enhancements to the DMD tests must be made to ensure high bandwidth:

Enhancement to IEC/EN 60793-1-49 and ANSI/TIA-492AAAC-A standards	
Parameters	Test Requirement
Speed of Laser	5 ps pulse width
Scan Resolution (Radial Increment)	1 μ m
Inner Mask Radial Coverage	0 – 18 μ m (no central hole)
Number of Quadrants Tested	4 quadrants
Test Length	300- 550 meters

- .13 The Cable Manufacturer must have the capability to test DMD for cabled product. Third party verification of the DMD test bench must be provided with the bid response.

2.6 OM3 Multimode Fiber Specification

- .1 The OM3 Multimode Fiber SCS shall comply with the following standards
ANSI/TIA-568-C
EN 50173-1:2011
EN 50173-2:2010
IEC 60603-7-4
IEEE 802.3 applications as outlined in section (b) ISO/IEC 11801:2010
Local/National Codes and Regulations
- .2 The OM3 Multimode Fiber SCS shall be capable of supporting, at minimum, the following IEEE Ethernet applications:

802.3j	10BASE-F 10 Mb/s
802.3j	10BASE-FL 10 Mb/s
802.3u	100BASE-FX 100 Mb/s
802.3u	100BASE-SX 100 Mb/s
802.3z	1000BASE-SX 1000 Mb/s
802.3ae	10GBASE-SR 10Gb/s
802.3aq	10GBASE-LRM 10Gb/s with EDC
802.3ba	40GBASE-SR4 40 Gb/s
802.3ba	100GBASE-SR10 100 Gb/s

- .3 Additionally, the OM3 Multimode Fiber SCS shall be capable of supporting the following Fiber Channel Applications Standards, per Technical Committee 11 of INCITS:

1GFC
2GFC
4GFC
8GFC
10GFC
16GFC

- .4 The multimode fibers shall fully meet or exceed the OM3 fiber specifications in:
ANSI/TIA-492AAAC standards
EN 50173-1:2011
IEC/EN 60793-2-10 (A1a fiber)
ISO/IEC 11801:2010
- .5 The OM3 multimode fiber shall be manufactured with an inside vapor deposition process such as the MCVD (Modified Chemical Vapor Deposition) or PCVD (Plasma Clad Vapor Deposition) processes. Multimode fibers produced with outside vapor deposition processes, such as OVD or VAD, will not be accepted. Inside vapor deposition manufacturing processes results in superior control of Refractive Index Profile required for high bandwidth.
- .6 The OM3 multimode fiber shall comply with the following physical specifications:

Cladding Diameter	125 µm
Cladding Diameter Tolerance	±1.0 µm
Cladding Non-Circularity, maximum	1%
Coating Diameter (Colored)	254 µm
Coating Diameter (Uncolored)	245 µm
Coating Diameter Tolerance (Colored)	±7 µm
Coating Diameter Tolerance (Uncolored)	±10 µm
Coating/Cladding Concentricity Error, maximum	6 µm
Core Diameter	50.0 µm
Core Diameter Tolerance	±2.5 µm
Core/Clad Offset, maximum	1.5 µm
Numerical Aperture	0.200 ± 0.015
Zero dispersion wavelength	1297 □ 1316 nm
Zero dispersion slope	≤ 0.105 ps/nm ² -km
Maximum DMD (note: must comply with at least one of the 6 templates specified below)	Meets or exceeds TIA-492AAAC-A and IEC 60793-2-10 A1a.2
850 nm	See attached templates
1300 nm	0.89 s/m

- .7 The OM3 multimode fiber shall meet the following requirements:

Maximum Fiber Cabled Loss	3.0 dB/km at 850 nm* 1.0 dB/km at 1300 nm*
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Minimum Bandwidth	2000 MHz.km at 850 nm (DMD, laser) 500 MHz.km at 1300 nm (DMD, laser) 1500 MHz.km at 850 nm (OFL) 500 MHz.km at 1300 nm (OFL)
Operating Temperature Range (cabled fiber)	-20°C to 50°C (-4°F to 122°F)*
Storage Temperature Range (cabled fiber)	0°C to 50°C (32°F to 122°F) for LSZH -40°C to 65°C (-40°F to 149°F) for others
Maximum Pulling Tension	90 kg
Minimum Tensile Strength	0.7 GPa (100,000 psi)

THIS VALUE REFLECTS CABLED FIBER LOSS. UN-CABLED FIBER VALUES WILL NOT BE ACCEPTED

- .8 The OM3 multimode fibers shall be color coded to facilitate individual fiber identification. Color coding shall follow industry standard ANSI/TIA-598-C Optical Fiber Cable Color Coding
- .9 The coating shall be mechanically strippable.
- .10 The OM3 fiber shall meet a minimum of one of the DMD templates listed below, accounting for the wider inner and outer mask specifications when compared with TIA 492AAAc and IEC 60793-2-10 standards:

Template	850 nm DMD-Inner Mask (ps/m) Radius from 0 to 18 µm)	850 nm DMD-Outer Mask (ps/m) Radius from 0-23 µm
1	≤ 0.23	≤ 0.70
2	≤0.24	≤ 0.60
3	≤0.25	≤ 0.50
4	≤0.26	≤ 0.40
5	≤0.27	≤ 0.35
6	≤0.33	≤ 0.33

- .11 The OM3 multimode fiber shall be tested in accordance with:
IEC/EN 60793-1-49
ANSI/TIA-455-220-A
ANSI/TIA-492AAAC-A
- .12 The following additional enhancements to the DMD tests must be made to ensure high bandwidth:

Enhancement to IEC/EN 60793-1-49 and ANSI/TIA-492AAAC-A standards	
Parameters	Test Requirement
Speed of Laser	5 ps pulse width
Scan Resolution (Radial Increment)	1 µm
Inner Mask Radial Coverage	0 – 18 µm (no central hole)
Number of Quadrants Tested	4 quadrants
Test Length	3061 meters

- .13 Third party verification of the DMD test bench must be provided with the bid response.

2.7 OS2 Single-mode 8.3 Micrometer Fiber Specification

- .1 The OS2 Single-mode Fiber SCS shall comply with the following standards
ANSI/TIA-568-C
EN 50173-1:2011
EN 50173-2:2010
IEC 60603-7-4
IEEE 802.3 applications as outlined in section (iii) ISO/IEC 11801:2010
Local/National Codes and Regulations
- .2 The OS2 optical fiber glass shall be manufactured from ultra-pure synthetic silica glass. Single-mode fibers manufactured from natural quartz will not be accepted.
- .3 The OS2 Single-mode Fiber SCS shall be capable of supporting, at minimum, the following IEEE Ethernet applications:

100M	100BASE-LX10
1G	1000BASE-LH
	1000BASE-BX10
	1000BASE-LX10
	1000BASE-PX10-D
	1000BASE-PX10-U
	1000BASE-PX20-D
	1000BASE-ZX
10G	10GBASE-LR
	10BASE-LX4
	10GBASE-ER
40G	40GBASE-LR4
100G	100GBASE-LR4

- .4 The OS2 single-mode Fiber SCS shall be capable of supporting the following Fiber Channel Applications Standards, per Technical Committee 11 of INCITS:

1GFC
2GFC
4GFC
8GFC
10GFC
16GFC

- .5 The OS2 single-mode fibers shall fully meet or exceed the specifications in: EN 50173-1:2011
ISO/IEC 11801:2010
IEC/EN 60793-2-50 (b1.3 fiber)
ANSI/TIA-492CAAB
ITU-T G.652.D
- .6 The OS2 single-mode fiber shall comply with the following physical specifications:

Physical Characteristics	
Cladding Diameter	125.0 ± 0.7 µm
Core/Clad Offset	≤ 0.5 µm
Coating Diameter (Uncolored)	245.0 ± 10 µm
Coating Diameter (Colored)	254.0 ± 7 µm
Coating/Cladding Concentricity Error, Max.	12 µm
Clad Non-Circularity	≤ 1.0 %

- .7 The OS2 single-mode fiber shall comply with the following mechanical specifications:

Mechanical Characteristics	
Proof Test	100 kpsi (0.69 Gpa)
Coating Strip Force	0.3 – 2.0 lbf (1.3 – 8.9 N)
Fiber Curl	≥ 4 m
Dynamic fatigue Parameter (nd)	≥ 18
Macrobending, Max. (100 turns)	0.05 dB (1,310/1550 nm @50mm) 0.05 dB (1,625 nm @ 60 mm)
Macrobending, Max. (1 turn @32 mm mandrel)	0.05 @1,550 nm

- .8 The OS2 single-mode fiber shall comply with the following mechanical specifications:

Optical Characteristics, Wavelength Specific				
	1310 nm	1385 nm	1550 nm	
Max Attenuation Loose Tube Cable	0.34 dB/km	0.31 dB/km	0.22 dB/km	
Max Attenuation Tight Buffer Cable	0.50 dB/km	0.50 dB/km	0.50 dB/km	
Mode Field Diameter	9.2 ± 0.3 µm	9.6 ± 0.6 µm	10.4 ± 0.5 µm	
Group Refractive Index	1.467	1.468	1.468	
Dispersion, Max.	3.5 ps/(nm-km) from 1,285 to 1,330 nm		18 ps/(nm-km)	

- .9 The OS2 single-mode fiber shall comply with the following optical and environmental specifications:

Optical Characteristics, General	
Points defects, Max.	0.10dB
Cut-Off Wavelength	≤ 1260
Zero Dispersion Wavelength	1,302 – 1,322 nm
Zero Dispersion Slope, max.	0.090 ps/[km-nm-nm]
Polarization Mode Dispersion Link Design Value	≤ 0.06 ps/sqrt (km)
Backscatter Coefficient	-79.6/-82.1 dB @ 1310/1550 nm
Index of Refraction	1.466/ 1.467 @ 1310/1550 nm

Environmental Characteristics	
Temperature Dependence -76°F to 185°F (-60°C to 85°C)	≤ 0.05dB
Temperature humidity Cycling 14°F to 185°F (-10°C to 85°C) up to 95% RH	≤ 0.05dB
Water Immersion, 73.4°F (23°C)	≤ 0.05dB
Heat Aging, 185°F (85°C)	≤ 0.05dB

2.8 Backbone Cabling

- .1 Approved Manufacturer: CommScope, Belden, Panduit, Hubbell, Leviton or approved equal

Part 3 Execution

3.1 Installation

- .1 General - Inter and Intra Building Fiber Backbone Cable
 - .1 Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any unique codes or requirements governed by the region where the work is to be performed.
 - .2 Provide all necessary products for installation of Fiber Backbone cabling to include cable attachments, etc.
 - .3 Where multiple cables are housed in conduits, fiber backbone cables shall be installed in a separate corrugated "inner duct" pathway inside the shared conduit.
 - .4 Backbone cable shall be installed following industry standard practices.
 - .5 Contractor shall not exceed the maximum pulling tension or the minimum bending radius for fiber cables per manufacturer's specifications.
 - .6 All installations shall comply with:
 - ANSI/TIA-568 Series Commercial Building Telecommunications Cabling
 - Standard ANSI/TIA-569 Telecommunications Pathways and Spaces
 - ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
 - ANSI-J-STD-607 Joint Standard for Commercial Building Grounding (Earthing)
 - and Bonding Requirements for Telecommunications
 - BICSI Telecommunications Distribution Methods Manual NFPA 70
 - National Electric Code
- .2 Backbone Cable Testing
 - .1 Complete end-to-end test results for all Fiber Optic cables installed are required.
 - .2 All fiber optic cable must be visually inspected and optically tested on the reel upon delivery to the installation site. Using an Optical Time Domain Reflectometer (OTDR), an access jumper with like fiber, a pigtail, and a mechanical splice, all fibers shall be tested for continuity and attenuation.

- .3 Testing for continuity and attenuation on the reel must confirm factory specifications to ensure that the fiber optic cable was not damaged during shipment. The test results must match the results of the factory-attached tag on the reel, or the fiber shall not be used. Reel data sheet must be provided showing test results.
- .4 End to end (bi-directional) test measurements shall be provided for single-mode and multimode fibers (2 wavelengths per test are required). Test results must be submitted for review as part of the installation inspection requirements. Test results shall be in paper form and electronic form, and must contain the names and signatures of the technicians performing the tests.
- .5 Testing shall be performed on 100% of the fibers in the completed end-to-end system. TIA-568, provides the technical criteria and formulae to be used in fiber optic testing. Note however, that all UH fiber must be tested, rated and guaranteed for Ethernet GigaSPEED 1000B-X performance.
- .6 Additionally, all fiber optic cable links must pass all installation and performance tests both recommended and mandated by the cable manufacturer.
- .7 The Owner is to be notified at least 24 hours prior to testing to allow observation at the Owner's discretion. If the Owner confirms his intention to observe, a reasonable starting time shall be agreed upon. Should the Owner not be present at the scheduled commencement time, the Contractor may begin testing as scheduled.
- .8 Testing Format: Test Results must be submitted in two (2) formats. First, must be original file(s) down loaded from tester. Second, the file must be cohesively placed in Excel format with the following fields:
ER/TR RM # / RM # of drop / Port # / all relevant test information in as many fields as necessary.
- .9 All test results are to be recorded and submitted to the Owner.
- .3 Cable and Termination Panel Labeling Backbone Cable Testing Label the installed cables in accordance with Section 27 05 53
- .4 Cable Support
 - .1 Provide cable supports and clamps to attach cables to backboards and walls.
 - .2 Backbone cables spanning more than three (3) floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors.
 - .3 Attach horizontal and vertical backbone cables at 2 foot intervals using Owner approved supports; such as D-rings or jumper troughs utilized for wire management.
 - .4 Attach cables to manhole racks using Owner approved methods
 - .5 Backbone cabling shall be secured to the cable/ladder tray following manufacturer recommended procedures, and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of all Copper Horizontal Cabling applications called for in the Bid Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Copper Horizontal Cables.
- .2 Horizontal cable shall consist of Category 5e, 6 or 6A copper cable for all Data and Voice applications.

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .2 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .3 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
 - ANSI/TIA-568 Series Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-568.1-E – Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-568.2-E - Balanced Twisted-Pair Telecommunications Cabling and
 - ANSI/TIA-569 Telecommunications Pathways and Spaces
 - ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
 - ANSI-J-STD-607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - BICSI – Telecommunications Distribution Methods Manual Components Standards
 - NFPA 70 – National Electric Code
 - ISO/IEC 11801 - Generic Cabling for Customer Premises
 - CENELEC EN-50173 - Generic Cabling Systems

1.4 Cable Construction (by Type):

- .1 Listed CMR(FT4) cable: Solid copper conductors with high-density polyolefin insulation and an overall low smoke polyvinyl chloride (PVC) jacket to achieve a riser (i.e., non- plenum) rating by applicable NEC requirements.
- .2 Listed CMP(FT6) cable: Solid copper conductors with fluorinated ethylene propylene (FEP) insulation and an overall low smoke PVC jacket to achieve plenum rating by applicable NEC requirements.

- .3 LSZH cable: Solid copper conductors with non-halogen high-density polyethylene (HDPE) insulation and a low smoke, zero halogen, compound jacket to achieve a LSZH rating by applicable IEC standards
- .4 LC cable: Solid copper conductors with FEP fluoropolymer insulation and overall FEP fluoropolymer jacket to achieve CMP 50 rating by UL standards
- .5 OSP outdoor cable rated for wet locations: Solid copper conductors with polyethylene insulation.

1.5 Submittals

- .1 Provide product data for the following:
 - .1 Manufacturers cut sheets, specifications and installation instructions for all products.

1.6 Coordination

- .1 Coordinate layout and installation of cable tray with other trades.

Part 2 Products

2.1 Data/Voice Communications Horizontal Cabling (Category 3/Class C)

- .1 Category 3 horizontal cabling shall not be used for Data Communication cable. Category 3 cabling may be used for telephone cable for special instances where ANALOG ONLY service is required and is specified in the bid document.
 - .1 All Cables shall be of round construction
 - .2 Each cable shall contain 4 to 100 color coded pairs as required in the bid document.
 - .3 Cable shall be listed for the environment where it will be installed (Plenum, Riser, LSZH, etc.)
 - .4 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .2 Category 3 Cabling shall comply with the following application standards:
 - .1 Voice, facsimile, modem, Switched 56, T-1, and ISDN. 2. RS-232, RS-422, and RS-485.
 - .2 IEEE 802.3 1BASE5, 10BASE-T, 100BASE-T, and 1000BASE-T.
 - .3 IEEE 1394B transfer mode S100.
 - .4 IEEE 802.5 at 4 megabits per second and 16 megabits per second at 100 meters (328 feet).
 - .5 TP-PMD technology at 100 megabits per second.
 - .6 ATM at 155 megabits per second and 622 megabits per second using parallel transmission schemes.
- .3 Category 3 Cabling shall comply with following BAS application specifications:
 - .1 Operating voltages for dry locations: 0 to 30 Vac at 60 hertz, 0 to 70.7 Vac for audio frequencies, and 0 to 60 Vdc

- .2 Operating currents at 25 degrees C (77 degrees F) ambient temperature
 - .1 One current-carrying pair per cable: 1.5 amperes on each conductor
 - .2 Two to Four current-carrying pairs per cable: 3.36 amperes for all pairs
 - .3 Audio frequencies and 1 current-carrying pair per cable: 1 ampere on each conductor

2.2 Data Communications Horizontal Cabling (Category 5e/Class D)

- .1 Category 5 Enhanced (5e) Unshielded Twisted-Pair (UTP) Cable
 - .1 All Cables shall be of round construction
 - .2 Each cable shall contain 4pr 24awg color coded conductors
 - .3 Cable shall be listed for the environment where it will be installed (Plenum/FT6, Riser/FT4, LSZH, etc.)
 - .4 Plenum (CMP/FT6) and riser (CMR/FT4) cables shall be cULus listed to UL 444 - CAN/CSA C22.2 No. 214.
 - .5 CMP/FT6 cable shall have an operating temperature range of -20°C to +75°C. CMR/FT4 cable shall have an operating temperature range of -20°C to +60°C.
 - .6 The cable shall support the following POE standards when installed according to Manufacturer's recommendations.
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts
 - .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .7 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal

2.3 Data Communications Horizontal Cabling (Category 6/Class E)

- .1 Category 6/Class E Unshielded Twisted-Pair (UTP) Cable
 - .1 All Cables shall be of round construction
 - .2 Each cable shall contain 4pr 24awg color coded conductors
 - .3 Cable shall be listed for the environment where it will be installed (Plenum, Riser, LSZH, etc.)
 - .4 Plenum (CMP/FT6) cables shall be cULus listed to UL 444 - CAN/CSA C22.2 No. 214. Riser (CMR/FT4) cables shall meet UL 1666 Fire rating.
 - .5 CMP/FT6 cable shall have an operating temperature range of -20°C to +75°C. CMR/FT4 cable shall have an operating temperature range of -20°C to +60°C.
 - .6 The cable shall support the following POE standards when installed according to Manufacturer's recommendations.

- .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
- .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts
- .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
- .7 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal

2.4 Data Communications Horizontal Cabling (Category 6A/Class EA)

- .1 Category 6 Augmented (6A)/Class EA Unshielded Twisted-Pair (UTP) Cable
 - .1 All Cables shall be of round construction
 - .2 Each cable shall contain 4pr 23awg color coded conductors
 - .3 Cable shall be listed for the environment where it will be installed (Plenum, Riser, LSZH, etc.)
 - .4 Cable shall be cULus listed to UL 444 - CAN/CSA C22.2 No. 214 and be RoHS Compliant.
 - .5 Cable shall have an operating temperature range of -20°C to +75°C.
 - .6 The cable shall support the following POE standards when installed according to Manufacturer's recommendations.
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts
 - .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .4 Cisco Universal Power Over Ethernet (UPOE) applications up to 60 watts
 - .5 IEEE 802.3bt (Type 4) Power over Ethernet (PoE+) applications up to 90 watts
 - .6 Power over HDBaseTTM (POH) applications up to 100 watts
 - .7 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal

2.5 Data Communications Horizontal Cabling COLOR

- .1 Data drop cables shall be in Blue.
- .2 Voice cables shall be in Green.
- .3 Wireless Access Point cables shall be in Orange.
- .4 Camera cables shall be in Yellow.
- .5 Intercom cables shall be in Red.
- .6 Clock cables shall be in Black.

- .7 Public Address cables shall be in White.
- .8 All other cables not list above shall be in Violet.

Part 3 Execution

3.1 Installation

- .1 Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any unique codes or requirements governed by the region where the work is to be performed.
- .2 Cable shall be installed following industry standard practices.
- .3 Horizontal cabling shall be installed from the work area outlet location to the nearest Telecommunications Space.
- .4 Horizontal cabling shall be terminated on a patch panel in the telecommunication space which is the same category rating as the Cable. i.e. Cat 6 cable terminates on Cat 6 panels.
- .5 Contractor shall not exceed the maximum pulling tension or the minimum bending radius for twisted pair cables per manufacturer's specifications.
- .6 Contractor shall test all horizontal links per the ANSI/TIA-568 Requirements.
- .7 Contractor shall provide PoE extender for all horizontal cablings exceed 90m at no additional cost to the Owner.

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of all Jack/Information outlets and connections called for in the Bid Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Jack/Information outlets and Connectors.
- .2 The channel performance for the installation shall meet or exceed the requirements of ANSI/TIA-568 and ISO/IEC 11801 for the specified Category.
- .3 The Jack/Information outlets shall match the category of the cabling
- .4 All jacks/information outlets shall meet UL 94 V-O

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative.
- .2 Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .3 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .4 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
 - ANSI/TIA-568 Series Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-569 Telecommunications Pathways and Spaces,
 - ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
 - BICSI Telecommunications Distribution Methods Manual
 - J-STD-607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - NFPA 70 National Electric Code
 - ISO/IEC 11801
 - CENELEC EN-50173

1.4 Submittals

- .1 Provide product data for the following:
 - .1 Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

1.5 Coordination

- .1 Coordinate installation of Jack/Information outlets and connectors with other trades.

Part 2 Products

2.1 General

- .1 All products will be compliant to RoHS 2002/95/EC
- .2 All products will be designed, manufactured and/or distributed under this quality management system: ISO 9001:2008
- .3 Telecommunications jacks shall be 8-position/8-conductor modular outlets accepting industry standard modular RJ45 type plugs and insulation displacement conductor (IDC) terminations.
- .4 The Universal design shall support T568A and T568B wiring and shall have universal wiring labels, including color-coded insert identification labels to ensure accurate identification.
- .5 Provide crosstalk cancellation with compensation and alien crosstalk mitigation using printed wiring board materials and compensation technology.
- .6 Jack shall be backward compatible with lower category cords and cables.
- .7 Low-profile wire cap shall protect against contamination and secure connection. Jacks shall be suitable for:
 - .1 Modular patching applications or as modular TO
 - .2 Installation without special faceplates at either 45- or a 90-degree angle in manufacturer's modular faceplates and frames, including those on surface- mounted boxes
- .8 Electrical Specifications
 - .1 Contact Resistance Variation, maximum: 20 mOhm
 - .2 Contact Resistance, maximum: 100 mOhm
 - .3 Current Rating: 1.5 A @ 20 °C, 1.5 A @ 68 °F
 - .4 Dielectric Withstand Voltage, RMS, conductive surface: 1500 Vac @ 60 Hz
 - .5 Dielectric Withstand Voltage, RMS, contact-to-contact: 1000 Vac @ 60 Hz
 - .6 Insulation Resistance, minimum: 500 MOhm
- .9 Environmental Specifications
 - .1 Flammability Rating: UL 94 V-0
 - .2 Operating Temperature: -10 °C to +60 °C (+14 °F to +140 °F)
 - .3 Relative Humidity: Up to 95%, non-condensing
 - .4 Safety Standard: cUL, UL
 - .5 Storage Temperature: -40 °C to +70 °C (-40 °F to +158 °F)
- .10 Mechanical Specifications

- .1 Conductor Type: Solid
- .2 Material Type: Copper alloy, High-impact, flame retardant, thermoplastic
- .3 Outlet/Module Contact Plating: Precious metals
- .4 Plug Insertion Life, minimum: 750 times
- .5 Plug Insertion Life, test plug: IEC 60603-7 compliant plug
- .6 Plug Retention Force, minimum: 30 lbf, 133 N
- .7 Rear Termination Contact Plating: Precious metals
- .8 Rear Termination Type: IDC
- .9 Wiring: T568A or T568B
- .10 Can be mounted either at 90 degrees (straight) or 45 degrees (angled)

2.2 Category 5 Enhanced (5e)/Class D Outlets

- .1 The modular connector shall be independently tested and verified by a Nationally Recognized Testing Laboratory to meet or exceed the Category 5e component performance requirements of ANSI/TIA-568.2-D and ISO/IEC 11801 from 1 MHz to 100 MHz to meet or exceed the IEEE 802.3 standard for 1000BASE-T network performance.
- .2 The connector module shall be third party certified to meet the IEC 60512-99-002 standard for support of IEEE 802.3bt Type 4 PoE (90 watt) applications.
- .3 The connector module will exceed IEEE 802.3bt standard to support up to 0.5 amps per conductor (100 watts) continuously
- .4 The connector module shall utilize an engineered tine geometry to prevent POE arcing damage due to plug removal cycles from occurring at the critical contact-mating zone between the plug and connector module tines.
- .5 The eight-position connector module shall utilize a method of tine tensioning that
 - .1 Prevents contact bouncing and arcing at the critical contact-mating zone between the plug and connector module tines.
 - .2 Prevents six-position modular plug insertion from damaging either the cord or the module.
- .6 Contact tines shall be plated with a minimum of 50 microns of gold.
- .7 All plastics used in construction of connector bodies shall be fire retardant with a UL flammability rating of 94V-0.
- .8 Connector Module shall comply with UL 2043 as suitable for installation in plenum spaces.
- .9 Backward compatible with Category 5 and 3 cords
- .10 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell or approved equal

2.3 Category 6/Class E Outlets

- .1 Electrical performance guaranteed to meet or exceed TIA-568-C.2 Category 6 and ISO/IEC Category 6/Class E specifications.

- .2 The modular connector shall be independently tested and verified by a Nationally Recognized Testing Laboratory to meet or exceed the Category 6 component performance requirements of ANSI/TIA-568.2-D and ISO/IEC 11801 from 1 MHz to 250 MHz to meet or exceed the IEEE 802.3 standard for 1000BASE-T network performance.
- .3 The connectors shall also be in compliance with US National Electrical Codes; compliant with ANSI/TIA-1096-A (formerly FCC Part 68); UL listed; and independently verified.
- .4 The connector module shall be third party certified to meet the IEC 60512-99-002 standard for support of IEEE 802.3bt Type 4 PoE (90 watt) applications.
- .5 The connector module will exceed IEEE 802.3bt standard to support up to 0.5 amps per conductor (100 watts) continuously
- .6 The connector module shall utilize an engineered tine geometry to prevent POE arcing damage due to plug removal cycles from occurring at the critical contact-mating zone between the plug and connector module tines.
- .7 The eight-position connector module shall utilize a method of tine tensioning that
 - .1 Prevents contact bouncing and arcing at the critical contact-mating zone between the plug and connector module tines.
 - .2 Prevents six-position modular plug insertion from damaging either the cord or the module.
- .8 Contact tines shall be plated with a minimum of 50 microns of gold.
- .9 Optional Plastic Icons and Dust Covers available
- .10 Backward compatible with Category 5e, 5 and 3 cords and cables, however optimal performance achieved when used with same manufacturer patch cords.
- .11 Can support network line speeds in excess of 1 gigabit per second.
- .12 Qualifies for a lifetime product and applications assurance warranty when included as part of a certified channel.
- .13 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell or approved equal

2.4 Category 6 Augmented (6A)/Class EA Outlets

- .1 The modular connector shall be independently tested and verified by a Nationally Recognized Testing Laboratory to meet or exceed the Category 6A component performance requirements of ANSI/TIA-568-C.2 and ISO/IEC 11801 from 1 MHz to 500 MHz to support the IEEE 802.3an standard for 10GBASE-T network performance.
- .2 The connector shall also be in compliance with US National Electrical codes; compliant with ANSI/TIA-1096-A; cUL Listed; and independently verified.
- .3 The connector module shall be third party certified to meet the IEC 60512-99-002 standard for support of IEEE 802.3bt Type 4 PoE (90 watt) applications.
- .4 The connector module will exceed IEEE 802.3bt standard to support up to 0.5 amps per conductor (100 watts) continuously

- .5 The connector module shall utilize an engineered tine geometry to prevent POE arcing damage due to plug removal cycles from occurring at the critical contact-mating zone between the plug and connector module tines.
- .6 The eight-position connector module shall utilize a method of tine tensioning that
 - .1 Prevents contact bouncing and arcing at the critical contact-mating zone between the plug and connector module tines.
 - .2 Prevents six-position modular plug insertion from damaging either the cord or the module.
- .7 Contact tines shall be plated with a minimum of 50 microns of gold.
- .8 Optimal performance is achieved when using the same manufacturers patch cords.
- .9 Can support network line speeds up to at least 10 gigabits per second.
- .10 Qualifies for the Lifetime Extended Product Warranty and Applications Assurance when included as part of a registered channel.
- .11 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell or approved equal

2.5 Data OUTLET COLOR

- .1 Data outlets shall provided per the drawings and Owner's Standards. Coordinate with Owner prior to procurement and installations.

Part 3 Execution

3.1 Installation

- .1 Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any unique codes or requirements governed by the region where the work is to be performed.
- .2 Jack/Information outlets and Connectors shall be installed following industry standard practices.
- .3 Horizontal cabling shall be terminated on a Jack/Information outlet which is the same category rating as the Cable. i.e. Cat 6 cable terminates on Cat 6 Jack/Information outlets.
- .4 Contractor shall not exceed the maximum pulling tension or the minimum bending radius for twisted pair cables per manufacturer's specifications.
- .5 Contractor shall test all horizontal links per the ANSI/TIA-568 Requirements.

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of all Fiber Connectors, Adapters and Adapter Panels called for in the Bid and Engineering Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Fiber Connectors, Adapters and Adapter Panels.
- .2 The performance for the installation shall meet or exceed the requirements of ANSI/TIA-568 and ISO/IEC 11801 and other requirements as noted in this specification for the specified Fiber Type.
- .3 The connectors and adapters shall match the fiber type of the cabling
- .4 All connectors and adapters shall meet UL 94 V-O

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative.
- .2 Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .3 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .4 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:

ANSI/TIA-568 Series Commercial Building Telecommunications Cabling Standard

ANSI/TIA-568.3-D – Optical Fiber Cabling Components Standard

ANSI/TIA- 569 Telecommunications Pathways and Spaces

ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure

ANSI-J-STD-607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

BICSI – Telecommunications Distribution Methods Manual

Belcore, fiber distributed data interface (FDDI) standards

NFPA 70 – National Electric Code

Telcordia's Generic Requirements for Optical Fiber and Optical Fiber Cable

ISO/IEC 11801 - Generic Cabling for Customer Premises

CENELEC EN-50173 - Generic Cabling Systems

1.4 Submittals

- .1 Provide product data for the following:
 - .1 Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

1.5 Coordination

- .1 Coordinate installation of Jack/Information outlets and connectors with other trades.

Part 2 Products

2.1 General

- .1 All products will be:
 - .1 Compliant to RoHS 2002/95/EC
 - .2 Designed, manufactured and/or distributed under this quality management system: ISO 9001:2008

2.2 LC Fiber Adapters

- .1 Multimode adapter for use with 50/125 OM3 and OM4 Fiber
 - .1 The adapter plate shall be modular and functional for use in panel or Panel (rack- or wall-mount) specified.
 - .2 The adapter plate shall be offered in 12, or 24 fiber configurations.
 - .3 The adapter plate shall be compliant to ANSI/TIA-568.3-D and ISO 11801 (for performance) and respective ANSI/TIA-604-X and applicable IEC (for intermateability) standards.
 - .4 Color – Aqua Entire adapter plate shall be color coded, not just feed-thrus, to identify performance grade.
 - .5 Alignment Sleeve Material - ~~Phosphorous bronze~~ zirconia ceramic sleeves
 - .6 LC adapters shall be compatible with locking keyed patch cords and port blockers.
 - .7 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell or approved equal
- .2 Single-mode adapter for use with G.652.D or G.652.D, OS2 fiber
 - .1 The adapter plate shall be modular and functional for use in panel or Panel (rack- or wall-mount) specified.
 - .2 The adapter plate shall be offered in SC, LC, and ST styles in 6, 8, 12, or 24 fiber configurations.
 - .3 The adapter plate shall be compliant to ANSI/TIA-568.3-D and ISO 11801 (for performance) and respective ANSI/TIA-604-X and applicable IEC (for intermateability) standards.

- .4 Color – Blue Entire adapter plate shall be color coded, not just feed-thrus, to identify performance grade.
- .5 Alignment Sleeve Material – Zirconia Ceramic sleeves
- .6 LC adapters shall be compatible with locking keyed patch cords and port blockers.
- .7 Approved Manufacturer
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell or approved equal

2.3 LC Fiber Connectors

- .1 Single-mode Connector for use with G.652.D or G.652.D, OS2 fiber
 - .1 Color – Blue
 - .2 Ferrule Geometry - Pre-radiused
 - .3 Ferrule Material - Zirconia
 - .4 Performance meets or exceeds ANSI/TIA-568-C.2 standard
 - .5 Insertion Loss, typical - 0.20 dB
 - .6 Return Loss, minimum - 55.0 dB
 - .7 Insertion Loss Change, mating - 0.30 dB
 - .8 Insertion Loss Change, temperature - 0.30 dB
- .2 Keyed Multimode Connector for use with OM3 and OM4 fiber
 - .1 Color – per key
 - .2 For use with Keyed adapters
 - .3 Offer a tamper-proof design, reducing the chance of unauthorized connections.
 - .4 Ten connector-adapter combinations must exist, identified by color
 - .5 The connector and adapter colors must match for a connection to be possible
 - .6 Ferrule Geometry - Pre-radiused
 - .7 Ferrule Material - Zirconia
 - .8 Performance meets or exceeds ANSI/TIA-568-C.3 standard
 - .9 Insertion Loss, typical - 0.17 dB
 - .10 Return Loss, minimum - 20.0 dB
 - .11 Insertion Loss Change, mating - 0.20 dB
 - .12 Insertion Loss Change, temperature - 0.30 dB
 - .13 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .3 Keyed Single-mode Connector for use with G.652.D or G.652.D, OS2 fiber
 - .1 Color – per key
 - .2 For use with Keyed adapters
 - .3 Offer a tamper-proof design, reducing the chance of unauthorized connections.

- .4 Ten connector-adapter combinations must exist, identified by color
- .5 The connector and adapter colors must match for a connection to be possible
- .6 Ferrule Geometry - Pre-radiused
- .7 Ferrule Material - Zirconia
- .8 Performance meets or exceeds ANSI/TIA-568-C.2 standard
- .9 Insertion Loss, typical - 0.20 dB
- .10 Return Loss, minimum - 55.0 dB
- .11 Insertion Loss Change, mating - 0.30 dB
- .12 Insertion Loss Change, temperature - 0.30 dB
- .4 LC Connectors with mechanical splice
 - .1 Color coded per industry standard requirements to aide in identification during and after installation
 - .2 Factory pre-polished for field installation
 - .3 Mechanical splice technology
 - .4 Must include a factory pre-cleaved fiber stub and a proprietary index-matching gel
 - .5 Options for singlemode and multimode fibers
 - .6 Compatible with 250µm and 900µm optical fibers
 - .7 Performance exceeds ANSI/TIA-568-C.2 standard
 - .8 Complete tool kit with cleaning solution, wipes, and scrap fiber container designed for quick setup and tear-down
 - .9 Factory-installed wedge clip shall be included with each connector; wedge is discarded upon completion of the termination
 - .10 Translucent wedge shall enable the use of a common VFI to provide a "pass/fail" signal once physical contact is achieved
 - .11 Capability to be re-terminated if the first installation fails
 - .12 Shall not require a custom termination kit
 - .13 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal

2.4 SC Fiber Adapters

- .1 Multimode adapter for use with 50/125 OM3 and OM4 Fiber
 - .1 The adapter plate shall be modular and functional for use in panel or Panel (rack- or wall-mount) specified.
 - .2 The adapter plate shall be offered in 6, or 12 fiber configurations.
 - .3 The adapter plate shall be compliant to ANSI/TIA-568.3-D and ISO 11801 (for performance) and respective ANSI/TIA-604-X and applicable IEC (for intermateability) standards.
 - .4 Color – Aqua Entire adapter plate shall be color coded, not just feed-thrus, to identify performance grade.
 - .5 Alignment Sleeve Material - zirconia ceramic sleeves

- .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .2 Single-mode adapter for use with G.652.D or G.652.D, OS2 fiber
 - .1 The adapter plate shall be modular and functional for use in panel or Panel (rack- or wall-mount) specified.
 - .2 The adapter plate shall be offered in 6, or 12 fiber configurations.
 - .3 The adapter plate shall be compliant to ANSI/TIA-568.3-D and ISO 11801 (for performance) and respective ANSI/TIA-604-X and applicable IEC (for intermateability) standards.
 - .4 Color – Blue Entire adapter plate shall be color coded, not just feed-thrus, to identify performance grade.
 - .5 Alignment Sleeve Material - Zirconia ceramic sleeves
 - .6 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal

2.5 SC Fiber Connectors

- .1 Multimode Connector for use with OM3 and OM4 fiber
 - .1 Color – Beige
 - .2 Ferrule Geometry - Pre-radiused
 - .3 Ferrule Material - Zirconia
 - .4 Performance meets or exceeds ANSI/TIA-568-C.3 standard
 - .5 Insertion Loss, typical - 0.30 dB
 - .6 Return Loss, minimum - 20.0 dB
 - .7 Insertion Loss Change, mating - 0.30 dB
 - .8 Insertion Loss Change, temperature - 0.30 dB
 - .9 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .2 Single-mode Connector for use with G.652.D or G.652.D, OS2 fiber
 - .1 Color – Blue
 - .2 Ferrule Geometry - Pre-radiused
 - .3 Ferrule Material - Zirconia
 - .4 Performance meets or exceeds ANSI/TIA-568-C.2 standard
 - .5 Insertion Loss, typical - 0.30 dB
 - .6 Return Loss, minimum - 55.0 dB
 - .7 Insertion Loss Change, mating - 0.30 dB
 - .8 Insertion Loss Change, temperature - 0.30 dB
 - .9 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal
- .3 SC Connectors with mechanical splice

- .1 Color coded per industry standard requirements to aide in identification during and after installation
- .2 Factory pre-polished for field installation
- .3 Mechanical splice technology
- .4 Must include a factory pre-cleaved fiber stub and a proprietary index-matching gel
- .5 Options for singlemode and multimode fibers
- .6 Compatible with 250µm and 900µm optical fibers
- .7 Performance exceeds ANSI/TIA-568-C.2 standard
- .8 Complete tool kit with cleaning solution, wipes, and scrap fiber container designed for quick setup and tear-down
- .9 Factory-installed wedge clip shall be included with each connector; wedge is discarded upon completion of the termination
- .10 Translucent wedge shall enable the use of a common VFI to provide a "pass/fail" signal once physical contact is achieved
- .11 Capability to be re-terminated if the first installation fails
- .12 Shall not require a custom termination kit
- .13 Approved Manufacturer:
 - .1 CommScope, Belden, Panduit, Hubbell, Leviton or approved equal

Part 3 Execution

3.1 Installation

- .1 Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any unique codes or requirements governed by the region where the work is to be performed.
- .2 Fiber Connectors, Adapters and Adapter Panels shall be installed following industry standard practices.
- .3 Horizontal cabling shall be terminated on a Fiber Connectors, Adapters and Adapter Panels which is designed for the fiber type of the cable. i.e. Singlemode cable terminates on Singlemode Connectors and Adapters.
- .4 Contractor shall not exceed the maximum pulling tension or the minimum bending radius for twisted pair cables per manufacturer's specifications.
- .5 Contractor shall test all horizontal links per the Relevant Standards and Requirements.

END of SECTION

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of all Faceplate/wall plates and Surface mount Boxes called for in the Bid Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Faceplate/wall plates and Surface mount Boxes.
- .2 Faceplates and SMB shall be designed to accept the CommScope, Belden, Panduit, Hubbell, Leviton or approved equal information outlets.
- .3 Number of outlets per faceplate shall be as detailed on the Telecommunications Drawings.

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative.
- .2 Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .3 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .4 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
ANSI/TIA-568 Series Commercial Building Telecommunications Cabling Standard
ANSI/TIA-568.1-E – Commercial Building Telecommunications Cabling Standard
ANSI/TIA-568.2-E - Balanced Twisted-Pair Telecommunications Cabling and Components Standards
ANSI/TIA-568.3-D – Optical Fiber Cabling Components Standard
ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
BICSI-Telecommunications Distribution Methods Manual
CENELEC EN-50173 - Generic Cabling Systems
ISO/IEC 11801 - Generic Cabling for Customer Premises
J-STD-607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
NFPA 70 – National Electric Code

1.4 Submittals

- .1 Provide product data for the following:

- .1 Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

1.5 Coordination

- .1 Coordinate installation of Faceplate/wall plates and Surface mount Boxes with other trades.

Part 2 Products

2.1 Flush Wallmount Faceplates w/ ID Windows

- .1 Wallplate housing shall be a one-piece, single- or dual-gang flush mount style that fits standard NEMA openings.
- .2 Wallplate shall provide 1, 2, 3, 4, 6, 8 or 12 ports.
- .3 Wallplate must be able to accept modular jacks from approved manufacturer.
- .4 Wallplate shall accommodate connections of any type, UTP, optical fiber, coax, or AV modules.
- .5 Wallplate must be made of high-impact, fire-retardant plastic rated UL 94V-0, and be UL Listed, cULus Listed (UL 1863 & CAN/CSA-C22.2 No. 182.4) and meet ANSI/TIA-568-D specifications.
- .6 Colors, port counts and configurations to be specified per schedule on plans.
- .7 Colors available are white, light almond, ivory, gray and black.
- .8 Wallplate screws must match wallplate color.
- .9 The flush faceplate housing the connector modules shall have no visible mounting screws.
- .10 The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
- .11 The faceplate housing the connector modules shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
- .12 The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, video, coaxial and optical fiber applications.
- .13 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.2 Angled Wallmount Faceplates w/ ID Windows

- .1 Angled Wallplate housing shall be a one-piece, single-gang flush mount style that fits standard NEMA openings.
- .2 Angled Wallplate shall provide 1, 2 or 4 ports and feature a 45-degree angled design to facilitate cable management.

- .3 Angled Wallplate must be able to accept modular jacks from approved manufacturer.
- .4 Angled Wallplate shall accommodate connections of any type, UTP, optical fiber, coax, or AV modules.
- .5 Angled Wallplate must be made of high-impact, fire-retardant plastic rated UL 94V-0, and be UL Listed, cULus Listed (UL 1863 & CAN/CSA-C22.2 No. 182.4) and meet ANSI/TIA-568-D specifications.
- .6 Colors, port counts and configurations to be specified per schedule on plans.
- .7 Colors available are white, light almond, ivory, and black.
- .8 The flush faceplate housing the connector modules shall have no visible mounting screws.
- .9 The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
- .10 The faceplate housing the connector modules shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
- .11 The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, video, coaxial and optical fiber applications.
- .12 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.3 Stainless-Steel Flush Wallmount Faceplates

- .1 Stainless-Steel wallplate housing shall be a single-gang or dual-gang flush mount style that fits standard NEMA openings.
- .2 Stainless-Steel Wallplate shall provide 1, 2, 3, 4, or 6 ports single-gang and 2, 4, 6, 8 or 12 ports dual-gang.
- .3 Stainless-Steel Wallplate must be able to accept modular jacks from approved manufacturer.
- .4 Stainless-Steel Wallplate shall accommodate connections of any type, UTP, optical fiber, coax, or AV modules.
- .5 Wallplate shall be manufactured from 304 stainless steel in a brushed finish to provide corrosion resistance in a non-magnetic material, ABS plastic carrier, be cULus Listed (UL 1863 & CAN/CSA-C22.2 No. 182.4) and meet ANSI/TIA-568-D specifications.
- .6 Port counts and configurations to be specified per schedule on plans.
- .7 The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
- .8 Specify port identification method with colored modules or designation labels or custom silk-screening.

- .9 The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, video, coaxial and optical fiber applications.

- .10 Approved Manufacturer:

- .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.4 Stainless-Steel Flush Wallmount Faceplates with ID Windows

- .1 Stainless-Steel Wallplate housing shall be a single-gang or dual-gang flush mount style that fits standard NEMA openings.
- .2 Stainless-Steel Wallplate shall provide 1, 2, 3, 4, or 6 ports single-gang and 4 or 8 ports dual-gang.
- .3 Stainless-Steel Wallplate must be able to accept modular jacks from approved manufacturer.
- .4 Stainless-Steel Wallplate shall accommodate connections of any type, UTP, optical fiber, coax, or AV modules.
- .5 Wallplate shall be manufactured from 304 stainless steel in a brushed finish to provide corrosion resistance in a non-magnetic material, ABS plastic carrier, be cULus Listed (UL 1863 & CAN/CSA-C22.2 No. 182.4) and meet ANSI/TIA-568-D specifications.
- .6 Port counts and configurations to be specified per schedule on plans.
- .7 The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
- .8 Specify port identification method with colored modules or designation labels.
- .9 Wallplate mounting screw holes shall be slotted to permit leveling (+/- 4 degrees for single -gang and +/- 2 degrees for double-gang).
- .10 The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, video, coaxial and optical fiber applications.
- .11 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.5 Angled Stainless-Steel Flush Wallmount Faceplates with ID Windows

- .1 Angled Stainless-Steel Wallplate housing shall be single-gang or dual-gang flush mount style that fits standard NEMA openings.
- .2 Angled Stainless-Steel Wallplate shall provide 2 or 4 ports single-gang and 4 or 8 ports dual-gang design that feature a 45-degree angled design to facilitate cable management.
- .3 Angled Stainless-Steel Wallplate must be able to accept modular jacks from approved manufacturer.
- .4 Angled Stainless-Steel Wallplate shall accommodate connections of any type, UTP, optical fiber, coax, or AV modules.

- .5 Wallplate shall be manufactured from 304 stainless steel in a brushed finish to provide corrosion resistance in a non-magnetic material, ABS plastic carrier, be cULus Listed (UL 1863 & CAN/CSA-C22.2 No. 182.4) and meet ANSI/TIA-568-D specifications.
- .6 Port counts and configurations to be specified per schedule on plans.
- .7 The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
- .8 Specify port identification method with colored modules or designation labels.
- .9 Wallplate mounting screw holes shall be slotted to permit leveling (+/- 4 degrees for single -gang and +/- 2 degrees for double-gang).
- .10 The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, video, coaxial and optical fiber applications.
- .11 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.6 Stainless-Steel Flush Wallmount Phone Faceplates

- .1 Stainless-Steel wallplate housing shall be a 1-port single-gang recessed or flush mount style designed with rivets to support a variety of wall mount telephones. Wallplate shall fit standard NEMA openings.
- .2 Stainless-Steel Wallplate must be able to accept modular jacks from approved manufacturer.
- .3 Wallplate shall be manufactured from 302 stainless steel in a brushed finish and provide corrosion resistance, be cULus Listed (UL 1863 & CAN/CSA-C22.2 No. 182.4) and meet ANSI/TIA-568-D specifications.
- .4 Recessed or flush configurations to be specified per schedule on plans.
- .5 The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
- .6 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.7 Surface mount boxes

- .1 The surface mount housing shall be small and low profile to accept 1, 2, 4, 6 or 12 field-configurable snap in connector modules.
- .2 Base and snap-on cover shall include knockouts for rear, bottom, or side cable entry.
- .3 Base shall also include cable anchor points.
- .4 The housing shall be mountable with screws, tape, or magnets, and have mounting holes compatible with standard NEMA and Euro wall boxes.
- .5 Cover shall include an identification window, which also hides a user provided #6 x 1/2" security screw.

- .6 Construction shall be of high-impact fire-retardant plastic rated UL 94V-0.
- .7 Box shall be cULus listed and compliant with ANSI/TIA-568-D.
- .8 1- and 2-port housings shall comply with UL 2043 as suitable for use in air-handling spaces per NEC 300-22(b)(c).
- .9 The surface mount box shall accommodate connections of any type, UTP, optical fiber or coax.
- .10 One and two-port housings shall comply with UL 2043 as suitable for use in air handling spaces per NEC 300-22(b)(c).
- .11 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.8 Industrial Outlet Kits

- .1 Industrial Outlet Kits shall be pre-assembled and available in single-gang and dual-gang stainless steel standard NEMA box dimensions.
- .2 The single-gang industrial outlet kit shall provide 1 or 2 ports and an equivalent amount of connector housings and dust caps assembled.
- .3 The dual-gang industrial outlet kit shall provide 2 or 4 ports and an equivalent amount of connector housings and connector caps assembled.
- .4 Industrial outlet wall plates shall include over molded gasket to seal to outlet boxes and screw holes shall have an embedded sealing feature.
- .5 Connector housings mounted in industrial wallplates shall accept all standard connector modules from the same Manufacturer and be encapsulated RJ-45 design to protect the standard connector modules.
- .6 Outlet assembly related components shall be IP67 rated for dust and liquid and have an operating temperature range of -40°C to 65°C.
- .7 Outlet assembly wallplate shall be constructed of stainless steel, with an integral over-molded gasket.
- .8 Connector housing shall be made of PBT, be cULus listed, and compliant with ANSI/TIA-1005 and ANSI/TIA-568-D.
- .9 Outlet kits shall mate via twist-lock seal with industrial category 6A patch cords.
- .10 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

Part 3 Execution

3.1 Installation

- .1 Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any
- .2 Unique codes or requirements governed by the region where the work is to be performed.

- .3 Faceplate/wall plates and Surface mount Boxes shall be installed following industry standard practices.
- .4 Contractor shall not exceed the maximum pulling tension or the minimum bending radius for twisted pair cables per manufacturer's specifications.
- .5 Contractor shall test all horizontal links per the ANSI/TIA-568 Requirements.

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of all Copper Patch cords into the approved patch panels called for in the Bid Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Copper Patch Cords.
- .2 All Patch/Equipment Cords shall be new.
- .3 On new installations, Patch/Equipment Cords shall be made by the same manufacturer as the Horizontal Cable used in the new installation.
- .4 All Patch/Equipment Cords shall be factory manufactured and tested for compliance to the appropriate standards and performance.
- .5 Patch/Equipment Cord length shall be determined by the end user.
- .6 Patch/Equipment Cords shall be installed using proper cable management.
- .7 Minimum bend radius shall not be exceeded.

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative.
- .2 Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .3 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .4 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
 - ANSI/TIA-568 Series Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
 - ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
 - BICSI – Telecommunications Distribution Methods Manual
 - J-STD – 607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - NFPA 70 – National Electric Code

1.4 Submittals

- .1 Provide product data for the following:

- .1 Manufacturers cut sheets, specifications and installation instructions for all products.

1.5 Coordination

- .1 Coordinate layout and installation of Patch/Equipment Cords with other trades.

Part 2 Products

2.1 Category 5 Enhanced (5e) Cords

- .1 The Modular Patch Cords shall meet or exceed Attenuation and NEXT Category 5 and Category 5e specifications for patch cords as specified in ISO/IEC 11 801, CENELEC, EN50173 and ANSI/TIA-568-C.2.
- .2 Patch cords shall be UTP construction, stranded 24 AWG conductors, and a nominal outside diameter of .220" (5.6mm)
- .3 Patch Cords shall have 8-position modular plug on each end and feature a narrow profile snagless strain relief boot.
- .4 Patch cord plug shall be industry standard, FCC compliant clear material with 50 micro inches of gold plating.
- .5 Patch cords shall meet UL 444 CM rating.
- .6 The patch cord shall comply with the following POE standards
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts,
 - .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .4 Cisco Universal Power Over Ethernet (UPOE) applications up to 60 watts
- .7 The cords shall be available in lengths of 3, 5, 7, and 10 feet. Additional lengths are available as non-stocked options.
- .8 The patch cords shall qualify as part of the Manufacturers Lifetime Product and Systems Performance Warranty when installed as part of a certified system.
- .9 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.2 IDC CATEGORY 5E PATCH CORDS

- .1 The IDC Patch Cords shall meet or exceed Attenuation and NEXT Category 5 and Category 5e specifications for patch cords as specified in ISO/IEC 11 801, CENELEC, EN50173 and ANSI/TIA-568-C.2.
- .2 Patch cords shall be UTP construction, solid 24 AWG conductors
- .3 Patch Cords shall have 8-position modular plug on each end and feature a narrow profile snagless strain relief boot.

- .4 Patch cord plug shall be industry standard, FCC compliant clear material with 50 micro inches of gold plating.
- .5 Patch cords shall meet UL 1666 CMR or CMP rating as appropriate.
- .6 The patch cord shall comply with the following POE standards
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts,
 - .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .4 Cisco Universal Power Over Ethernet (UPOE) applications up to 60 watts
- .7 Cords shall come in custom lengths
- .8 The patch cords shall qualify as part of the Manufacturers Lifetime Product and Systems Performance Warranty when installed as part of a certified system.
- .9 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.3 Category 6 / Class E Patch Cords

- .1 Patch cords shall be tested and verified to meet ANSI/TIA-568.2-D and ISO 11801-1 Category 6 component requirements.
- .2 Patch cords shall be UTP construction, stranded 24 AWG conductors, and a nominal outside diameter of .225" (5.72 mm).
- .3 Patch Cords shall have 8-position modular plug on each end and feature a narrow profile snagless strain relief boot.
- .4 Patch cords shall meet ANSI/TIA-1096-A (formerly FCC Part 68) and be RoHS compliant with 50 micro inches of gold plating.
- .5 Patch cords shall meet UL 444 CM rating.
- .6 The patch cord shall comply with the following PoE standards
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts,
 - .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .4 IEEE 802.3bt (Type 4) Power over Ethernet (PoE+) applications up to 90 watts
 - .5 Cisco Universal Power Over Ethernet (UPOE+) applications up to 90 watts
 - .6 Power over HDBaseT™ (POH) applications up to 95 watts
- .7 For 100-watt applications – up to 100 cables in a bundle.
- .8 The patch cords shall have an operating temperature range of -4°F to +140°F (-20°C to +60°C).

- .9 The cords shall be available in standard lengths of 3, 5, 7, 10, 15 and 20 feet (custom lengths available upon request).
- .10 The patch cords shall qualify as part of the Manufacturers Product and Systems Performance Warranty when installed as part of a certified system.
- .11 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.4 IDC CATEGORY 6 PATCH CORDS

- .1 The IDC Patch Cords shall meet or exceed TIA ANSI/TIA-568-C.2 Category 6 and ISO/EIC Category 6/Class E specifications and shall be fully backward compatible with Category 5e and 5 connectors.
- .2 Patch cords shall be UTP construction, solid 24 AWG conductors
- .3 Patch Cords shall have 8-position modular plug on each end and feature a narrow profile snagless strain relief boot.
- .4 Patch cord plug shall be industry standard, FCC compliant clear material with 50 micro inches of gold plating.
- .5 Patch cords shall meet UL 1666 CMR or CMP rating as appropriate.
- .6 The patch cord shall comply with the following POE standards
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts,
 - .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .4 Cisco Universal Power Over Ethernet (UPOE) applications up to 60 watts
- .7 Cords shall come in custom lengths
- .8 The patch cords shall qualify as part of the Manufacturers Lifetime Product and Systems Performance Warranty when installed as part of a certified system.
- .9 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.5 Category 6 Augmented (6A) / Class 6A Patch Cords

- .1 The Modular Patch Cords shall meet or exceed the channel specifications of Amendment 1 to ISO/IEC 11 801:2002 Class EA and ANSI/TIA-568-C.2 Category 6A up to 500 MHz when used as part of a UTP Channel.
- .2 Patch cords shall be independently tested and verified to meet ANSI/TIA-568.2-D and ISO 11801-1 Category 6A component requirements.
- .3 The patch cord shall be 26 AWG, FTP construction with stranded conductors and nominal outside diameter of .240".
- .4 Patch cords shall be universal, can be used in both shielded and unshielded channels.

- .5 The patch cord shall incorporate shielded plugs with a snagless tab design. Boots shall be short body style without bend radius control for limited space applications.
- .6 Product shall meet ANSI/TIA-1096-A requirements to include 50 micro inches of gold plating.
- .7 The patch cord jacket shall meet UL 444 CMR (300V) rating.
- .8 The patch cord shall be RoHS compliant and cULus listed.
- .9 The patch cord shall comply with the following POE standards
 - .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
 - .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts,
 - .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
 - .4 IEEE 802.3bt (Type 4) Power over Ethernet (PoE+) applications up to 90 watts
 - .5 Cisco Universal Power Over Ethernet (UPOE+) applications up to 90 watts.
 - .6 Power over HDBaseT™ (POH) applications up to 95 watts
- .10 Cord labels shall include part number, length and lot information.
- .11 The patch cords shall be available in standard 3, 5, 7, 10, 15, and 20 foot lengths. Custom lengths shall also be available through a made to order program.
- .12 Channel performance shall be tested and verified in a 4 connector, 100 meter channel.
- .13 The patch cords shall qualify as part of the Manufacturers Product and Systems Performance Warranty when installed as part of a certified system.
- .14 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.6 IDC CATEGORY 6A PATCH CORDS

- .1 The IDC Patch Cords shall meet or exceed the channel specifications of Amendment 1 to ISO/IEC 11 801:2002 Class EA and ANSI/TIA-568-C.2 Category 6A up to 500 MHz when used as part of a UTP Channel.
- .2 Patch cords shall be UTP construction, solid 23 AWG conductors
- .3 Patch Cords shall have 8-position modular plug on each end and feature a narrow profile snagless strain relief boot.
- .4 Patch cord plug shall be industry standard, FCC compliant clear material with 50 micro inches of gold plating.
- .5 Patch cords shall meet UL 1666 CMR or CMP rating as appropriate.
- .6 The patch cord shall comply with the following POE standards

- .1 IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
- .2 IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts,
- .3 IEEE 802.3bt (Type 3) Power over Ethernet (PoE+) applications up to 60 watts
- .4 IEEE 802.3bt (Type 4) Power over Ethernet (PoE++) applications to 90 watts
- .5 Cisco Universal Power Over Ethernet (UPOE) applications up to 90 watts
- .7 Cords shall come in custom lengths
- .8 The patch cords shall qualify as part of the Manufacturers Lifetime Product and Systems Performance Warranty when installed as part of a certified system.
- .9 Approved Manufacturer:
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.7 Patch / equipment cord COLOR

- .1 Data patch cords shall be in Blue.
- .2 Voice patch cords shall be in Green.
- .3 Wireless Access Point patch cords shall be in Orange.
- .4 Camera patch cords shall be in Yellow.
- .5 Intercom patch cords shall be in Red.
- .6 Clock patch cords shall be in Black.
- .7 All other patch cords not list above shall be in Violet.

Part 3 Execution

3.1 Installation

- .1 Copper Jumpers/patch cables
 - .1 Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any unique codes or requirements governed by the region where the work is to be performed.
 - .2 Cable shall be installed following industry standard practices.
 - .3 Contractor shall not exceed the maximum pulling tension or the minimum bending radius for copper cables per manufacturer's specifications.
 - .4 All installations shall comply with:
 - .1 ANSI/TIA-568 Series Commercial Building Telecommunications Cabling Standard,
 - .2 ANSI/TIA-569 Commercial Building Standard for Telecommunications

- .3 Pathways and Spaces ANSI/TIA – 606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- .4 BICSI – Telecommunications Distribution Methods Manual
- .5 J-STD – 607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- .6 NFPA 70 – National Electric Code

END OF SECTION

Part 1 General

1.1 Work includes

- .1 Provide all labor, materials, and equipment for the complete installation of all 50 Micron Multimode Optical Fiber Cords and Pigtails into the approved patch panels called for in the Bid Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Fiber Patch Cords.
- .2 All Patch/Equipment Cords shall be new.
- .3 On new installations, Patch/Equipment Cords shall be made by the same manufacturer as the Horizontal Cable used in the new installation.
- .4 Patch/Equipment Cords shall be available in multiple colors. Colors required are to be detailed in the Bid Documents.
- .5 All Patch/Equipment Cords shall be factory manufactured and tested for compliance to the appropriate standards and performance.
- .6 Patch/Equipment Cord length shall be determined by the end user.
- .7 Patch/Equipment Cords shall be installed using proper cable management.
- .8 Minimum bend radius shall not be exceeded.

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative.
- .2 Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .3 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .4 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
 - ANSI/TIA – 568 Series Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
 - ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
 - BICSI-Telecommunications Distribution Methods Manual
 - J-STD-607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - NFPA 70-National Electric Code

Telcordia, GR-20-CORE, Generic Requirements for Optical Fiber and Optical Fiber Cable

1.4 Submittals

- .1 Provide product data for the following:
 - .1 Manufacturers cut sheets, specifications and installation instructions for all products.

1.5 Coordination

- .1 Coordinate layout and installation of Fiber Cords and Pigtailes with other trades.

Part 2 Products

2.1 Optical Fiber Patch Cords and Pigtailes

- .1 To maintain channel integrity, optical fiber patch cords and pigtailes shall be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors shall be equipped with boots, and shall have same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords and pigtailes shall be available with the following options as indicated on the bid document.

2.2 Multimode Fiber Patch Cords

- .1 Multimode fiber patch cords shall meet or exceed the requirements of ANSI/TIA-568.3-D.
- .2 Multimode Fiber Patch Cords shall be available in 62.5/125 micron OM1, 50/125-Micron OM2, and 50/125-Micron Laser Optimized OM3 and OM4.
- .3 Multimode patch cords shall meet an optical return loss equal to or better than 25 dB per mated pair.
- .4 Insertion loss shall not exceed 0.4 dB per mated pair.
- .5 Multimode fiber patch cord shall have a maximum attenuation of:
 - .1 3.5dB/km@ 850 nm and 1.5 dB/km @1300 nm for OM1
 - .2 3.0dB/km@ 850 nm and 1.0 dB/km @1300 nm for OM2/OM3/OM4.
- .6 The optical fiber cord connectors shall have precision pre-radiused zirconia ferrules.
- .7 Patch cords shall be available with LC, SC, ST connectors in any combination.
- .8 Cable Jacket color shall be: OM1/OM2 (Orange), OM3/OM4 (Aqua), OS2 (Yellow).
- .9 The fiber cord assembly shall be dual zip, OFNR or OFNP rated as required.
- .10 LC Patch cord outside diameters:
 - .1 Simplex: 1.6 mm (0.063 in)
 - .2 Duplex: 1.6 mm x 3.3 mm (0.063 in x 0.130 in)

- .11 SC Patch cord outside diameters:
 - .1 Simplex: 3.0 mm (0.118 inches)
 - .2 Duplex: 3.0 mm x 5.9 mm (0.063 in x 0.232 in)
- .12 Duplex LC and SC fiber patch cords shall be A-B polarity.
- .13 Standard stock lengths of 1m, 2m, 3m, 5m, and 10m shall be available. Custom lengths shall be available through a made to order program.
- .14 Approved Manufacturer
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.3 MULTIMODE FIBER PIGTAILS

- .1 Multimode fiber Pigtails shall meet or exceed the requirements of ANSI/TIA-568.3-D.
- .2 Multimode Fiber Pigtails shall be available in 62.5/125 micron OM1, 50/125-Micron OM2, and 50/125-Micron Laser Optimized OM3 and OM4.
- .3 Multimode Pigtails shall meet an optical return loss equal to or better than 25 dB per mated pair.
- .4 Insertion loss shall not exceed 0.35 dB per mated pair.
- .5 Multimode fiber Pigtail shall have a maximum attenuation of:
 - .1 3.5dB/km@ 850 nm and 1.5 dB/km @1300 nm for OM1
 - .2 3.0dB/km@ 850 nm and 1.0 dB/km @1300 nm for OM2/OM3/OM4.
- .6 The optical fiber pigtail connectors shall have precision pre-radiused zirconia ferrules.
- .7 The fiber pigtail assembly shall be 3m in length, tight buffered 900m O/D.
- .8 Pigtails shall be available in kits of 12.
- .9 Approved Manufacturer
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

Part 3 Execution

3.1 Installation

- .1 Fiber Optic Jumpers/patch cables
 - .1 Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any unique codes or requirements governed by the region where the work is to be performed.
 - .2 Cable shall be installed following industry standard practices.
 - .3 Contractor shall not exceed the maximum pulling tension or the minimum bending radius for fiber cables per manufacturer's specifications.
 - .4 All installations shall comply with:

ANSI/TIA – 568 Series Commercial Building Telecommunications Cabling
Standard ANSI/TIA-569 Commercial Building Standard for
Telecommunications Pathways
and Spaces
ANSI/TIA-606 Administration Standard for the Telecommunications
Infrastructure
BICSI-Telecommunications Distribution Methods Manual
J-STD-607 Joint Standard for Commercial Building Grounding (Earthing)
and Bonding Requirements for Telecommunications
NFPA 70-National Electric Code
Telcordia, GR-20-CORE, Generic Requirements for Optical Fiber and
Optical Fiber Cable

END OF SECTION

Part 1 General

1.1 Work Includes

- .1 Provide all labor, materials, and equipment for the complete installation of all Single- Mode Optical Fiber Cords and Pigtails into the approved patch panels called for in the Bid Documents.

1.2 Scope of Work

- .1 This section includes the minimum requirements for Fiber Patch Cords.
- .2 All Patch/Equipment Cords shall be new.
- .3 On new installations, Patch/Equipment Cords shall be made by the same manufacturer as the Horizontal Cable used in the new installation.
- .4 Patch/Equipment Cords shall be available in multiple colors. Colors required are to be detailed in the Bid Documents.
- .5 All Patch/Equipment Cords shall be factory manufactured and tested for compliance to the appropriate standards and performance.
- .6 Patch/Equipment Cord length shall be determined by the end user.
- .7 Patch/Equipment Cords shall be installed using proper cable management.
- .8 Minimum bend radius shall not be exceeded.

1.3 Quality Assurance

- .1 All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative.
- .2 Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- .3 Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- .4 Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
 - ANSI/TIA – 568 Series Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
 - ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure
 - BICSI-Telecommunications Distribution Methods Manual
 - J-STD-607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - NFPA 70-National Electric Code

Telcordia, GR-20-CORE, Generic Requirements for Optical Fiber and Optical Fiber Cable

1.4 Submittals

- .1 Provide product data for the following:
 - .1 Manufacturers cut sheets, specifications and installation instructions for all products.

1.5 Coordination

- .1 Coordinate layout and installation of Fiber Cords and Pigtailes with other trades.

Part 2 Products

2.1 Optical Fiber Patch Cords and Pigtailes

- .1 To maintain channel integrity, optical fiber patch cords and pigtailes shall be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors shall be equipped with boots, and shall have same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords and pigtailes shall be available with the following options as indicated on the bid document.

2.2 SINGLEMODE FIBER PATCH CORDS

- .1 Singlemode fiber patch cords shall meet or exceed the requirements of ANSI/TIA-568.3-D
- .2 Single mode patch cords shall meet an optical return loss equal to or greater than 50 dB per mated pair FOR UPC polish or 55dB for APC polish.
- .3 Insertion loss shall not exceed 0.35 dB per mated pair.
- .4 Single mode fiber patch cord shall have a maximum attenuation of:
 - .1 .4 dB/km@ 1310 nm and .3 dB/km @1550 nm
- .5 The optical fiber cord connectors shall have precision pre-radiused zirconia ferrules.
- .6 Cable Jacket color shall be: OS2 (Yellow).
- .7 The fiber cord assembly shall be dual zip, OFNR rated.
- .8 Patch cords shall be available with LC, LC/APC, SC, SC/APC, FC or ST connectors in any combination.
- .9 Duplex fiber patch cords shall be A-B polarity.
- .10 Standard stock lengths of 1m, 2m, 3m, 5m, and 10m shall be available. Custom lengths shall be available through a made to order program.
- .11 LC Patch cord outside diameters:
 - .1 Simplex: 1.6 mm (0.063 in)

- .2 Duplex: 1.6 mm x 3.3 mm (0.063 in x 0.130 in)
- .12 SC Patch cord outside diameters:
 - .1 Simplex: 3.0 mm (0.118 inches)
 - .2 Duplex: 3.0 mm x 5.9 mm (0.063 in x 0.232 in)
- .13 Lengths: As specified in the bid document
- .14 Approved Manufacturer
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

2.3 SINGLEMODE FIBER PIGTAILS

- .1 Singlemode fiber Pigtails shall meet or exceed the requirements of ANSI/TIA-568.3-D.
- .2 Singlemode Pigtails shall meet an optical return loss equal to or better than 50 dB per mated pair.
- .3 Insertion loss shall not exceed 0.25 dB per mated pair.
- .4 The optical fiber pigtail connectors shall have precision pre-radiused zirconia ferrules.
- .5 The fiber pigtail assembly shall be 3m in length, tight buffered 900m O/D.
- .6 Pigtails shall be available in kits of 12.
- .7 Approved Manufacturer
 - .1 Leviton, CommScope, Belden, Panduit, Hubbell, or approved equal

Part 3 Execution

3.1 Installation

- .1 Fiber Optic Jumpers/patch cables
 - .1 Contractor shall comply applicable codes, standards and with all local codes and requirements. It is the responsibility of the contractor to identify and adhere to any unique codes or requirements governed by the region where the work is to be performed.
 - .2 Cable shall be installed following industry standard practices.
 - .3 Contractor shall not exceed the maximum pulling tension or the minimum bending radius for fiber cables per manufacturer's specifications.
 - .4 All installations shall comply with:
 - ANSI/TIA-568 Series Commercial Building Telecommunications Cabling Standard
 - ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
 - ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - BICSI – Telecommunications Distribution Methods Manual
 - J-STD-607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

NFPA 70 – National Electric Code

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Division 1, General Requirement, and all documents referred to therein.

1.2 APPLICATION

- .1 This Section applies to and is a part of all Sections of Division 28.

1.3 SCOPE OF WORK

- .1 **In case of discrepancy of the specifications details, the Owner's standards and requirements attached in the Appendices shall take precedence.**
- .2 The intent of the Tender is to obtain pricing for the supply, installation, testing and demonstration of a fully operational security systems as specified herein and shown on the contract drawings.
- .3 Work related to security systems shall be installed and programmed by manufacturers authorized and certified trained technician and installer. Owner reserves the right to review and approves any personnel assigned to this project in a supervisory or managerial role.
- .4 The Security Contractor shall have had at least 10 years of comparable experience with security projects. As part of the proposal, the contactor shall submit at least three (3) comparable Project reference descriptions with reference contacts. Comparable projects shall equal or exceed size and complexity of work on drawings.
- .5 The Contractor shall be the security systems integrator to fully integrate all the systems described in Division 28 specifications.
- .6 The successful Contractor shall be required to co-ordinate all work with the Division 26 Electrical Contractor, who will be responsible for the installation of raceways and power.
- .7 The successful Contractor shall be required to co-ordinate all work with the Division 27 Communications Contractor, who will be responsible for the installation of communications cabling.

1.4 PRE-QUALIFIED SECURITY INTEGRATORS

- .1 The following security integrators are on the MCW's pre-qualified list. Other security integrators will be considered to accept bidding on this project, subject to the acceptance by the Owner or Owner's representative.
- .2 Security Systems shall be provided by one of the following pre-qualified (Preferred) Value Add Resellers (VAR):

Firm	Contact Name	Email	Phone
360 Advanced Security Corporation	Andrew Pierce	Andrew.p@360asc.com	416-798-2228

Firm	Contact Name	Email	Phone
Chubb Fire and Security Canada Corporation	Stephen Yates	Stephen.yates@chubbfs.com	416-659-1754
ComNet Networks and Security	Andrew Reedman	areedman@com-net.ca	416-704-7434
Paladin Technologies Inc	Marc Kingsbury	mkingsbury@paladintechologies.com	647-459-5691
Securitas Technology	Tom Nanou	tom.nanou@securitasES.com	416-678-7353

- .3 Lenel security systems shall be provided by and completed by one of the following pre-qualified (Preferred) Security Integrators:

Firm	Contact Name	Email	Phone
AC Electric	Alex Chambers	estimating@acelectricinc.ca	416-939-0244
CEC Services Inc.	Kyle Feinstein	estimating@beswickgroup.com	905-713-3711
Electro-Works Ltd.	Dondi Keough	dondi@tcsecure.ca	416-529-7180
Ozz Electric	Shamil Abaev	sabaev@ozzelectric.com	416-999-9417

DEFINITIONS

- .4 Refer to the Standard Construction Document CCDC 2 and the Supplementary Conditions for all contract Definitions.
- .5 The following definitions shall also apply:
- .1 Wherever the term "install" (and tenses of "install") is used, it means install and connect complete.
 - .2 Wherever the term "supply" is used it means supply only.
 - .3 Whenever "Drawings and Specifications" are referred to herein, it means "the Contract Documents".
 - .4 Wherever the terms "Authorities" or "Authorities having jurisdiction" are used in this Division, they shall mean any and all current laws and/or by-laws of any federal, provincial or local authorized agencies having jurisdiction over the sum total or parts of the work including, but not restricted to the Municipal Planning and Building Department, Municipal Fire Department, The Construction Safety Act, Municipal Public Works Department, Federal and/or Provincial Fire Marshall, the Ontario Electrical Safety Code and the Ontario Building Code.

1.5 WORK INCLUDED

- .1 Sections of Division 28 are not intended to delegate functions nor to delegate work and supply to any specific trade and the Work shall include all labour, materials, equipment and tools required for a complete and working installation as described.

1.6 PERMITS, FEES AND INSPECTIONS

- .1 Apply for, obtain, and pay for all permits, licenses, inspections, examinations and fees required for Work of Division 28.
- .2 Prepare professional engineer stamped documents and apply for Electromagnetic (Maglock) Permit with AHJ.
- .3 Arrange for inspection of all Work by the Authorities having jurisdiction over the Work.
- .4 In case of conflict, the codes take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the drawings and specifications by applying any of the codes referred to herein.

1.7 CONTRACT DRAWINGS

- .1 The Drawings are performance drawings, diagrammatic, intended to convey the scope of work and indicate general arrangement and approximate location of devices. The Drawings do not intend to show architectural and structural details.
- .2 Do not scale Drawings. Obtain information involving accurate dimensions from dimensions shown on Architectural drawings, and by site measurement.
- .3 Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (conduits around beams, columns etc.)
- .4 Alter, at no additional cost, the locations of materials and/or equipment as directed that do not necessitate additional material.
- .5 Install ceiling mounted components in accordance with reflected ceiling drawings.
- .6 Confirm on the site the exact location and mounting details as related to Architectural details.

1.8 EXAMINATION OF SITES AND DOCUMENTATIONS

- .1 Prior to submitting tender, carefully examine conditions at the site which could affect the Work. Refer to and examine all contract documents.
- .2 Ensure that materials and equipment are delivered to the site at the proper time and in such assemblies and sizes so as to enter into the building and to be moved into the spaces where they are to be located without difficulty. Be responsible for any cutting and patching involved in getting assemblies into place.

1.9 RECORD DRAWINGS

- .1 The drawings for this Project have been prepared using AutoCAD. For the purpose of producing record (as-built) drawings, copies of contract drawings may be purchased from the Consultant based on the following rates plus HST. In

using the drawings from the Consultant to produce record drawings, the Contractor is deemed to have agreed to take full responsibility for any and all information on the drawings.

- .2 The drawings for this Project have been prepared using Revit/BIM 360. For the purpose of exchanging model and producing record (as-built) drawings, a model file will be made available to the trade for a cost of \$850 plus HST. In using the model from the Consultant to produce record drawings, the Contractor is deemed to have agreed to take full responsibility for any and all information on the drawings.

For 1 to 10 files	\$550.00
For 11 to 20 files	\$650.00
For 21 to 50 files	\$850.00
For 51 to 100 files	\$1,350.00
For greater than 100 files, charge \$10.00 per file + \$350.00.	

- .3 At the completion of construction, pay for all services required such as recreating, plotting and printing to produce "as constructed" drawings.
- .4 At the completion of the project, submit as part of the close-out documents in searchable PDF in flash drive with all design information including operating and instruction manuals as described below.

1.10 PRODUCT STANDARDS AND ALTERNATIVES

- .1 Provide new material and equipment as specified and to the acceptance of the Consultant.
- .2 Equipment is specified as "generic". Provide details of all proposed equipment for review by the Consultant.

1.11 PATENTS

- .1 Pay all royalties and license fees, and defend all suits or claims for infringement of any patent rights, and save the Owner and Consultant harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters, patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters, patent or rights.

1.12 RIGHTS RESERVED

- .1 Rights are reserved to furnish any additional detail drawings, which in the judgment of the Consultant may be necessary to clarify the work, and such drawings shall form a part of this contract.

1.13 EXPEDITING AND DELIVERY

- .1 Continuously check and expedite delivery of equipment and materials. If necessary, inspect at the source of manufacture.
- .2 Continuously check and expedite the flow of necessary information to and from all parties involved.
- .3 Immediately inform the Consultant in case information is required from him.

- .4 Provide delivery records updated monthly.

1.14 WORKMANSHIP

- .1 Install equipment and cables in a workmanlike manner to present a neat appearance to function properly to the satisfaction of the Consultant.
- .2 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement with due allowance therefore.
- .3 Include in the work all requirements of manufacturers shown on the shop drawings or manufacturers installation instructions.
- .4 Replace work unsatisfactory to the Consultant without extra cost.
- .5 Make provision to accommodate future plant and equipment indicated on drawings.
- .6 Protect from damage all equipment delivered to the site and during installation. Any damage or marking of finished surfaces shall be made good to the satisfaction of the Consultant.

1.15 TRIAL USAGE AND TESTS

- .1 The Owner has the privilege of the trial usage of the Security Systems or parts thereof for the purpose of testing and learning the operational procedures.
- .2 Assist in trial usage over a length of time as deemed reasonable by the Consultant at no extra cost and do not waive any responsibility because of trial usage.
- .3 Trial usage shall not be construed as Substantial Completion of the Work, or acceptance by the owner.
- .4 Provide and pay for all testing required on the system components where, in the opinion of the Consultant, manufacturer's ratings or specified performance is not being achieved.

1.16 CLEANING

- .1 Before energizing any systems, inspect and clean all equipment to ensure that they are completely free from dust and debris.
- .2 Remove all debris, surplus material and all tools.

1.17 COMPLETION

- .1 Leave Security work in specified working order.

1.18 INSTRUCTION TO OWNERS

- .1 Instruct the Owner's representatives in all aspects of the operation of systems and equipment.
- .2 Arrange for, and pay for services of service engineers and other manufacturers' representatives required for instruction on specialized portions of the installation.
- .3 Submit to the Consultant at the time of final inspection a complete list of systems stating for each system:
 - .1 Date instructions were given to the Owner's staff.

- .2 Duration of instruction.
- .3 Name of persons instructed.
- .4 Other parties present (manufacturer's representative, consultants, etc.).
- .5 Signature of the Owner's staff stating that they properly understood the system installation, operation and maintenance requirements.

1.19 DOCUMENTATION AND SYSTEMS EXPERIENCE

- .1 Assemble three (3) copies of operating and instruction manuals in three ring binders with index tab each and searchable PDF in flash drive, containing this subcontractor's and supplier's names and telephone numbers.
- .2 Each manual shall contain the following data:
 - .1 A set of as-built prints;
 - .2 Letters of Owners Instructions
 - .3 A copy of each "reviewed" shop drawing;
 - .4 Detailed equipment list itemizing the quantity, model number and serial number of all installed equipment;
 - .5 Complete explanation of operation principles and sequences;
 - .6 Complete part lists with numbers;
 - .7 Recommended maintenance practices and precautions;
 - .8 Complete wiring and connections diagrams;
 - .9 Certificate of warranty.
- .3 Ensure that operating and maintenance instructions are specific and apply to the models and types of equipment provided.

1.20 PHASING AND SCHEDULE OF WORK

- .1 Execute work in accordance with the phasing and construction schedule. Provide all necessary temporary connections and equipment to provide functional, operational systems during construction period when part of the building will be occupied and construction is still continuing in other portions.

Part 2 Products

2.1 NIL

Part 3 Execution

3.1 NIL

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with the requirements of Division 1 and all documents referred to therein.
- .2 **In case of discrepancy of the specifications details, the Owner's standards and requirements attached in the Appendices shall take precedence.**

1.2 WORK INCLUDED

- .1 The project is to be considered "turn-key" meaning that any omissions under the drawings and specifications that are deemed to be part of the overall general scope shall be included by the Contractor at no additional cost to the Owner.
- .2 The Contractor may specify at the time of bid proposal, any item deemed to be "outside" of the contract scope, but must submit a price for the item(s) at the time of bidding. No item shall be considered an "extra" after the award of the contract if it is deemed to have made the original project "turn-key".
- .3 The Contractor agrees to supply all necessary permits (and thus drawings and approvals) where required, by Local Municipal, Provincial or Federal laws.
- .4 The Contractor shall make known to the Owner, any deficiencies in the specifications prior to bid closing and thus contract award. The Contractor is required to "make-good" for any equipment either missed or unforeseen post contract award that would have been required to make the installation "turn-key".
- .5 The Contractor shall propose alternate product at no additional cost to the Owner, if the design-based product has been discontinued or obsoleted. The proposed alternate product shall have equal or better performance than the original design-based product.

1.3 INDIVIDUAL MERIT

- .1 Bidders are invited to include information on themselves that may influence the final decision. This may include company history, project history, prior dealings with the Owner, testimonials and referrals.
- .2 The contractor shall be vendor certified with certified technicians for the proposed systems and products.

1.4 SUBMITTALS

- .1 Submit Shop Drawings for all equipment, including:
 - .1 A detailed list of equipment.
 - .2 Component data sheets.
 - .3 Conceptual drawings of the proposed equipment layouts.
 - .4 Functional and wiring diagrams.
 - .5 A list of recommended spare parts and consumable items.
 - .6 An operator training course outline for both operations and administration staff.
 - .7 An overall project schedule containing dates for all project milestones.
- .2 Provide a brief overview of the system's proposed configuration and operation, including a block diagram which illustrates the system configuration.

- .3 Provide step by step procedures for the operator to perform each operation of the Integrated Security Systems including Video Surveillance System, Access Control, Intrusion Alarm and Video Management System (VMS) at the control desk or locations as shown on the drawings. These procedures are to be written in plain text and shall not require technical knowledge over and above that typically encountered with security guard forces and operation staff.
- .4 Provide manufacturer's operating instructions of all system front and components.
- .5 Provide a detailed equipment list itemizing the quantity, model number and serial number of all installed equipment.
- .6 Provide wiring lists presenting all system interconnect wiring detail in tabular form. As a minimum the lists shall contain the following information from each wire:
 - .1 Associated cable number
 - .2 Originating equipment jack/terminal block number
 - .3 Terminating equipment jack/terminal block number
 - .4 Wire colour code.
- .7 Provide a cable pull schedule which identified the cable content of each conduit run in tabular form. As a minimum, the schedule shall provide the following information for each cable run:
 - .1 Cable type(s) pulled
 - .2 Quantity of each type of cable
 - .3 Function of each cable
 - .4 Cable number/identification
- .8 Prior to start of work, the contractor is required to meet and coordinate all wiring and infrastructure with Div. 26 and 27 to ensure a complete and coordinate installation.
- .9 As the site is an active construction site, the contractor is advised to make arrangements to visit the site and understand the installed rough-in services. This contractor shall be responsible to extend services from rough-in points as required to complete the installation.

1.5 WARRANTIES AND MAINTENANCE

- .1 Warranty the complete system, including all equipment, computer software and documentation for a period of one (1) years from the date of final acceptance. The warranty shall include all parts and labour.
- .2 Assign to the Owner any manufacturer's warranties which exceed one (1) year.
- .3 Maintain the system during the warranty period and, as a minimum, provide preventative maintenance on a semi-annual basis, based on schedule submitted to, and approved by the Owner.
- .4 As a minimum during the warranty period, provide guaranteed response time of eight (8) hours for major system failure and twenty four (24) hours for a minor system failure, on a 24 hour per day, 7 days per week basis.

- .5 A major system failure is defined as the failure of any operator controls, recording components, camera power supply, or cable link which renders a number of cameras/devices inoperative.
- .6 A minor system failure is defined as the failure of a single device such as a camera, monitor, etc.
- .7 Include a current service price list for comparison purposes. If any future (beyond warranty) service price list is available, this may influence the decision of tender award. It is a requirement to list at the time of tender any mandatory service contract that may be required at the time of tender or in any future years of the system(s) operation.

1.6 QUALITY ASSURANCE

- .1 Unless otherwise specified, all equipment shall be designed to operate in a continuous unattended state and the performance of the equipment shall be maintained under varying voltage, frequency, current and environmental conditions. All components shall operate within their stated tolerances.
- .2 All equipment powered by 120 VAC shall be either CSA, ULC or ESA certified.
- .3 All AC and DC power wiring shall conform to CSA Standard C22.1 and other applicable Local and National Codes.
- .4 All wires and cables supplied under this contract shall be formed, neatly laced or Velcro wrapped and clamped into position. No adhesive or stick-on clamps or tie raps are permitted. The use of masking tape is not acceptable under any condition. The use of electrical tape is only acceptable where the use of lacing or Velcro wraps is not practical. Zip ties are not acceptable unless all other methods are not practical.
- .5 Sufficient slack shall be provided to prevent undue stress and strain on connectors and cables, to allow easy disconnection of equipment and to allow a minimum of three re-terminations of each cable or wire in the event of breakage.
- .6 Where wires run through open holes in metal, they shall be protected by suitable grommets.
- .7 Wires and cables external to equipment and enclosures shall be run in conduit or wireway. Where free movement of equipment is required, flexible conduit shall be employed. All cables in racks shall be neatly bundled and fanned into position with minimal excess on or behind the rack.
- .8 Wires and cables shall be continuous between termination and connection points. Connectors and splices shall be located within secure enclosures and are not permitted inside conduit or wireway.
- .9 Wires and cables shall be located so that inductive and capacitive effects do not degrade system operation.
- .10 All field terminations must be tested and individual test results shall be included in the completion documents.
- .11 Alpha-numerical labelling shall be installed on all equipment including equipment racks with wire list left on the site in the equipment rack. This shall be in the form of printable or pre-printed labels or wire markers.

- .12 All visible wires and cables typically accessed for service shall be labelled at both ends. As well, all connecting strips, terminal blocks, plugs and sockets shall be labelled. The marking on the labels shall be consistent with the as-built drawings. This shall be in the form of printable or pre-printed labels or wire markers.
- .13 Indoor camera equipment installed in a sheltered and heated environment shall be capable of operating in a continuous unattended mode under the following conditions:
 - .1 Ambient Temperature: 0°C to 50°C
 - .2 Ambient Humidity: 20% to 90% RH
- .14 Outdoor camera equipment installed in an exposed environment shall be capable of operating in a continuous unattended mode under the following conditions:
 - .1 Ambient Temperature: -40°C to 55°C
 - .2 Ambient Humidity: up to 100% RH
 - .3 Adverse Weather: wind up to 165 km/hr and 5cm of ice loading
 - .4 Sand and Dust: fine dust up to 150 microns.
- .15 The Contractor shall ensure that all services in the immediate areas of the System installation are protected against damage or interference by the Contractor.
- .16 Damage done to property (including equipment, buildings, etc.) during the course of the installation or testing shall be made good by the Contractor.
- .17 Any damage whatsoever during installation of the equipment supplied by the Contractor shall result in that equipment being replaced by new undamaged equipment.
- .18 During installation activities, the work area must be kept as clean and free of debris as practicable. At the end of each day during the installation period, the portions of the site utilized by the Contractor shall be cleaned, tidied and any waste material generated by the Contractor shall be disposed of. At the conclusion of an installation, the site and equipment shall be thoroughly cleaned and all damage to site or equipment made good.

1.7 COMMISSIONING

- .1 The commissioning phase begins when the installation is complete.
- .2 The Owner will perform a visual and mechanical inspection in accordance with the installation requirements of this Section and with particular emphasis on but not limited to, the following:
 - .1 Neatness, clamping and tying of wiring and cabling.
 - .2 Wire, cable and equipment identification, labelling and documentation.
 - .3 Crimping of cables and neatness around and in equipment racks, general appearance and finish.
 - .4 Programming of all systems
 - .5 Detailed staff training and records
 - .6 Field equipment installation neatness
- .3 All field devices and front end components will be acceptance tested to manufacturer's installation standards. Following acceptance tests, the Owner will

prepare and submit a deficiency list to the Contractor. Correct all deficiencies and notify the Owner when the work is complete.

- .4 Upon verifying that all deficiencies have been corrected, the Owner will issue a letter of technical acceptance signifying that the equipment and installations have been accepted.

1.8 FINAL SYSTEM ACCEPTANCE

- .1 Final system acceptance shall be awarded when all the terms of the Commissioning and the Project's Contract have been met.

Part 2 Systems INFORMATION AND PRODUCTS

2.1 SECURITY SYSTEMS - GENERAL

- .1 Provide a **fully unified, integrated and compatible** security platform for the access control, intrusion detection, video surveillance, intercom, and all other systems included in this Specifications.
- .2 Provide rack mounted UPS with 20 mins back up time for the system if the building UPS power is not available.
- .3 The security systems shall be limited to the following manufacturers and as shown on the drawings, or approved equal by the Consultant.
 - .1 Access Control System Platform (Software)
 - .1 See ICAT Specifications Appendix B
 - .2 Access Control Panels
 - .1 See ICAT Specifications Appendix B
 - .3 Access Control Card Readers (Mobile credentials ready)
 - .1 See ICAT Specifications Appendix B
 - .4 Video Management System (VMS)
 - .1 See ICAT Specifications Appendix B
 - .5 Video Surveillance Cameras (ONVIF compliant)
 - .1 See ICAT Specifications Appendix B
 - .6 Video Surveillance Monitors
 - .1 See ICAT Specifications Appendix B
 - .7 Intrusion Detection
 - .1 See ICAT Specifications Appendix B
 - .8 Intercom
 - .1 See ICAT Specifications Appendix B
 - .9 Entry Phone
 - .1 See ICAT Specifications Appendix B
 - .10 Security Switch & Server Manufacturers
 - .1 See ICAT Specifications Appendix B

2.2 ACCESS CONTROL SYSTEM (ACS)

- .1 Refer to drawings for Electronic Security & Door Hardware Responsibility Matrix and similar matrix in Division 8.
- .2 100 access fobs, 100 smartcards.
- .3 100 long range windshield tags, 100 combi cards for garage overhead door control.
- .4 Initial fob/card and system programming.
- .5 Capable of control of up to a minimum of 8 remote sites within supplied software.
- .6 System to have a fully distributed database, allowing it to be fully functional, including the execution of time tasks, without the computer/software being "on-line".
- .7 Software to be capable of running under Windows multi-tasking conditions.
- .8 Rack mount computer server, flat screen monitor and keyboard.
- .9 Power supply and door controllers. The Contractor shall provide and propose the power supply and door controller, types and quantities to suit the number of connected doors for a fully functional system.
- .10 The Electronic Access Control System software shall provide a fully integrated system package, with standard software modules to support:
 - .1 Access Control (including Biometric technologies)
 - .2 Alarm Monitoring & Reporting
 - .3 Cardholder ID Badging and Design
 - .4 System Command & Control
 - .5 Report generation for database & historical records
 - .6 Elevator control
 - .7 Guard Tour
 - .8 Asset management
 - .9 CCTV video surveillance
 - .10 Interactive Graphical mapping
 - .11 Automatic data import/export
 - .12 Data Integration Services for Active Directory and Relational Databases (such as SQL and Oracle)
 - .13 Visitor Management
 - .14 Time & Attendance and Muster Report Generation
 - .15 E-Mail/SMS Messaging
 - .16 Wireless PDA integration for Remote ID verification of Cardholders, as well as Entry & Exit Control
 - .17 Fire Alarm System Integration
 - .18 Intrusion Detection Alarm Integration (including Perimeter Detection)
 - .19 Building Management System Integration
- .11 The Electronic Access Control System shall provide the capability to fully integrate with virtually any video surveillance system, providing on-screen display of live video, and playback of recorded video from any camera on the video

surveillance system. Video display shall be manually requested, or linked to automatically display based on any specified system event. The following functionality shall be included as a minimum:

- .1 View Live Images
 - .2 Recorded Image playback
 - .3 Transaction Search
 - .4 SMS event Search
 - .5 Full PTZ Control
 - .6 Manual Recording Start/Stop
 - .7 JPEG Snapshot of Live image
 - .8 JPEG Snapshot of Recorded Image
 - .9 Download of Video Clip to AVI
 - .10 Recording Start/Stop from EACS Event
 - .11 Send PTZ pre-sets based on alarm event
 - .12 Reporting of DVR/NVR Alarm Input events
 - .13 Reporting of DVR/NVR Analytic alarm events
 - .14 Instant Replay of last minute
 - .15 Loss of Connection reporting
 - .16 Auto Reconnect
- .12 Where as shown on the drawings, electromagnetic locks (maglocks) system shall be provided by the Security Contractor, the following shall be included but not be limited to.
- .1 Maglocks shall be fail-safe, auto-sensing voltage between 12-24V DC
 - .2 All maglocks to have an LED, bond sensor and door status switch and to be ULC approved.
 - .3 Maglock power supply shall be fail-safe, complete with 120V AC input, 12-24V DC output, AC power fail and battery fail supervisory outputs, onboard DC fail and status supervisory outputs, and shall be connected to the Access Control panel for power supply monitoring.
 - .4 Maglock power supply shall be compatible with the maglocks, access control panels, fire alarm system, the maglock override/reset key switch, and batteries back-up.
 - .5 Maglock override and reset tamper-resistant key switch.
 - .6 Submit wiring diagram to the Consultant for review.
 - .7 Apply for, provide and pass all permits required for maglocks installation.

2.3 INTRUSION DETECTION SYSTEM

- .1 8 – 32 zones control panel
- .2 One zone per security device
- .3 Fully program touchscreen keypad
- .4 Ensure all devices are programmed, located and set to minimize false alarms
- .5 All devices to be fully wired. Wireless devices be accepted

2.4 VIDEO SURVEILLANCE SYSTEM

- .1 Refer Camera Schedule on drawings for details.
- .2 All cameras shall be ONVIF compliant.
- .3 Cameras shall be set to record on motion.
- .4 Outdoor housing to be provided with heater if required by manufacturer to operate.
- .5 Network Video Recorder (NVR) shall be 2U rack mounted server with licenses included, 8 HDD slots and 64 video channels.
- .6 Network Video Recorder (NVR) shall be minimum 24TB, minimum of 30 days camera recording storage. Use 50% motion as basis for storage calculation at 30 frames/second at maximum resolution in H.264 video compression format.
- .7 Contractor to submit calculations in the shop drawings to justify the proposed storage capacity to in line with the proposed cameras characteristic.
- .8 Provide all PoE and PoE+ switches, and network cable extenders as required for a complete system.
- .9 Provide rack mount computer servers, flat screen monitor and keyboard at Security Desk or location as shown on the drawings.

2.5 VIDEO ANALYTICS SYSTEM

- .1 Provide Video Analytics system functionality as below.
 - .1 Video Motion Detection: enables the camera to detect motion in the video and trigger a recording, either locally or in a video management system.
 - .2 Digital Autotracking: automatically detects, zooms in on and follows moving objects such as persons and vehicles, making it possible for the operator to effectively handle incidents and object identification.
 - .3 Fence Guard: for intrusion detection by detecting moving objects crossing user-defined virtual lines.
 - .4 Motion Guard: for motion detection in predefined areas.
 - .5 Loitering Guard: for time-based alerts of unwanted presence in semi-public areas.
 - .6 People Counter: for staff planning and entrance management.
 - .7 Queue Monitor
 - .8 Demographic Identifier
 - .9 Occupancy Estimator
 - .10 Tailgating Detector: for providing real-time alerts of unauthorized entry.
 - .11 Direction Detector: for detecting people moving in the wrong direction.
 - .12 Random Selector: for unbiased inspection of items such as shopping bags to help reduce theft and fraud.
 - .13 Perimeter Defender: a highly accurate video analytics application for perimeter protection.

2.6 VIDEO MANAGEMENT SYSTEM (VMS)

- .1 The Video Management System (VMS) shall IP-based and consist of central stations, multiple monitors, application system, system switches & servers and field installed cameras and equipment connected by the building common converged network through the application of segregated virtual dedicated local area network. The VMS shall be capable of the following:
 - .1 Scalable to add more equipment on the system.
 - .2 Available as a stand-alone system offering or pre-loaded on turnkey workstations and servers with configurable storage.
 - .3 Streaming live and recorded video from cameras connected to the system.
 - .4 Display and export saved views.
 - .5 Require no proprietary recording hardware, multiplexers, time-division technology.
 - .6 Support decompression of H.264 video through client graphics card or graphical processing
 - .7 Secure video and audio data by transmitting all command and control data via TCP/IP using cryptographic keys based on SSL.
 - .8 Support storage and processing of high definition video and audio.
 - .9 Support industry standard compression formats including but not limited to JPEG2000, H.264, MJPEG and MPEG-4.
 - .10 Provide footage of minimum 1080p resolution at 30fps.
 - .11 The Video Surveillance System servers shall deliver camera database, video streaming, video storage and video archiving functions. The server be sized to provide video retention at 15fps, H.264 compression for a minimum period of 30 days. Failover servers shall provide failover redundancy architecture such that the system is capable of complete operational integrity without system downtime due to hardware failure or maintenance.
- .2 The VMS shall be managed by a comprehensive centralized Network Video Management System (VMS).
- .3 The VMS shall be able to integrate with the Access Control System Platform seamlessly by integration or unification. The VMS shall be able to control the Access Control System Platform or vice versa under the same user interface application without the need to switch between VMS and the Access Control System Platform.
- .4 The VMS shall be capable of easily pinpointing the cameras by building, by floor, by sector and by point of interest.
- .5 The VMS shall be capable of displaying up to 16 images on any one monitor.
- .6 The VMS shall be capable of simultaneously executing viewing commands in real time and off-line, recording commands and system configuration commands.
- .7 The VMS shall be capable of remotely accessing a given camera's menu to modify its configuration parameters.

- .8 The VMS shall support a configuration and compression format that reduces bandwidth and increases archiving time, without unreasonably sacrificing the quality of the information received.
- .9 The VMS shall perform video detection so as to attract attention and to optimize archiving.
- .10 The VMS shall be capable of automatically displaying a video clip that includes images that were recorded before and during a triggering event.
- .11 The VMS shall incorporate the ability to limit access to system functions based on a person's priority levels and shall require the use of a password.
- .12 The VMS shall incorporate the appropriate functionality to ensure that the images recorded are legally admissible (protection from fabricated images).
- .13 The VMS shall allow for display and review through network-based client applications allowing for authorized users to remotely view, control and manage all aspects of the surveillance system across the network. System will have network and web access for remote monitoring, using predefined user authentication.
- .14 The VMS shall reside on system servers that shall be sized to allow for maximum system performance without any degradation, lag or video footage quality reduction.
- .15 The VMS system shall allow for viewing of all cameras at a minimum of thirty frames per second (30fps).

2.7 SECURITY SWITCHES AND SERVERS

- .1 The Video Network Switch shall be BCD BCD-ALE-6360p48X and better, or approved equal.
- .2 The Video Recording Server shall be BCD Professional grade BCD218-PVS and better, or approved equal.
- .3 The Video Surveillance Workstation shall be BCD Professional grade BCD102SD-PWS and better, or approved equal.
- .4 The Video Surveillance Storage shall be BCD SAN Storage Arrays BCD584X-SAN and better, or approved equal.

2.8 SYSTEMS INTEGRATION

- .1 The security systems shall be integrated on a single common IP network via respective servers; controllers and a common data switch to provide integrated functions as described in this specifications document and on Contract Drawings.
- .2 Access Control System and Video Surveillance System
 - .1 Upon invalid card, forces entry at a secured door or door held open beyond pre-set acceptable duration, the access control system shall signal the Video Surveillance System to display the video streams from the Video Surveillance camera with view of the respective door. The video stream shall be displayed immediately on each Security Station Monitor following the event. It shall be possible to display the video stream in full screen format or reduces size format.

- .3 Intrusion Detection System and Video Surveillance System
 - .1 Upon activation of an intrusion alarm the intrusion detection system shall signal the Video Surveillance System to display the video streams from the Video Surveillance camera with view of the activated alarm point. The video stream shall be displayed immediately on each Security Station Monitor following the event. It shall be possible to display the video stream in full screen format or reduces size format.
- .4 Access Control System and Intrusion Detection System
 - .1 Upon activation of an alarm on the access control system, the access control system shall relay the alarm as a unique addressed alarm to the intrusion detection system. The intrusion detection system shall relay the alarm to 3rd party alarm monitoring company.
- .5 Access Control System and Intercom System
 - .1 Upon activation of a door / gate intercom substation, an operator shall have the ability to open the respective door by activating a door / gate release button on the answering master intercom station.
- .6 Video Surveillance System and Intercom System
 - .1 Upon activation of an intercom station, the video feed from the activated intercom station shall be displayed at the relative master video intercom station. The video feed from the activated intercom station shall be recorded on the network video recorder.
- .7 Video Surveillance System and Duress Alarm System
 - .1 Upon activation of Panic / Duress Alarm station, the Panic / Duress Alarm shall signal the Video Surveillance system to automatically pop-up and display video streams from the Video Surveillance cameras that are in view of each activated Panic / Duress Alarm station.
- .8 Intrusion Detection System and 3rd Party Alarm Monitoring Company
 - .1 Upon activation of an alarm on the intrusion detection system the intrusion detection system shall relay the alarm as a unique addressed alarm to the 3rd party alarm monitoring company.
- .9 Access Control System and Elevator Control System
 - .1 For elevator cabs equipped with card reader, a cardholder shall be able to call the cab using the elevator call button, present their access control credential and select the destination floor. Once a selection has been made, all other floors become de-activated unless another card holder selects a different floor to travel to.
 - .2 For floors equipped with card readers located in the elevator lobby, a cardholder shall be able to call the cab by presenting their access control credential to the card reader and then press the elevator call button.
 - .3 When leaving the building, a similar procedure shall be necessary unless the destination is the ground floor.
 - .4 Each elevator control unit shall have provision to support an elevator access control board capable of individually controlling access of a minimum of thirty-two (32) floors in one elevator cab.

- .5 The service elevator control unit shall support access of all floors.
- .6 Each elevator control unit / elevator access control board combination shall control one elevator cab card reader and one floor call card reader where floor call card readers are required.
- .7 The elevator control panel shall interface with the building fire alarm panel in order to provide a hardware bypass of the access control system during a fire alarm (elevator operation shall revert to normal).
- .8 The system shall provide the ability to specify a unique unlock schedule for each elevator floor. As with reader unlock schedules, elevator schedules shall support an unlimited number of windows per day and include holiday support.
- .9 All elevator card transactions shall be sorted in memory and become available for historical report printing, including complete floor tracking capabilities, which shall capture and store which floors specific users accessed and the corresponding times and dates.
- .10 Access to controlled floors shall be restricted to cardholders with access authority for those specific floors after-hours access and shall be granted to individuals who present their card to the verification reader first.
- .11 Cardholder access authority shall be granted on a cab-by-cab and a floor-by-floor basis to provide maximum flexibility in defining a cardholder's floor access authority.
- .12 Elevator access control shall be enabled and disabled automatically according to a 7 day schedule. This schedule shall include provisions for 40 Holiday Dates on which the schedules are overridden.
- .13 Manual enabling / disabling of access control for individual floors shall be possible both remotely (from the Host) and locally using specified access cards at the cab reader.
- .14 When elevator access control is disabled, elevator operation shall revert to normal (e.g. free access shall be granted to the cab and all floors).
- .15 The response time from the moment an access card is presented to the elevator cab reader to the moment the elevator panel becomes active shall be no more than one (1) second.
- .10 Code White and Panic / Duress Alarm
 - .1 Upon activation of a Panic / Duress Alarm station, the intrusion detection system shall signal the code white system to display the activated station on a graphical map of the facility on the Security Station.
- .11 Code White
 - .1 Upon activation of a Code white wireless button, the code white system shall display the location of the wireless button on a graphical map of the facility on the Security Station.
- .12 Hospital Various Code Systems
 - .1 To be agreed with the hospital project team and user groups

Part 3 Execution

3.1 ACCESS CONTROL SYSTEM

- .1 Install front-end equipment in rack or cabinet provided by Div.27 as shown on the drawings.
- .2 Provide connection to one Owner workstation per area via Owner's network.
- .3 Conduit with pull string will be provided by Division 26.
- .4 Use cable only as specified by the manufacturer and all cables to be wire marked with detail left on-site and provided to Owner.
- .5 All exposed cable shall be mechanically protected with conduit, boxes or metal flex.
- .6 Anchor all enclosures to surfaces with lead expansion anchors and lag bolts in concrete or toggle bolts in hollow finishes or tile ceilings where electrical boxes are not provided.
- .7 Provide all wiring required to complete the installation.
- .8 Fire alarm relay and secondary contacts will be provided by Division 26 in all pull stations where maglocks are to be installed.
- .9 Provide maglock signs where and as required by building code for all maglock doors.
- .10 Division 26 will provide emergency lighting at all maglock doors.
- .11 Each/any door on the system, to be individually controlled and individually identified of an alarm condition through software.
- .12 Attach computers via Ethernet card and set up all computers in the project via Ethernet connections.
- .13 Coordinate with the Owner (minimum 8 hours) for system programming.
- .14 Show system operation (8 hours training) to Owner staff as required.

3.2 INTRUSION DETECTION SYSTEM

- .1 Use appropriate ceiling or wall mount as required for the installation.
- .2 Cost for monthly digital (phone line) monitoring per area.
- .3 Cost for 3G GSM transmission device per area and additional monthly cost.
- .4 Cost for opening closing signals per area.
- .5 Cost for failure to close (station watches for openings and closings).
- .6 Cost for monthly opening and closing reports per site.
- .7 Use cable only as specified by the manufacturer and all cables to be wire marked with detail left on-site and provided to Owner.
- .8 Conduit with pull string will be provided by Division 26.
- .9 Coordinate with the Owner (minimum 8 hours) for system programming.
- .10 Show system operation (8 hours training total) to Owner staff as required.

3.3 VIDEO SURVEILLANCE SYSTEM

- .1 Actual camera positions to be determined by this Contractor based on the intended locations shown on the drawings.
- .2 Install front-end equipment in rack or cabinet provided by Division 27.
- .3 Exposed cable installations shall be completely enclosed by conduits or Wiremold if cannot be concealed behind walls and ceilings.
- .4 Anchor all enclosures to surfaces with lead expansion anchors and lag bolts in concrete or toggle bolts in hollow finishes or tile ceilings where electrical boxes are not provided.
- .5 Conduit with pull string will be provided by Division 26.
- .6 Final camera images to be acceptable to the Owner/Consultant.
- .7 Coordinate with the Owner (minimum 8 hours) for system programming.
- .8 Show system operation (8 hours training total) to Owner staff as required.

3.4 VIDEO MANAGEMENT SYSTEM (VMS)

- .1 The product shall perform in all material respects in accordance with the accompanying user manual, and the media on which the Software Product resides will be free from defects in materials and workmanship under normal use. Software defects are covered through Service Releases and Cumulative Updates which are available for a period of 1 year from the date of the software purchase.
- .2 Extended warranty, up to 5 years, shall be available through the purchase of the manufacturer's support service which includes the following additional services over the standard warranty:
 - .1 Access to phone support and online chat for technical assistance
 - .2 Online case management
 - .3 Online system availability monitor
 - .4 Access to Major and Minor Release Upgrades
 - .5 24/7 pager support and dedicated support specialist
- .3 The contractor shall engage the services of the VMS vendor to assist in the end user training of the VMS at the end-user site.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Comply with Division 1, General Requirement, and all documents referred to therein.

1.2 APPLICATION

- .1 This Section applies to and is a part of all Sections of Division 28.

1.3 SYSTEM DESCRIPTION

- .1 IP Network Compatible Video Intercom System: A network-based communication and security system featuring video entry security, internal communication, emergency stations, and paging. All units and app in the systems shall be able to unlock doors remotely on a network, assist onsite visitors from an offsite location, broadcast emergency announcements, and communicate using a PoE network.
 - .1 Power Source: Power over Ethernet (802.3af).
 - .2 Network Interface: 10 BASE-T / 100 BASE-TX Ethernet (RJ-45).
 - .3 Network Protocols: IPv4, IPv6, TCP, UDP, SIP, HTTP, HTTPS, MJPEG, RTSP, RTP, RTCP, IGMP, MLD, SMTP, DHCP, NTP, DNS.
 - .4 Bandwidth Usage:
 - .1 G.711: 64Kbps x 2 per video call.
 - .2 64Kbps per monitor.
 - .3 H.264: 24Kbps ~ 2,048Kbps.
 - .5 Communication: Hands-free (VOX), push-to-talk (simplex), or handset (full-duplex).
 - .6 Video Display: 3-1/2 inches (89 mm) color LCD.
 - .7 Camera: Type:
 - .1 1/4 inch (6 mm) color CMOS.
 - .2 View Area: 2 feet 2 inches (660 mm) vertical x 3 feet 1 inch (940 mm) horizontal at 20 inches (508 mm).
 - .8 Video Stream: ONVIF Profile S.
 - .9 Door Release: Programmable Form C dry contact, 24V AC/ DC, 500mA - use EL-12S (use RY-24L for larger contact rating, which requires 24V DC power supply) or use RY-IP44 with 4 multipurpose relays.
 - .10 Wire Type: CAT-5e or CAT-6.
 - .11 Distance:
 - .1 Door Station or RA Station to Network Node: 330 feet (100 meters).
 - .2 Master Station to Network Node: 330 feet (100 meters).

1.4 SUBMITTALS

- .1 Product Data: Manufacturer's data sheets on each product to be used, including:
 - .1 Preparation instructions and recommendations.
 - .2 Storage and handling requirements and recommendations.

- .3 Installation methods.
- .2 Shop Drawings: Submit the following:
 - .1 Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.
 - .2 Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
- .3 Installation and Operation Manuals:
 - .1 Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
 - .2 Provide detailed information required for Owner to properly operate equipment.
- .4 Warranty: Submit manufacturer's standard warranty.

1.5 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: ISO 9001:2008 certified company.
- .2 Installer Qualifications: Factory trained and experienced with system installations of scope and size required for the Project.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- .2 Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
- .3 Handling: Protect materials during handling and installation to prevent damage.

1.7 PROJECT CONDITIONS

- .1 Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturer: Aiphone Corp.
- .2 Substitutions: 2N, Guardian or approved equal.
- .3 IP Video Intercom System: IX Series Intercom System as manufactured by Aiphone Corporation.

2.2 SYSTEM DESIGN

2.3 FUNCTIONAL COMPONENTS:

- .1 As indicated on the drawings or as required to complete system.

- .1 Video Master Station Model IX-MV7-H:
 - .1 An IP addressable video master station with a 7" color LCD touchscreen, wall or desk mounted (desk stand included), PoE, SIP compatible, 8 speed dial buttons, camera for 2-way video calls, hands-free communication with handset for privacy, card slot for microSD card, 500 station address book capacity.
- .2 Audio/Video Door Station Model with Wave To Call Model IX-DVF-HW:
 - .1 Wave to call, hand wave touchless call sensor, SIP 2.0 compliant, 1.23MP fixed color video camera, white LED for low light illumination, ONVIF compliant, card slot for microSD card, weather and vandal resistant, contact outputs/tigger inputs, stainless steel, 802.3af PoE compliant, RJ45 in/out with PoE pass-through, flush mount.
- .3 Audio/Video Door Station with Card Reader Model IX-DVF-P:
 - .1 IP addressable, HID multiclass SE proximity (or other approved 3rd party) card reader, PoE, SIP compatible, fixed camera, stainless steel panel, weather and vandal resistant, flush mount.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine areas to receive integrated security and communication system.
- .2 Notify Architect of conditions that would adversely affect installation or subsequent use.
- .3 Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

- .1 Verify the following compliance before starting installation.
 - .1 The unit turns inoperative during power failure.
 - .2 Keep the intercom wires at least 1 foot (30 cm) away from strong electrical wiring (AC 100-240V) including, in particular, wiring for inverter electrical appliances. Noise and malfunction could result.
 - .3 If a strong light shines on the main unit screen, the picture may turn white or only silhouettes will be visible.
 - .4 Other manufacturer's devices (such as sensor, detectors, door releases) used with this system, comply with the manufacturer's installation requirements.
 - .5 The LCD panel is manufactured with very high precision techniques, inevitably will have a very small portion of its picture elements always lit or not lit at all. This is not considered a unit malfunction. Please be aware of this in advance.

3.3 INSTALLATION

- .1 Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.

- .2 Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.4 SET-UP AND ADJUSTING

- .1 Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION AND TRAINING

- .1 Demonstration:
 - .1 Demonstrate that integrated security and communication system functions properly.
 - .2 Perform demonstration at final system inspection by qualified representative of manufacturer.
- .2 Instruction and Training:
 - .1 Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
 - .2 Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
 - .3 Provide instruction and training by qualified representative of manufacturer.

3.6 PROTECTION

- .1 Protect installed integrated security and communication system from damage during construction.

END OF SECTION

Appendix A

YRND – ITS Standards and Guidelines

York Region Information Technology Services

Standards and Guidelines



ITS Corporate Network Cabling Standard

Current Published Version

February 14, 2025

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Document History

Revision & Schedule History

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Change Summary

Date	Summary
July 28, 2016	Minor grammar and syntax updates. Fax Lines Requirement – Deleted. Appendix D & E updated.
January 9, 2017	Replaced must with shall, and added Document Changes table to document history.
August 28, 2017	Changed cabling 6A to 6A F/UTP.
April 24, 2018	Changed in-building renovations in scope, multimode optical fibre to OM4, added appendix B, changed BAS, Security Panel (Honeywell), rack cabinet installation, and applied new corporate writing style.
May 9, 2018	Updated contact information.
June 28, 2018	Added Appendix K.
January 22, 2019	Updated technical specifications.
December 19, 2019	Renamed from Cabling and Wiring for Voice and Data Communications to Corporate ITS Cabling & Wiring Standard. Updated network equipment.
March 25, 2020	Formatting, grammar, spelling updates.
April 21, 2020	Updated Appendix 2, and general requirements for network equipment.

July 9, 2020	Updated network devices on York Networks, category patch cords, and vertical cable managers.
September 14, 2020	Minor grammar and syntax updates. Removed duplicate heading product specifications n page 18. Promoted second and first level heading, fibre optical cable page 20. Added Appendix L – WAP/Mounting.
November 9, 2020	Updated appendices H with cable talk 2 post rack; M with WAN/ISP duct bank; N with WAN/ISP ducts inside communications room; updated network equipment; and updated communication rack and cabinet.
March 1, 2021	Background & Purpose, Network Devices on York Network, updated to Securing Network Devices on York Network,c, d, and e added. Technical Specifications, updated to Structured Cabling Technical Specifications Termination Hardware, updated to Termination Specification Horizontal Cables, updated to Category Patch Panels Fibre Optic Cable, Connectors moved to section Termination Specification PS Security section updated Enclosure Wiring, changed to Labeling Guidelines Update: Property Services – Security Panel, Building Automation System (BAS)
April 12, 2021	Minor update and changes.
June 28, 2021	The following has sections that have been modified, relocated or deleted: Enforcement Language; Background and Purpose, Contact, Objectives, Scope; Structured Cabling Technical Specification, Recognized Media, Regulatory References & Standards, Waste Management & Disposal, Testing & Commissioning; Product Specification, Backbone Cabling, Conduits, Backbone Interconnect, Fibre Optic Cable, Fibre Optic Connectors, Category Patch Cord; Network Access Closet has been changed to Network Access Room; Execution, Horizontal Cable Installation, Fibre Optic Cable Installation; Appendix; References
July 21, 2021	Further changes to grammar, syntax and tightening of language through the standard.
February 8, 2022	Minor spelling, grammar changes.
February 6, 2023	Updates to the following sections: Site Walk through; Telecom Contractor to provide port count; Structural Cabling Technical Cabling update to include end-to-end by specified color and single contractor for cabling; Cabinets for small deployment and for ENV NEMA4 inserted Appendix F, Category Cabling Color Scheme for Services inserted Appendix L; Sample Matrix of Port Count Report inserted Appendix M; Network Closet Checklist for Standard Sites inserted Appendix N, and remaining adjusted accordingly;
May 12, 2023	Added wall mount cabinet to Appendix D; updated Appendix K, and changed underscore to hyphen.
June 18, 2024	Updates to the Environmental section #3.; Appendix G: removed Hammond and replace with Hoffman Cabinet; and updated the URL in Appendix E.
February 10, 2025	Appendix A, update data drop format; NAC Floor finish epoxy; Patch cable gauge from 26 to 28; correct grammar; change name of file/document to reflect name on title page.

Additional Information

Enterprise Architecture manages annual reviews and promotion of the standard.

Contact

This standard is updated frequently. Contact the person below to ensure that you have the most recent version of this document.

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Consulted Organizations

The following individuals and groups were consulted in the formation of this standard.

Organization Consulted	Division	Branch	Date
Ministry of Government Services	Infrastructure Technology Services	Corporate Architecture Branch	April 2011
Belden			May 18, 2021

Committee or Working Group Consulted	Date
Enterprise Architecture	March 2012
Infrastructure and Operations	March 22, 2011
ITS Branch Review	April, 2012

Enforcement Language

The meaning of the words shall or should or must and recommend are clearly define here:

- Shall: this word, or the terms required or must, means that the statement is an absolute requirement.
- Should: this word, or the adjective recommended, means that there may exist valid reasons in particular circumstances to ignore the recommendations, but the full implications must be understood and carefully weighed.
- Exception: An exception refers to a specific case where a standard does not apply, even though the general rule remains in effect for all other cases. Exceptions are often temporary.
- Exemption: An exemption is the complete release from the standard for specific individuals, groups, or circumstances. An exemption is more permanent and grants full freedom from compliance with a particular rule or requirement.

Cabling and its installation shall comply with the requirements of the authority having jurisdiction (AHJ) and applicable regulations. This includes, but is not limited to, the cabling jacket ratings.

Introduction

Background & Purpose

This standard defines the design minimum technical and quality requirements for wiring of voice and data communications rooms in all buildings that are managed by, or on behalf of The Regional Municipality of York.

This standard includes new developments, revisions, and updates in cabling plant such as Power over Ethernet (PoE) data centre specific standards, cabling for wireless access points, digital signage, security, and other operational technologies (O/T) that use structured cabling for their infrastructure and the administration standard for cabling plant management. Four topic areas include.

1. **Data centres that are managed by or on behalf of the Regional Municipality of York.** Data centres are included to provide requirements and guidelines for the data centre design and installation. These requirements and guidance are found in ANSI/TIA-942: Telecommunications Infrastructure Standard for Data Centres.
2. **The Cabling of buildings for wireless access points.** Provides requirements and guidelines on the installation of a customer premises cabling system infrastructure for an array of coverage areas that form a wireless network grid within a building. These requirements and guidelines are found in TIA TSB-162: Telecommunications Cabling Guidelines for Wireless Access Points.
3. **Specific adherence to the IEEE 802.3 standards** provides for the implementation of power over Ethernet or data lines within the plant owned by, or managed on behalf of the Regional Municipality of York.
4. Specifies a uniform administration approach to the management of a telecommunications cabling system as found in ANSI/TIA -606: Administration Standard for Telecommunications Infrastructure.

This standard applies to all new or major retrofit wiring of data and voice communications in existing Regional Municipality of York buildings.

Network Equipment

1. Project will provide the budget for all network equipment including network switches, wireless access points, wireless controller, uninterrupted power supply, firewalls and any other network equipment that ITS considers mandatory to support the setup and configuration the network to meet ITS standards.
2. ITS will procure all network equipment including network switches, wireless access points, wireless controller, uninterrupted power supply, firewalls and any other network

equipment that ITS considers mandatory to support the setup and configuration of the network to meet ITS standards based on the budget.

3. Telecom contractor shall supply network racks, cables, patch panels, cable trays and any associated supplies for cabling based on ITS Cabling and Wiring Standards.
4. Telcom contractor shall provide port count by network closet and by device type (data/voice, WAP, BAS, Energy, Camera, IoT) to enable Corporate ITS requested quotes for network equipment and to assign IP-addresses (see Appendix M).
5. Telecom contractor shall provide any emulated Wi-Fi surveys with input, review and acceptance for Corporate ITS.
6. Telecom shall install racks, run network cables and terminate to patch panels, install UPS and WAPs based on instructions provided by Corporate ITS.
7. Backbone and horizontal infrastructure cabling shall be completed by an installer certified by the cabling system manufacturer, and the cabling shall be certified upon completion.
8. ITS recommends that category cable patch panels be from manufacturers that meets or exceeds ANSI/TIA 568.2 Category 6A performance requirements and design specifications.

Securing Network Devices on York Network

1. All devices that require connectivity to York Networks shall be direct network run.
2. A list of all devices not issued by York ITS that will connection to the York Network must be provided to Corporate ITS. The list must include the make, model and specification and function.
3. ITS Security must conduct ITS security testing on all devices prior to connection to the York Region Network.
4. If testing of device is not done prior to connection, then it is done when the first device is added to the network.
5. If York ITS identifies security issues, these issues need to be resolved by the vendor.
6. ITS Security and Enterprise Architecture will review and make recommendations as well as provide a path to ensure that the device is a safe device to be on the York Region network.

Objectives

The Objectives of this standard are to:

1. Provide safe, reliable, uniform and up to date facilities for the convenient connection of telephones, computers, computer terminals and other communications related technologies utilizing cabling and wiring in Regional offices.
2. Achieve significant cost savings in the rearrangement of government offices and the relocation of government services and personnel by uniform and flexibly arranged communications connections.
3. Increase the value of the investment in the cabling infrastructure by reducing the labour expense of maintaining the system, extending the useful life of the system and providing effective service to users.

Scope of Standard

The following platforms, and facilities are in scope of this standard.

1. Horizontal and vertical structured cabling platforms
2. Data centre structured cabling platforms
3. In-building facilities including
 - a. Main telecommunications room
 - b. Telecommunications rooms
 - c. Workstations
4. In-building renovations
 - a. If cabling is less than Category 6 standard or older than 10 years, must be replaced with current standard including the patch panel and all related connectivity.

Out of Scope

Electrical cabling is not covered by this standard.

Education & Training

Data Centre and technical staff shall be trained and experienced on the technologies used pertaining to structure cabling infrastructure.

ITS Corporate Network Cabling Standard

eDOCS: 5708119

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Last updated: February 14, 2025
Last Reviewed: February 14, 2025
Approved by: TSB

Authority, Exceptions and Exemptions

Any change, exception, exemption or deviation from this standard shall be reviewed by the Region's Strategy & Architecture, Technology Planning units and approved by the Technology Standards Working Group (TSWG). Any change to this standard shall be submitted to the TSWG.

Structured Cabling Technical Specification

1. The contractor shall provide a complete and operating Structured Cabling Platform to support existing and future communication systems in Regional facilities. This includes all horizontal cabling for data applications as well as backbone.
2. All cabling for the network shall be completed by one cabling contractor that is able to provide cable as built and test results.
3. Network (horizontal) cabling shall adhere to York ITS Network Standard Category cabling color specification and installed end-to-end including keystone and patch cables.
4. If product specifications, design and installation guidelines are not provided or in conflict with references listed below. The more stringent requirement shall apply.
5. The Horizontal Structured Cabling Platform installed shall meet or exceed the channel requirements for voice and data transmissions as defined by ANSI/TIA-568.2.
6. Any Structured Cabling Platform installed in a Data Centre or Communications Room shall follow the mandatory requirements, guidelines and best practices for data centre cabling systems, pathways and design considerations found in Regulatory References and Standards: Telecommunications Infrastructure Standard for Data Centres.
7. Category 6A UTP (500MHz) 23AWG cabling shall be used as the minimum rated twisted pair cable. Horizontal cabling should be installed point-to-point, no network consolidation point.
8. Cables, associated connecting hardware, jumpers, patch cords, equipment cords and zone area cords shall meet all applicable requirements specified in ANSI/TIA-568.2.2 and ANSI/TIA-568.3.

Recognized Media

1. 100 ohm twisted-pair cable, ANSI/TIA-568.2, Category 6A UTP 23AWG.
2. Patch cables of minimum Category 6A F/UTP 28AWG.
3. Multimode optical fibre cable OM4, ANSI/TIA-568.3.
4. Single-mode optical fibre cable, ANSI/TIA-568.3.

Regulatory References & Standards

The standard defines specific categories of cabling, components, transmission performance, system models, and measurement procedures. These are needed for verification of cabling performance that shall be used at a minimum for any new or major retrofit wiring of data and voice communications in existing York Region buildings. These are the requirements found in recognized telecommunications industry standards:

Cabling Systems

1. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises
2. ANSI/TIA-568.1: Commercial Building Telecommunications Infrastructure Standard
3. ANSI/TIA-568.2: Balanced Twisted Pair Telecommunications Cabling and Components Standard
4. ANSI/TIA-568.3: Optical Fibre Cabling and Component Standard

Spaces and Pathways

5. ANSI/TIA-569: Telecommunications Pathways and Spaces.

Cabling Administration

6. ANSI/TIA606: Administration Standard for Telecommunications Infrastructure.

Telecommunications Infrastructure Standard for Industrial Premises

7. ANSI/TIA-1005: Telecommunications Infrastructure for Industrial Premises.

Telecommunications Infrastructure Standard for Data Centers

8. ANSI/TIA-942: Telecommunications Infrastructure Standard for Data Centres.

Wireless Access Points

9. TIA TSB-162: Telecommunications Cabling Guidelines for Wireless Access Points

In addition, coverage of this standard includes new developments and updates in cabling plant such as Power Over Ethernet (PoE) data centre specific standards, cabling for wireless access points and the administration standard for cabling plant management.

All work shall conform to industry accepted practices, manufacturer's component installation guidelines, the Ontario building code, the Canadian Electrical Code, and all applicable standards. The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies. Furthermore, compliance with the AHJ will supersede all other specifications.

This standard applies to all new or major retrofit wiring of data and voice communications in existing Regional Municipality of York buildings.

Documentation

Documentation related to the installation, maintenance and disposal of cabling plant shall be created and maintained by the parties responsible for installing and maintaining the cabling infrastructure on behalf of the Regional Municipality of York. This administration of the cabling plant is governed by the mandatory use of Standard Update to Administration for the telecommunications infrastructure; and the labelling convention described in Regulatory References and Standards under Cabling Administration.

The following line items describe individual requirements that are to be applied to all Communications Cabling projects. The line items are meant to serve as a guideline for the Regional requirements.

All horizontal cabling shall be installed from the workstation location, or on modular patch panels installed into racks or cabinets. For small sites, the customer can specify wall-mounted patch panels in lieu of racks where appropriate due to site constraints and capacity requirements.

Allowances

Devices, racks, cabinets, backboards or outlets may be relocated, prior to installation, from the location shown on the contract drawings, to a maximum distance of 3.05 meters (10 feet) without adjustment to the contract price.

Waste Management & Disposal

1. The cabling contractor shall remove and dispose of all abandoned horizontal voice, data and coaxial cabling.
2. If the cabling contractor is unsure of the status of the cables, they shall confirm the removal with the project manager prior to performing the work.

Testing & Commissioning

1. Provide two copies of testing and commissioning documentation for all items and their related components to the project manager prior to the completion of the project or at the project manager's request.
2. Include maintenance manuals, operating instructions for the Region's staff.
3. All test data, including daily equipment reference checks, shall be submitted in native tester format (e.g. FLW files for Fluke) and summary in PDF.

Warranty

1. The contractor shall provide a complete and operating Structured Cabling Platform to support existing and future communication systems in Regional facilities. This includes all horizontal cabling for data applications as well as backbone.
2. The structure cabling platform in each individual building or site shall be manufactured and warranted by a single manufacturer for all components of the structured cabling platform including backbones.
3. The successful bidder shall install a complete structured cabling platform that is manufactured and warranted by a single vendor.
4. The successful bidder shall be authorized by the cable vendor to install and warranty the system.
5. If a sub-contractor is used for the installation, it is mandatory that the sub-contractor be currently authorized to install and warranty the system.

Site Walkthrough

The cabling contractor shall participate in network cabling walkthroughs:

1. 0% walkthrough: Initial pre-construction walkthrough with ITS, York Region and General Contractor (GC) to ensure that the scope of work is understood and for questions regarding ITS Network cabling standards.
2. 50% walkthrough: to confirm the project is on track and the cabling standards are adhered to.
3. 100% walkthrough: for the network closet acceptance (cabling is completed, Network closet is free of all debris, testing results and has builds have been provided, etc) with ITS, York Region, GC and cabling contractor. The acceptance is contingent on satisfying the criteria outlined in "ITS New/Renovated Site Networking Provisioning Checklist" (Appendix N).

Product Specifications

Backbone Cabling

Optical Cabling Backbone

1. OM4 fibre backbone cabling shall comply to ANSI/TIA-568.3.
2. Each Fibre backbone cable shall have a minimum of 12 strands OM4 distribution type fibre. The OM4 distribution type fibre will perform as per industry standards over the required distance defined for the site. Mated connector loss for OM4 shall not to exceed 0.25 dB.

Conduits

1. Conduit fill ratios shall never exceed the recommendations of ANSI/TIA-569.

Backbone Interconnect

1. If there is a requirement for an interconnection between wiring closets on the same floor, or multiple floors, it shall be interconnected with minimum of six fibre OM4 rated fibre optic backbone terminated with LC connectors.
2. All connectors for the termination of the fibre optic backbone cable shall be duplex LC connectors.
3. Fibre optic enclosure shall meet the following requirements:
 - a. Enclosure shall include a slide-out drawer for front access of the terminations.
 - b. Enclosure shall support LC connectors.
4. For multimode fibre optic terminations inside access closets fibre patch panels the connectors shall be preloaded adapters configured with LC duplex multimode adapters.
5. Provide duplex OM4 fibre optic patch cables LC to LC.

Termination Specification

Category Patch Panels

5. All horizontal cables are to be terminated on RJ45 jacks, inserted into modular category patch panels, and placed in the telecommunications room for that floor.
6. The modular patch panel should minimise the rack space used and should not exceed two rack units in height.

Fibre Patch Panels

1. If required, the number of strands to be supplied and installed is a minimum of 12. The project manager, in consultation with the Region, will finalize quantity and type of fibre to be installed.
2. All Fibre backbone is to be terminated using a fibre patch panel on a communications rack.
 - a. The 12 strands of fibre shall be installed in the fibre patch panel and placed in a rack in the telecommunications room for that floor.
 - b. The fibre patch panel should minimize the rack space used, it cannot exceed three rack units in height.
 - c. The fibre patch panel shall be serviceable from the front by allowing the fibre patch panel to slide or pivot away from the rack.
 - d. The fibre patch panels are to be mounted at the upper most position on the racks of each floor.
3. Provide all necessary accessories for a complete fibre patch panel including, but not limited to: clear cover plates, mounting brackets and hardware, LC duplex fibre bulkheads, LC connectors and fibre cable management.
4. The physical fibre optic cabling topology and the type of fibre connectors shall be determined and finalized during design build of project.

Fibre Optic Cable

1. Provide all fibre optic cable, connectors and appurtenances that make up the backbone cable segments.
2. The fibre optic backbone cable segments shall meet the requirements of the TIA/EIA-568.3 specifications.
3. Multi-mode fibre optic backbone cable shall be OM4.
4. Single mode fibre optic backbone cable shall be OS2.

Connectivity

Category Patch Cord

1. Three patch cords seven feet in length per drop shall be provided on site, two for the IP phone/desktop connectivity, and one for the patch panel to network switch.
 - a. These cords shall match the cabling category being installed. Further small OD patch cords shall be used where the performance of the network will not be negatively affected: i.e. channel length and configuration, data transmission and power delivery.
2. The project manager, in conjunction with the ITS planner and Network Operations, shall determine the fibre and category patch cable length as needed.

Fibre Patch Cord

1. All fibre patch cords shall be connected to the customer supplied active equipment using LC duplex zip cords.
2. The fibre patch cords are to be seven feet in length. LC duplex zip cords are to be consistent with the grade and manufacturer of the fibre cable that is being warranted.

Communications Rack & Cabinet

1. All racks and cabinets to be supplied and installed to be bolted to the floor or otherwise secured to prevent tipping, 19" floor mounted with 44U of rack mounting space.
 - a. Racks and cabinets shall be tapped both front and back with mounting holes as per EIA-310-C, size 10-32, as well as include a ground lug to accept a #6 AWG grounding wire.
2. All network access spaces dedicated to York Region ITS network and Security should utilize 2-Post open frame rack (see Appendix H).
 - a. If other services beyond ITS Network/Security is to be hosted, types of rack/cabinet installation should be discussed and determined by York Region IT Services.

Vertical Cable Managers

1. Network cabinet shall come complete with two vertical cable managers installed: one mounted on each side.
2. Network rack cable managers shall be one of two dimensions. Micro and small sites four inches wide by four inches deep.
3. Medium and large sites 7.5 inches width by six inches deep.
4. The vertical cable manager shall have hinged front door(s), back and side cut outs to allow for patch cords.
 - a. It shall also have lancets along the back of the cable manager to allow for the fastening of the horizontal cable to the outside of the manager itself.
 - b. Higher density drops may require vertical cable management with increased width and depth.

Overhead Cable Manager & Chimney

1. Each cabinet and rack shall come complete with a hinged overhead cable manager installed, with minimum dimensions of eight inches wide by two inches deep.
 - a. Where racks are ganged, the overhead cable manager is to be continuous across the gang of racks; both ends of the ganged racks are to be completed with end caps.

2. At the right side of each rack a cable management chimney shall be installed. They shall extend from the top of the overhead cable manager to the underside of the ladder tray/ceiling tile above.

Equipment Shelves

1. Each cabinet and rack is to be supplied with, at a minimum, one equipment shelf if requested; this is to be installed at the direction of the customer.
2. The equipment shelf shall be centre mounted and have a minimum of 18 inches of depth.

Vertical Switched Zero PDU

1. Each cabinet and rack is to come complete with two vertical switched Zero U PDU mounted to the back of the rack.
2. Each PDU is to have a minimum of eight outlets rated at 110V, 15A. The power bars are to have a minimum power cord length of six feet.
3. The power bars shall not have reset breakers or an on/off switch.
4. The Customer may require additional power requirements over and above what is detailed above. It is the responsibility of the Project Manager to provide these requirements to the Cabling Contractor.

General Enclosure Requirements

1. All indoor enclosures containing network components are to be installed in a two-post, four-post open rack frame, or cabinet.
2. All screws, bolts, fasteners etc. are to be corrosion resistant stainless steel.
3. All wall-mounted panels are to be separated from the wall by stainless steel spacers or galvanised steel struts.
4. Doors shall have continuous hinges with removable pin and oil resistance cellular neoprene gasket secured by gasket retainers.
5. Door handles shall be recessed type (freestanding enclosures) or three-point external latch wall mount, complete with key locks. All key locks are to be identically keyed. The key number shall be provided to the Contractor during construction.
6. Cable bundles shall be neatly laced, run in ducting or approved cable managers and secured to 19-inch rack or mounting back-panel.
7. All enclosure doors shall open through 180 degrees without restriction.
8. Enclosure layout and equipment spacing shall be constructed to allow for device removal, calibration and maintenance without disassembly of adjacent devices.
9. All freestanding, floor-mounted enclosures shall have removable CSA eyebolts to facilitate sling handling of each enclosure.
 - a. Eyebolt mounting shall be a part of the structural support bracing to distribute stresses and enclosure weight while sling handling enclosures during installation.
10. All enclosures shall have sufficient structural reinforcements to ensure a limited plane surface vibration and to provide rigidity during shipment, installation and operation without distortion or damage to the enclosure, mounting panel or mounted instruments.
11. All enclosure seams shall be continuously welded and ground smooth to be undetectable after painting.
12. Devices shall be installed on the enclosure back-panel or 19-inch rack.
13. There shall be no devices installed on the side plates of the enclosure.

Enclosure Wiring

1. All enclosure wiring shall run through cable management. All cabling is managed, protected, and enclosed.
2. Cable managers shall not be filled to more than 50 percent of their volume upon initial installation.

3. All wires and cables, including spares, shall be identified at each end and at any connection. Use durable non-fading sleeve type wire markers to identify all network cables as follows:
 - a. Labels for cabling shall be laser printed, self-laminating, adhesive, polyester (indoor/outdoor).
 - b. Hand-written labels will not be accepted.
 - c. Lettering shall be black on a white background. Characters shall be a minimum of four millimetre high.
 - d. Wire markers are required on each conductor in panel board gutters, and at load connections. The identification shall include branch circuit or feeder number for power and lighting circuits, and control wire numbers for control wiring.
 - e. All field wires and cables terminated within enclosures shall be identified at each termination with a marking that corresponds with the drawings and supporting documentation.
 - f. Power wiring insulation shall be rated at 600 volts at 90 C and be type RW 90 THHN. Conductors shall be stranded copper. No wire smaller than 12 AWG shall be used for power wiring, unless noted otherwise on the drawings.

Rack & Cabinet Installation

1. All cable is to enter through the bottom or top of the cabinets. If coring of the floor is required for the passage of cable the Contractor is to X-Ray the floor in accordance with Division 1.
2. Provide a 12" wide minimum cable tray segregated for power, fibre and horizontal UTP cables for overhead cabling as shown on the Contract drawings. Cable management is to be provided from the cable tray to the enclosure to ensure that the minimum bend radius for each cable is maintained and the cable is rigidly supported.
3. Electrical
 - a. Provide the electrical distribution for each core and server closet as per the related Electrical Distribution drawings and relevant standards.
 - b. Provide each core and server closet with required number of duplex 15A, 120 VAC.
 - c. The project manager will provide UPS Receptacle specification to the contractor, typically one of the following which will be dependent on Load/Runtime requirement or if building generator/UPS is in scope.

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UPS Receptacle Option	UPS Series	Input Power
Option 1	APC UPS 1500	NEMA 5-15R
Option 2	APC UPS 2200	NEMA 5-20R
Option 3	APC UPS 3000	NEMA L5-30R
Option 4	APC UPS 5000	NEMA L6-30R

- d. Secure each rack and cabinet to ground.
- e. The duplex receptacles shall be mounted in such a manner as not to interfere with access to or removal of other equipment within the enclosures.
- f. Power distribution within the enclosure shall be via vertically mounted power bars.
- g. Redundant power supplies, within the same device, shall not be connected to the same UPS circuit.

Network Access Room

1. Network Access Rooms (NAR) shall be large enough to accommodate all of the equipment and wiring that will be placed in it and include extra space to accommodate any future growth.
2. NAR shall meet the requirement of ANSI/TIA-569

Environmental Specifications

1. Shall satisfy environmental requirements that include, but not be limited to power supply, heating, ventilation, and air conditioning.
2. NAR should maintain a room temperature between 19 to 23 degrees Celsius for the cold zone with the assumption that air flow is from front to back (cold to hot) when all LAN equipment is in full operation and a relative humidity of between 30 to 50 percent.
3. Open water sources are prohibited. Sources include but are not limited to hose bibs, slop sinks, plumbing fixtures and maintenance drains in hydronic heating and cooling.
4. The wiring closet shall not double as a storage area for cleaning products, chemicals, equipment, cardboard, or furniture. The wiring closet shall be kept clean and free of any debris.
5. There should be at least one duplex power outlet positioned every 1.8 meters along each wall of the room and should be positioned 15 cm above the floor. A wall switch that controls the room's main lighting should be placed immediately inside the door.
6. Floor finish to be general service, low volatile organic compound (VOC) solid colored (grey) epoxy coating.
7. UPS plug type and BTU for equipment shall be provided by York Region ITS.

Cable Access & Support

1. If data closet serves as a Main Distribution Facility/Facilities (MDF), all cables running from it to Intermediate Distribution Facility/Facilities (IDF), computers and communications rooms on other floors of the same building should be protected by a four inch conduit or sleeved core.
2. The exact amount of conduit that is required is determined by the amount of fibre optic, UTP, and STP cable that shall be supported in each NAR.
3. Cabling should be run through four-inch sleeves that are placed above the door level. To ensure proper support, the cable should be run from the sleeve directly onto a 12-inch ladder racked in the room.

4. Supply and install all horizontal wiring, jack boxes, raceway, wall plates, telephone punch-down blocks and identification labels.
5. Identify all wiring at both ends, at the jack end and in wiring closet.
6. Terminate, test and certify all installed wiring in accordance with industry standards.
7. Include additional lengths of conduit to provide for future growth.

Property Services — Security Panel

1. Lenel solutions is used for access control, Bosch for Intrusion and Milestone for CCTV for all new sites. CCTV system is a requirement for facilities accessed by the public unless otherwise specified (examples. Court Services, YRT, ENV and Corporate Sites). This will include an onsite video server, UPS back-up and the XProtect application connected to the database servers at 17250 Yonge Street, Newmarket.
2. Security cabinets shall be placed in the NAR or Electrical room and will require a standard wall space of four feet high by eight feet wide. This may increase depending on the size of the facility and requirements for card access and panic alarms.
3. The following requirements shall be adhered to:
 - a. There shall be 32 square feet of wall space.
 - b. Be eight-inch in depth, and require an additional 28 inches of clearance for a total of three feet.
 - c. Panel area should be situated three feet vertically from the floor and the panel should be installed on fire retardant backboard.
 - d. Security panels should not be placed in mechanical rooms, or general areas opened to staff or other personal.
 - e. Security panels are to be supplied with dedicated emergency power.
4. Category 6A cable, Purple in color should be used for end-to-end horizontal cabling, patch cable and keystone.
5. Facilities with on-site security guards will require a XProtect Smart Client workstation with monitors. The quantity referenced in site specific design and are to be in the security office.

Building Automation System (BAS)

1. Building automation equipment may be in various locations including, but not limited to the NAR, ceiling, mechanical room and the electrical Room.
2. Typical cabinet size that would be expected to be in the NAR.

- a. Two feet wide by three feet high and six inches in depth with a door swing of two feet, seven inches
 - b. Eighteen inches wide by eighteen inches high and six inches in depth with a door swing of nineteen inches
 - c. Quantity maybe one to three depending on number of points Panels should be situated six feet vertically from the panel top to floor and should be installed on fire retardant backboard.
3. Conduits should be used to join the larger cabinets.
4. Power Supply to BAS panel should be separate and has its own junction box or panel.
5. Category 6A cable, Orange in color should be used for end-to-end horizontal cabling, patch cable and keystone.
6. All BAS Category 6A drops shall be terminated to a patch panel in the network rack.
7. Requirement of one data jack per IP device located beside the cabinets in which the devices are located.
8. If placed in the vicinity of a network racks, there should be an additional two feet of clearance.
9. All enclosure wiring shall run through cable management. All cabling is managed, protected, and enclosed.
10. Cable managers shall not be filled to more than 50 percent of their volume upon initial installation.

Labeling Guidelines

1. All wires and cables shall be identified at each end, and at any connection. Use durable non-fading sleeve type wire markers to identify all network cables as follows:
 - a. Labels for cabling shall be laser printed, self-laminating, adhesive, polyester suitable for indoor and outdoor use.
 - b. Hand-written labels will not be accepted.
 - c. Lettering shall be black on a white background. Characters shall be a minimum of four millimeters high.
 - d. Wire markers are required on each conductor in panel board gutters, and at load connections. The identification shall include branch circuit or feeder number for power and lighting circuits, and control wire numbers for control wiring.

- e. All field wires and cables terminated within enclosures shall be identified at each termination with a marking that corresponds with the drawings and supporting documentation.

Category & Fibre Patch Panel Identification

1. York Region Category and fibre patch panels identification shall follow the standards outlined below. Any exceptions to the following requirements shall be approved by the Region's project manager.
 - a. Labels for patch panels shall be laser printed, self-laminating, adhesive, and polyester or polyolefin.
 - b. Hand-written labels will not be accepted.
 - c. Lettering shall be black on a white background and shall be a minimum of six millimetres high.
 - d. Labels shall be applied to be readily visible, and not obscured by structured cabling or patch cords.
 - e. The tagging convention for network closet patch panels will employ a six-character alphanumeric tag. The first three characters will indicate location consisting of floor and access closet identifier. The last three characters shall use a unique number incrementing with each drop within each closet.

Face Plate

1. York Region UTP patch panel termination point identification shall follow the standards outlined below. Any exceptions to the following requirements shall be approved by the Region's project manager.
 - a. Labels for faceplate shall be laser printed, self-laminating, adhesive, and polyester or polyolefin.
 - b. Hand-written labels will not be accepted.
 - c. Lettering shall be black on a white background and shall be a minimum of four millimetres high.
 - d. A label shall be applied to the top of each faceplate indicating the destination of the faceplate.

Fibre Optic Patch Panel

1. York Region fibre optic patch panel termination point identification shall follow the standards outlined below. Any exceptions to the following requirements shall be approved by the Region's project manager.
 - a. Terminate all fibres of each fibre optic cable in either 36/72 Fibre Enclosures for access closets, or 36/72/144 Fibre Enclosures for core closets.
 - b. The ordering and colour of individual fibres will be the same for each fibre cable and compliant with ANSI/EIATIA-568.3.
 - c. Labels shall be laser printed, self-laminating, adhesive, and polyester or polyolefin.
 - d. Hand-written labels will not be accepted.
 - e. Lettering shall be black on a white background and shall be a minimum of four millimetres high.
 - f. A label shall be applied to the top of the fibre duplex adapter modules associated with a single fibre cable indicating the destination of the cable.

Backbone & Horizontal

1. York Region network cable identification shall follow the standards outlined below. Any exceptions to the following requirements shall be approved by the Region's project manager.
 - a. Use durable non-fading sleeve type wire markers to identify all network cables.
 - b. Labels for cabling shall be laser printed, self-laminating, adhesive, and polyester for indoor and outdoor use.
 - c. Hand-written labels will not be accepted.
 - d. Lettering shall be black on a white background and shall be a minimum of four millimetres in height.
 - e. Fibre Optic Backbone Cables
 - i All fibre optic backbone cables are to be labelled at both ends of the cable.
 - ii The fibre backbone cables are to be labelled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
 - iii If the fibre cable is run in conduit, then the transition labels shall be applied to the conduit.

- iv The tagging convention for identification of fibre optic backbone cables shall indicate the source and destination of the cable.

- b. Horizontal Cables

- i As a minimum, all horizontal Category 6A UTP cable is to be labelled at both ends of the cable.
- ii The tagging convention for identification of horizontal cables shall indicate the drop sequence and Telecommunications Room (TR) of the cable.

Execution

1. Provide all components and appurtenances necessary to ensure that the network closets are functional and meet the intent of this specification.
2. Locate work area outlets where the length of the horizontal cable runs from the access closet interconnect to the work area outlet shall be less than 90 meters. For work area outlets where this proves impossible the Contract Administrator will authorize in writing an exception if the link still meets the performance requirements of this specification.
3. The Contract Administrator reserves the right to relocate access closets and work area outlets within three metres of the locations identified in the contract drawings at no additional cost to the Region.
4. The contractor is responsible to size all power supply cables to meet the requirements of the Ontario Hydro Safety Code based on field verified length of cable run and power supply load.
5. Cable & Conduit
 - a. Provide one Category 6A UTP, horizontal cables to each work area outlet from an access closet in a Electric Magnetic Tube (EMT) conduit, sized to accommodate quantity of cabling and a minimum trade size of 35 1-1/4.
 - b. Conduit carrying horizontal cables shall enter the work area outlet through the top or bottom.
 - c. Conduit shall be Electric Magnetic Tube conduit (EMT). Corrosive environments will be noted on the access closet Installation drawings. Conduit running through corrosive environments shall be Rigid PVC.

Work Area Outlets

1. Work Area Outlets
 - a. Horizontal cabling installed using wall outlets and floor boxes are to use single gang, or double gang if required, and they are to match the decora straps. Each

decora style strap is to have a minimum of two positions for communications modules. Each outlet is to be equipped with the appropriate modules. Any unused communication positions in wall outlets shall be filled with a blank. The colours of the UTP modules and furniture adapter plates may be changed at the discretion of the project manager.

- b. Provide one one-port, single-gang, metal work-area outlets, connectors and appurtenances for termination of the horizontal Category 6A UTP cables. If four Category 6A UTP cables are consolidated at the Work Area Outlet, then one four-port work-area outlet is required. If eight Category 6A UTP cables are consolidated at the Work Area Outlet, then one eight-port work-area outlets is required.
- c. Each work-area outlet will be associated with a one-port, snap-in faceplate installed in the access closet or Core Closet patch panel.
- d. All Category 6A UTP connectors shall be modular jacks and wired for a T568A wire-map.
- e. All Category 6A UTP shielded connectors shall be bonded to ground.

Horizontal Cable Installation

- 1. All horizontal cabling from the access closet to the work area shall comply with the manufacturer's certification requirements and recommendations; as well as meet the performance parameters of ANSI/TIA-568.2 and the design requirements of ANSI/TIA-568.1.
- 2. Pathways shall be in EMT conduit minimum trades size 1-1/4 or as specified by the AHJ. Pathways shall be sized according to the requirements of the AHJ in addition to the recommendations of ANSI/TIA-569 with a planned capacity threshold of initial installation requirements +20%.
- 3. All labeling to confirm to ANSI/TIA-606 and a sample of the proposed labeling scheme to be submitted to the client for approval.

Fibre Optic Cable Installation

- 1. All fiber optic cabling from the access closet to the work area shall comply with the manufacturer's certification requirements and recommendations. They shall meet the performance parameters of ANSI/TIA-568.3 and the design requirements of ANSI/TIA-568.1. For outside plant installations, the requirements of ANSI/TIA-758 shall be followed. No cable splices are allowed for inbuilding fiber optic cabling.
- 2. Indoor pathways shall be in EMT conduit minimum trades size 1-1/4 or as specified by the AHJ. Pathways shall be sized according to the requirements of the AHJ in addition to

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the recommendations of ANSI/TIA-569 with a planned capacity threshold of initial installation requirements +20%.

3. All labeling to confirm to ANSI/TIA-606 and a sample of the proposed labeling scheme to be submitted to the client for approval.

Appendix A — Horizontal Cable Labelling Format

First Floor with one data closet

D1-0001 to D1-nnnn

First Floor with multiple data closets

D1A-0001 to D1A-nnnn D1B-0001 to D1B-nnnn

Second Floor with one data closet

D2-0001 to D2-nnnn

Second Floor with multiple data closets

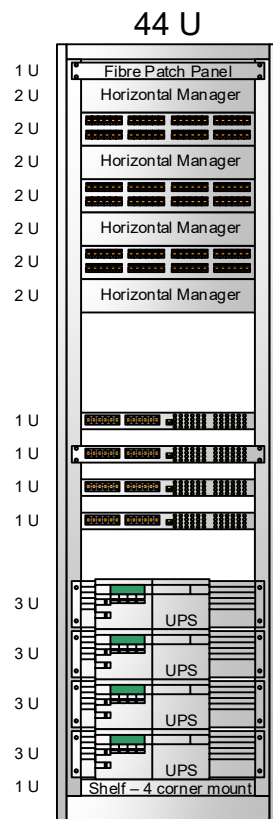
D2A-0001 to D2A-nnnn D2B-0001 to D2B-nnnn

Multiple Floors with multiple data closets

Increment the 2nd position of the format above for each floor.

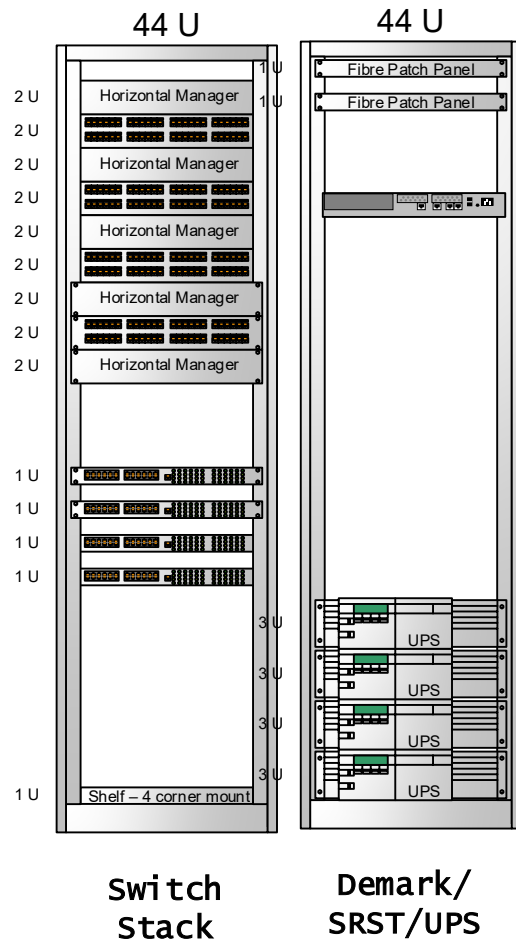
Appendix B — Network Rack/Cabinet Layout (Single)

Typical Single Network rack/cabinet layout.



Appendix C — Network Rack and Cabinet Layout (Dual Rack)

Typical Dual Network rack/cabinet layout.



Appendix D – Network CableTalk Cabinets

<https://www.cabletalk.com/cabinet-solutions>

30"x 42"x 83" - 44U

CTC3-3042K-03PF-B		
CTC3-3042K-B	Cabinet Frame 30"x 42"x 83" - 44U	1
CTC3-30-05-PF-B	Perf Lockable Front Door	1
CTC3-30-03-PF-B	Perf Lockable Split Door	1
CTC3-42-11-B	Solid Side Panels	2
CTC3-MA-16L-B	19" EIA Mounting Angles - Tapped 10/32	2
CTC3-CMS-11-B	Vertical Cable Management	1
CTPBV-1277-B	12 Outlet 15A PowerBar	2

30"x 36"x 83" - 44U

CTC3-3036K-03PF-B		
CTC3-3036K-B	Cabinet Frame 30"x 36"x 83" - 44U	1
CTC3-30-05-PF-B	Perf Lockable Front Door	1
CTC3-30-03-PF-B	Perf Lockable Split Door	1
CTC3-36-11-B	Solid Side Panels	2
CTC3-MA-16L-B	19" EIA Mounting Angles - Tapped 10/32	2
CTC3-CMS-11-B	Vertical Cable Management	1
CTPBV-1277-B	12 Outlet 15A PowerBar	2

Network Wall Mount Cabinet

<https://www.cabletalk.com/wall-mount-solutions>

CTCWH-2524-DSO-B		
CTCWH-2524-DSO-B	Commercial Wall Mount Cabinet 11U	1
CTPBH-069-B	6 Outlet 15A Powerbar	1
CTC-FS-2	2 Fan Assembly	1

CTCWH-3428-DSO-DR		
CTCWH-3428-DSO-DR	3428 WINDOW FROND DOOR	1
CTCWH-3428-DSO-MB	MID-BODY, 3428-DSO	1
CTCWH-3428-DSO-004	REAR BODY	1
CTCWH-3428-CMS	3428 WALL MOUNT CMS	2

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MTG ANGLE		2
CTCWD-D-HINGE-BKT	HINGE BKT MALE	2
CTCWH-2524-DSO-B-014	MID HOUSING, BOLT-ON-HINGE, FEMALE	2
CTC-44-B	COVER PLATE	4

Appendix E — Network CableTalk 4-Post Open Frame Racks

<https://www.cabletalk.com/4-post-racks>

30"x 36"x 83

CTC3-3036-03-B		
CTC3-3036K-B	Cabinet Frame 30"x 36"x 83" - 44U	1
CTC3-MA-16L-B	19" EIA Mounting Angles - Tapped 10/32	2
CTC3-CMS-11-B	Vertical Cable Management	1
CTPBV-1277-B	12 Outlet 15A PowerBar	2

30"x 42"x 83"

CTC3-3042-03-B		
CTC3-3042K-B	Cabinet Frame 30"x 42"x 83" - 44U	1
CTC3-MA-16L-B	19" EIA Mounting Angles - Tapped 10/32	2
CTC3-CMS-11-B	Vertical Cable Management	1
CTPBV-1277-B	12 Outlet 15A PowerBar	2

Appendix F – Network Small Site Deployment Cabinets

Where wall space is limited utilize Hammond HLP Series Low-Profile Wall Mount Rack Cabinet of application-appropriate size and configuration **complete with HWCF Cabinet Sealing and Filter Kit and padlock/lock hasp or equivalent to be approved by York Region.**

<https://www.hamdfg.com/dci/products/wall-mount/hlp#similar-products>



Appendix G — Network Environmental Services Facilities NEMA4

For Environmental Services' facilities, utilize Nema4 Hoffman ProTek Double-Hinge Solid Door PTHW242424G4 (or other application appropriate size). Complete with rack-mount, steel shelf vented, back plate, cable management and padlock handle.

<https://hoffman.nvent.com/products/protek-single-door-ul-and-nema-type-4-12-0>

https://hoffman.nvent.com/sites/g/files/hdkjer316/files/acquiadam_assets/2021-09/Spec-00713.pdf?asset_type=Data%20Sheet

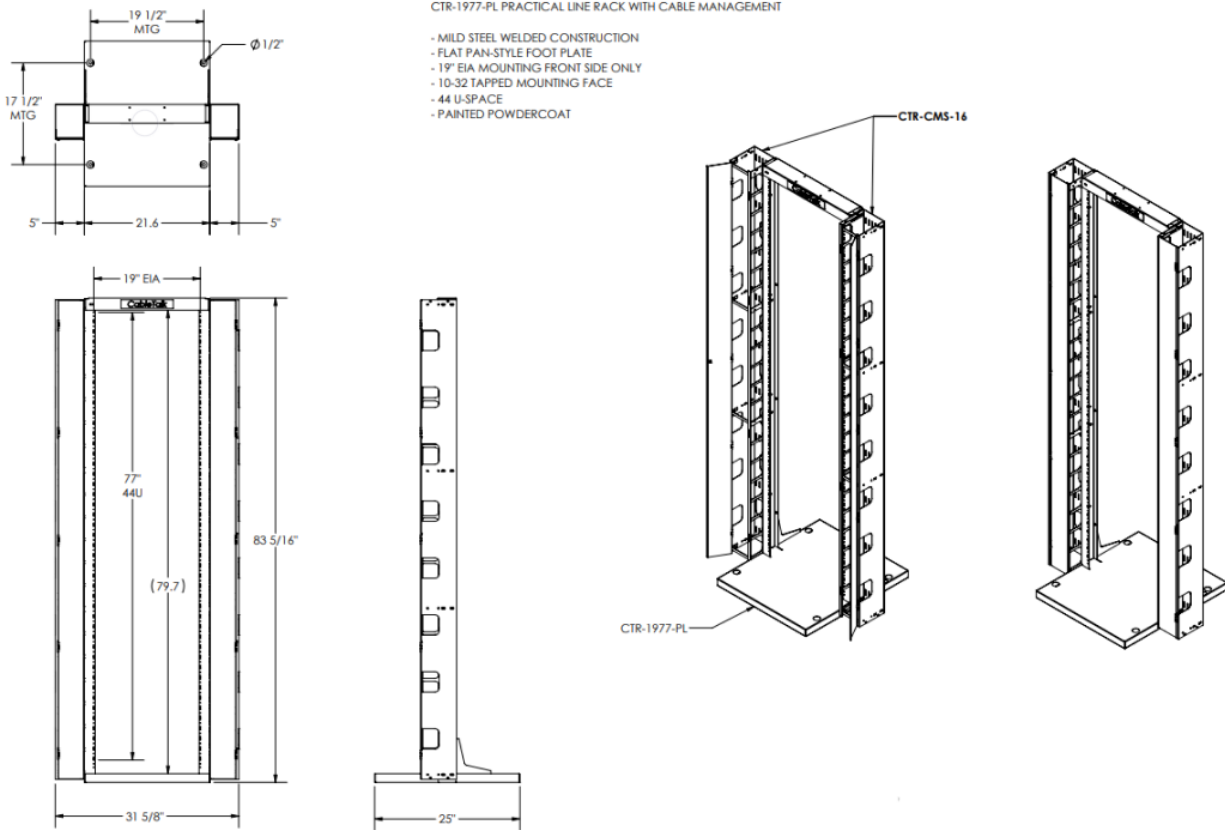


Appendix H – HP Server Rack

HP 42U 600mm x 1075mm Enterprise Pallet Rack		
HPE-P9K37A	HPE 42U 600x1075 Ent G2 Pallet Rack	1
HPE-P9L15A	HPE G2 Rack 42U 1075mm Side Panel Kit	1
Option - Shelves for HP		
234672-B21	HP 100Kg Sliding Shelf (Sliding)	1
253449-B21	HP Mon/Utl Shelf (Fixed)	1

Appendix I – Network CableTalk 2-Post Rack

Part Number and Description: CTR-1977-PL Practical Line Rack with Cable Management



Appendix J – Naming Convention for Wi-Fi Access Point (AP)

Staff Wi-Fi

1. AP should be labelled: **Site-FL-RM-AP#**. Where Site is Site Name, FL is the floor, RM is the Network Closet Room Number, AP# is the number of AP on that floor and numbering should restart on each floor.
 - a. le: AP number 16 on the first floor in the Annex that is cabled back to room 1-006 would be labelled as follows: ANNEX-1-1-006-AP16
2. Data Jack labelling: **RM-AP#**
 - a. le: data jack that is used for AP number 16 on the first floor of the Annex that is cabled back to room 1-006 would be labelled as follows: 1-006-AP16
3. Patch Panel should be labelled: **AP#**
 - a. le: patch panel that is used for AP number 16 on the first floor of the Annex that is patched back to room 1-006 would be labelled as follows: AP16

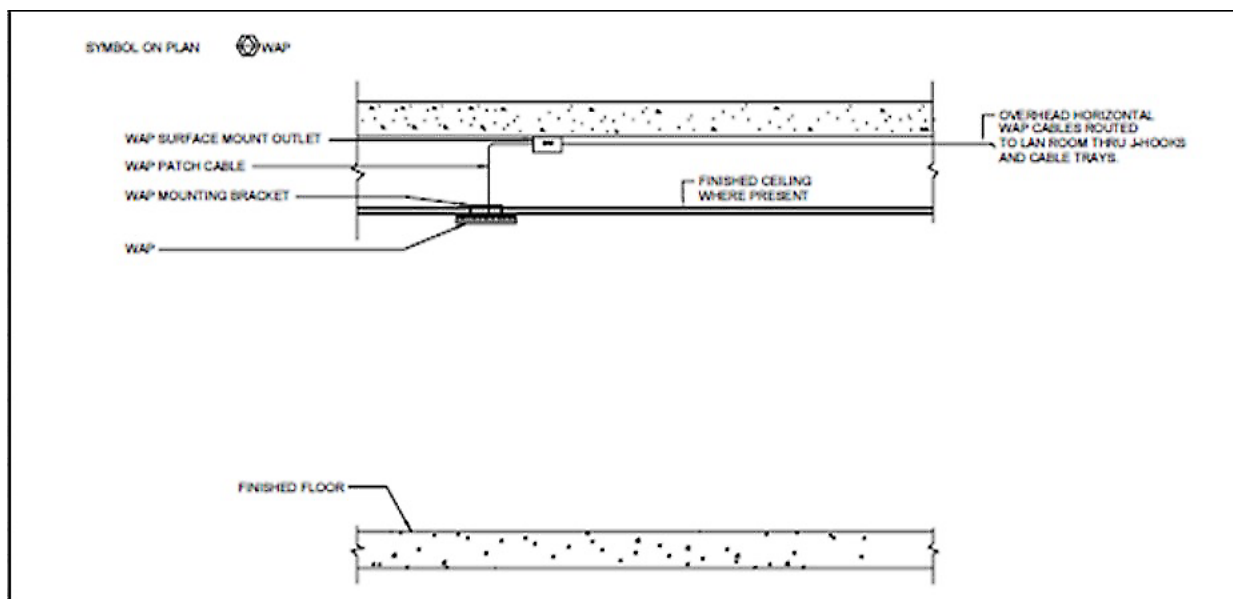
Public Wi-Fi

4. Public AP should be labelled: **PUB-FL-RM-AP#**. Where PUB represents Public Wi-Fi, FL is the floor, RM is the Network Closet Room Number, AP# is the number of AP on that floor and numbering should restart on each floor.
 - a. le: Public Wi-Fi AP number 16 on the first floor in the Annex that is cabled back to room 1-006 would be labelled as follows: PUB-1-1-006-AP16
5. Data Jack labelling: **PUB-RM-AP#**
 - a. le: data jack that is used for Public Wi-Fi AP number 16 on the first floor of the Annex that is cabled back to room 1-006 would be labelled as follows:
PUB-1-006-AP16
6. Patch Panel should be labelled: **PUB-AP#**
 - a. le: patch panel that is used for Public AP number 16 on the first floor of the Annex that is patched back to room 1-006 would be labelled as follows:
PUB-AP16
7. Cabling for Public Wi-Fi shall on a separate patch panel from the York Region internal network.

Appendix K – Wireless Access Point (WAP) Installation & Mounting

Installation of WAP shall meet the requirements of manufacturer and follow recommendations of TIA-TSB-162.

1. The communication contractor shall install all wireless access points (WAP) which shall be supplied by York Region.
2. Provide patch cable and all necessary hardware to mount WAP's as shown.
3. Communication contractor shall
 - a. Receive WAP's
 - b. Unpack the WAP's
 - c. Attach the WAP's mounting bracket
 - d. Mount the WAP's
 - e. Patch the WAP's at both ends
 - f. Record AP MAC address and WAP Cable ID that AP was patched into. Record this into the AP Connectivity Table that shall be submitted upon AP installation completion of each floor.



Appendix L – Category Cabling Color Scheme for Services

Blue	Data/WiFi/Clock/IoT Category Cable and anything that is not specified.
Purple	Security Category Cable
Orange	BAS Category Cable
Green	Energy Category Cable

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Appendix M – Sample Matrix of Port Count Report

For ITS and Cabling Contractor Use

NAC	Data					WAP	IoT	Security Camera		BAS			Energy			TOTAL DATA
Network Access Closets	1-DATA OUTLETS	2-DATA OUTLETS	3-DATA OUTLETS	4-DATA OUTLETS	DATA DROPS	WAP	CLOCK/IOT	SECURITY DEVICE	INTERCOM	BAS	ELEVATOR CONTROL RM	ELECT HOT WATER HEATER	WATER METER	GAS METER	METERS FOR ELECT PANELS	
- N.A. -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEL P1-006																0
TEL G-006																0
TEL 1-108																0
TEL 2-108																0
TEL 2-109																0
TEL 2-006																0
TEL 3-021																0
TEL 3-022																0
TEL 3-006																0
TR located on 4th floor																0
TR located on 5th floor																0
TR located on 6th floor																0
TR located on 7th floor																0
TR located on 8th floor																0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix N – Network Closet Checklist for Standard Sites

For ITS and Cabling Contractor Use

Walkthrough: 100% ☐ Final ☐

Network Closet : New/Renovated Closet *			
Details (Y/N)	T1	T2	Comment
Cabling Trays or J hooks			
Fire Rated Plywood Wallboard			
Power Receptacles NEMA L5-20R			
HVAC (with central monitoring)			
Rack Installation (clearance for vertical and horizontal cable management)			
Patch Panels			
Fibre Backbone (York Net Sites Only) (shielded/protected/labeled)			
Copper/analog line installed			
Verify that network closets are secure by lock or proximity scanners			
Electrical Grounding			
Room sweep/clean and all refuse/garbage is removed			
Network Closet ready for setup			
Network Closet setup complete			
Cabling Test Submitted and Accepted			
As-Built Diagram Submitted & Accepted			

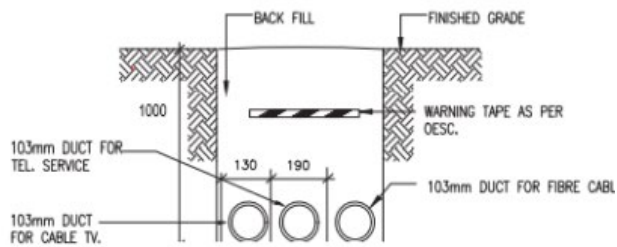
* Each network closet must have a completed checklist

Appendix O - WAN/ISP Duct Bank

Communication conduits can be placed on top of electrical conduits

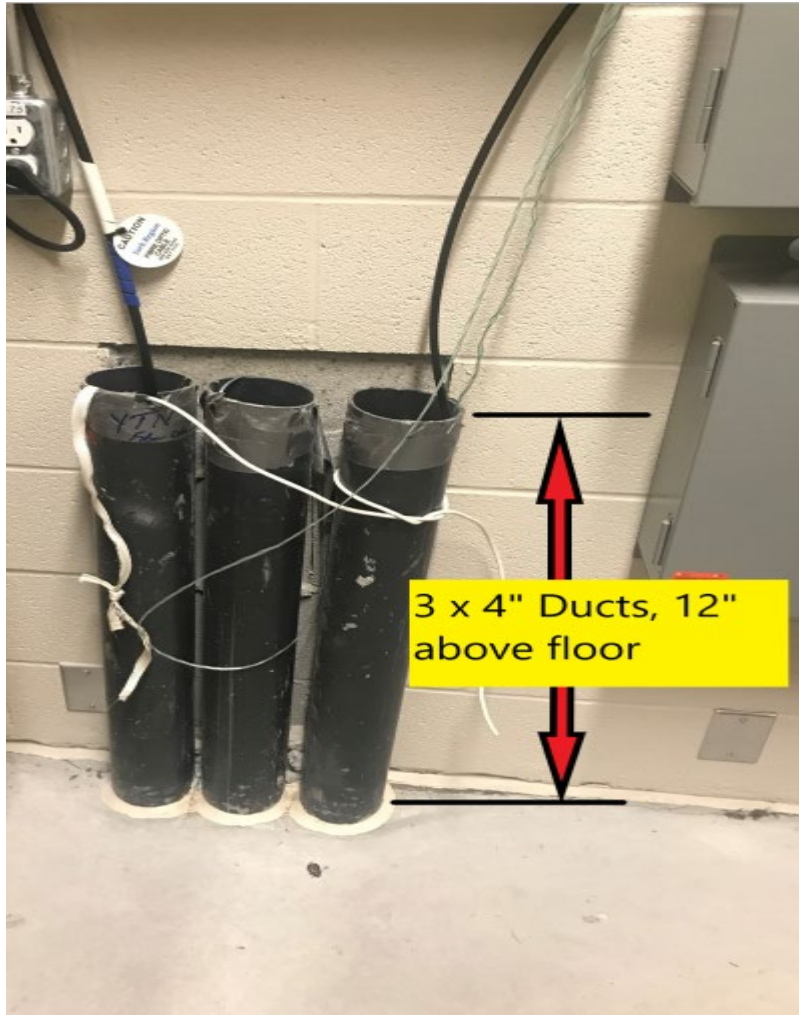
NOTES:

- .1 PROVIDE DUCTBANK TO OESC STANDARDS AND APPROVAL.
- .2 PROVIDE BELL FITTINGS AT EACH END. PROVIDE DUCT SPACERS AT 1.0M INTERVALS.
- .3 REFER TO SPECIFICATIONS FOR DETAILED DESCRIPTION.
- .4 ALL DIMENSIONS ARE TYPICAL IN MM.



Appendix P - WAN/ISP Ducts Inside Communication Room

Three 4" ducts stubbed inside communication room, preferred height minimum 12" above the floor.



References

York Region Transit local area network	eDocs: 1027531
American National Standards Institute	http://www.ansi.org
Canadian Standards Association	http://www.csa.ca
Construction Specifications Institute/Construction Specifications Canada	http://www.masterformat.com
European Committee for Electrotechnical Standardization (ECES)	http://www.cenelec.eu/Cenelec/Homepage.htm
International Electrotechnical Commission (IEC)	http://www.iec.ch
International Organization for Standardization	http://www.iso.ch/iso/en/ISOOnline.frontpage
Internet Engineering Task Force	http://www.ietf.org
IEEE	http://www.ieee.org
Ontario Realty Corporation	http://www.orc.on.ca/site3.aspx
Telecordia Technologies Inc.	http://telecom-info.telecordia.com
Telecommunications Industry Association	http://www.tiaonline.org
Underwriters Laboratories Inc.	http://www.ul.com

Appendix B

YRND – Security System Specifications

Security System Specifications LENEL

Version	Date	Description of Revisions	Reason for Revisions
1	June 22, 2021	General updates from consultant completed	
1.1	July 28, 2021	Updated Part Numbers	
1.2	August 19, 2021	Updated Part Numbers. Updated submission requirements	
1.3	January 11, 2022	Updated Part Numbers	
1.4	March 6, 2023	Wireless Network Equipment Updated Cabinet Part Number	
1.5	November 24, 2023	Updated prequalified vendor list	
1.6	April 15, 2024	Update to installer list	
1.7	February 21, 2025	Update to VAR list	

NOTE:

This Guideline does not override any governing codes, by-laws or municipal standards. When conflict exists, the most stringent requirements will govern.

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

Notice: This Document hardcopy must be used for reference purpose only.

The on-line copy is the current version of the document.

Any deviation from this document shall be approved by the Region Project Manager prior to proceeding.

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SECURITY REQUIREMENTS AND SPECIFICATIONS

1. GENERAL REQUIREMENTS

1.1 INTRODUCTION

- .1 This document provides all of the General Requirements applicable to any security related project undertaken by or on behalf of York Region. These requirements are at all times subordinate to the requirements as defined in the Project Specifications and related documents, i.e., be it in the Specifications, the drawings or the Contract Documents.
- .2 If there is any perceived lack of clarity or confusion, the Contractor has the responsibility to obtain clarification from York Region.
- .3 The contractor is responsible for ensuring the reference documents, standards and specifications are the most recent version applicable to the current project.
- .4 York Region will ensure that, as may occur, any modifications to its General Requirements are communicated to the Contractor.
- .5 The Contractor shall use the General Requirements as provided in this document as a reference describing the design and installation procedures to be used for delivery of the project. These procedures generally follow industry Best Practices applicable to Information Technology and Security Applications.
- .6 This “General Specifications Document” consists of two inter-related sections:
 - a. General Requirements – which describes the overall design and functionality to be provided by the completed security system without reference to specific products; and
 - b. Appendices – which provide detailed reference to specific equipment, standards, protocols etc.
- .7 Contractors are invited to advise York Region of any suggestions for improvements that could be made to the design or specifications.
- .8 As technology evolves the Region will continue to upgrade software and hardware in order to ensure the highest levels of security and reliability for all of its properties and facilities. Hence the contractors working on new projects are responsible to validate the versions of software, firmware and hardware currently in service and to validate the compatibility of any new installations with the existing installations.
- .9 All equipment installed during the execution of any security projects shall be acquired through manufacturer approved dealers and installed by factory trained and approved technicians. Approved sources for the primary items of equipment are identified in the Appendices I, J, K and L.
- .10 The contents of this document are to be considered confidential and remain the property of York Region and prior permission shall be obtained for any use or copying of the contents which is unrelated to work which is being undertaken for York Region.

1.2 OVERVIEW

- .1 The Regional Municipality of York (York Region) is committed to operating a single security system for the all the Region's properties. The state-of-the-art system is configured using industry standard products as specified here. The implementation is currently in operation at many locations but will continue to be deployed at additional locations as opportunities arise.
- .2 The Regional security system has 3 distinct components and these components are described further below. The components are designed to monitor and control:
 - a. Access Control (AC) using personal access cards;
 - b. Intrusion Detection (ID) using multiple sensors and detectors;
 - c. Closed Circuit Television (CCTV) cameras used to monitor key locations;
 - d. Intercoms which allow for those wishing access at a gate or door to communicate with the operations centre; and
 - e. Panic alarms/buttons can be wired or wireless, generally located in areas where staff interact with the public e.g., reception areas, judicial services, social services, health services, etc. Wired panic buttons are to be used when fixed furniture is available, wireless panic buttons are to be used if there is no fixed furniture where staff interact with higher risk clients.
- .2 The independent, commercial products are integrated so that the system operators are able to control and manage all the security functions enumerated above from the single user interface which is connected only to the Access Control System. The diagram below (Figure 1) is intended to provided a high-level overview of how the key components of the Region's security system are interconnected.
- .3 Figure 2, below shows how York Region's remote sites are interconnected with the Main Regional Control Centre. Key aspects are that the security system at each site functions locally but all activities and exceptions are communicated to the primary equipment which is located at the Main Regional Control Centre. The architecture is fully scalable and is the same at all sites as appropriate, e.g., the water treatment facilities use SCADA displays for local alarm monitoring which are different than at other sites.

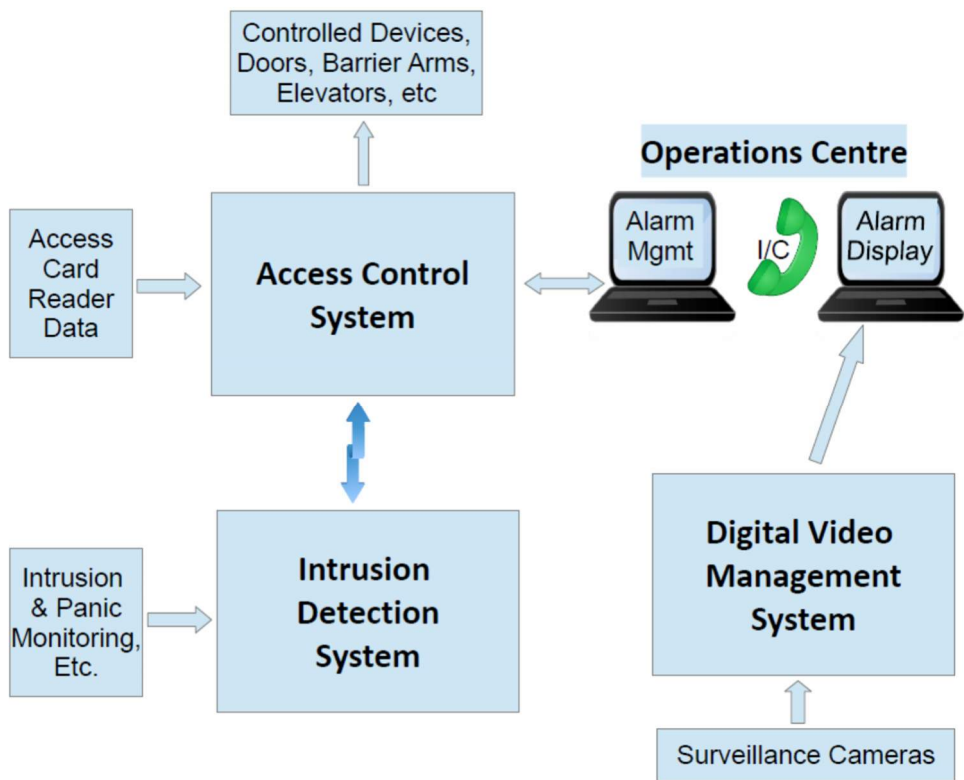


Figure 1: Overview of York Region's Security System Architecture

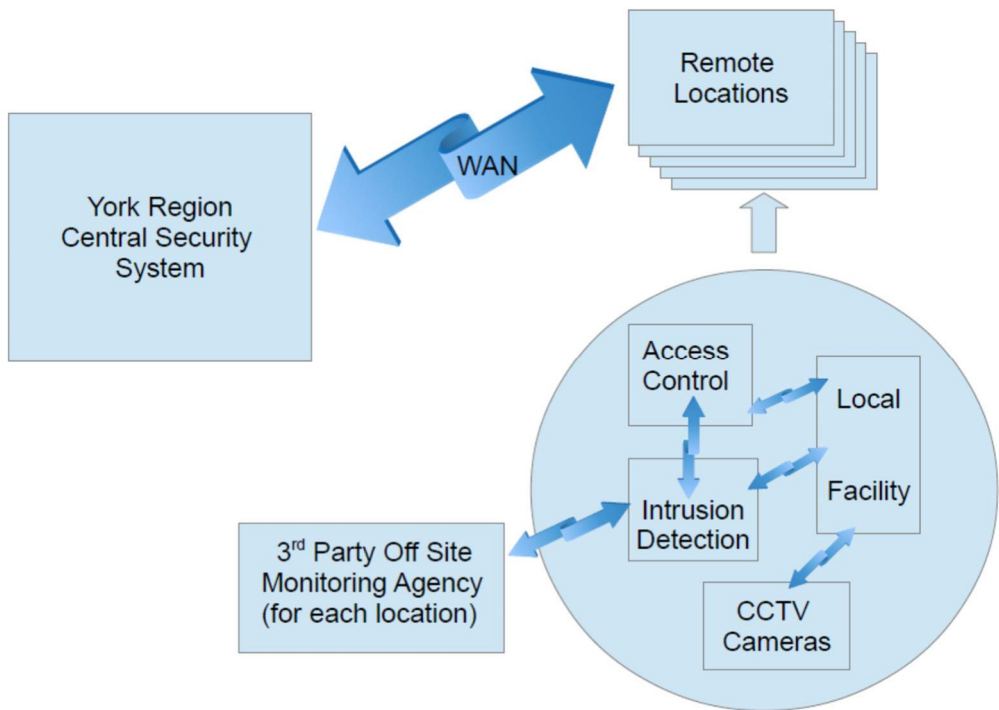


Figure 2: Architecture for the Sites Connected to the Main Regional Control Centre

- .4 The Access Control System and also its User Interface are based on a single, previously approved, security system, for which details can be found in Appendices J and K. The door hardware is controlled by the most recent available interfaces available from the same single manufacturer or supplier. Power supplies are all provided by a single manufacturer, who must be approved by the security system manufacturer. More details regarding these devices may be found in Appendix J.
- .5 The integration of the Access Control and the Intrusion Detection aspects of the security system shall be achieved via the network for full control of both components via the server as well as at a local level for seamless offline operation.
- .6 The CCTV System shall be based on a standard, commercial, digital video management system as detailed in Appendix P.
- .7 The Contractor shall work with York Region on the technical design of the proposed system or contract work, clarification of technical requirements and shall provide a full set of Technical Shop Drawings for approval before proceeding to installation. The Technical Shop Drawings shall include, but not be limited to, network connectivity diagrams, high level riser diagram(s), system riser diagram(s), vertical and horizontal wiring diagrams, point-to-point wiring diagrams, typical and site specific device termination/wiring schematic(s) and diagrams, hardware DIP Switch setting configuration(s), device landing schedule(s), system integration wiring diagrams, intrusion detection point schedule(s), tub/enclosure layout diagram(s), electrical connections and wiring diagrams, explanation of the sequence of operation, integration techniques and operational scenarios. The Contractor shall adhere to the Region's conventions including the allocation of sequential addresses commencing from "1" and avoidance of any reserved addresses. The Contractor shall clearly identify any dependencies which are not included in these Drawings, such as wall space, electrical requirements, air conditioning.
- .8 In addition to the foregoing Shop Drawings, the Contractor shall provide addressing charts, product specifications, and cut-sheets, and other relevant information, required by York Region to complete the full evaluation of the design and to provide for the contractor's installation.
- .9 Following approval by York Region, the Contractor shall deliver one hard copy and one electronic copy of the Technical Shop Drawings to the security system installer for review and comment. The hard copy of these documents shall be printed so that they may be readily read and marked up as may be required.
- .10 The electronic documents shall be delivered both in editable form, i.e., AutoCAD or Word and also in PDF formats.
- .11 The Contractor shall at all times certify that all the electronic documents and the media which are being submitted have all been checked for all forms of malware prior to their submission for any purpose to any other party using any means of transmission.
- .12 The comments made by the security system installer are to be shared with York Region so that it is aware of any concerns which may have been expressed by the installer. York Region shall approve or, as may be appropriate, justify adoption of the original design or

a modified variation before any changes are incorporated. The costs and schedule impact of any such changes shall be clearly identified in these documents.

- .13 The Contractor shall be fully responsible for the work completed by its employees as well as its sub-contractors, including the security system installers, electrical contractor, locksmith and door hardware subcontractors. The Contractor shall employ the installation services of one of the Region's approved security system installers, as listed in Appendix I; to perform the installation and configuration of the security system.
- .14 The installation and termination of all required conduit, cabling, network equipment, communication lines and devices, security devices and head end equipment shall be completed by a pre-qualified security system installer (See Appendix I). All necessary cable, conduit, fittings, and other general installation hardware shall be specified by the Contractor and supplied and installed by the security system installer or by other specialist sub contractors retained by the security system installer, e.g., network installers or electricians.
- .15 The Contractor shall be responsible for supplying the system equipment, licencing, and hardware in accordance with the Contract Documents, including Specifications and Drawings provided by the Region. The Contractor shall be responsible for the final design, supply, installation, configuration, testing and commissioning of the fully operational system to the satisfaction of the Region.
- .16 Where an item is shown on the Drawings and is specified in this Specification, such item shall conform to the requirements of this Specification Section.
- .17 The Contractor and all others working for the Contractor shall conform to all of the requirements of this Specification, including as may be appropriate, all of the related appendices.
- .18 The Contractor shall provide design (shop) drawings prior to the execution of the work, identifying all physical security devices which are to be installed at each field location in accordance with the requirements in the Contract Documents as provided by York Region and as specified in Appendices E, J, K, L, M, N and O.
- .19 All work undertaken in this project shall conform to the standards and practices identified in these security specifications and as noted in Appendix D.
- .20 As required, the Contractor shall submit the necessary number of working drawings and specifications to any applicable authority for examination and approval prior to commencement of work. Any changes required by the examining authority shall be reviewed and approved by York Region.
- .21 Carry out all changes and alterations required by an authorized inspector of the ESA and any other authority having jurisdiction without delay to the progress of the Work. All such changes shall be reviewed and approved by York Region.
- .22 The Contractor shall fully train the Region's personnel (and contractors if applicable) to operate and to perform routine maintenance on the systems and equipment which is installed under the current contract.

- .23 The Contractor shall provide all warranty services for facility security system for a period of two (2) years from the date of Total Performance of the Work, and shall provide all necessary material required to replace any defective products during this period. The warranty period shall restart from the date of the completion of such replacement.
- .24 Details of the Pre-Qualified Value-Added Resellers and Installers may be found in Appendix I.

1.3 APPLICABLE STANDARDS

- .1 All work performed for York Region must be inspected and approved prior to being commissioned. Such work must be compliant with all of the applicable Standards. Some of these Standards may be found in Appendix D. It is the responsibility of the contractor to ensure that the Standards being applied to any project are:
 - a. The most current version of the Standard or Code; and
 - b. Those applicable in the specific project and in the specific jurisdiction.

1.4 SOFTWARE/SYSTEM CONFIGURATION

- .1 The Security System installed as part of this Contract or any modifications to the existing installation shall be reflected in the existing security system database. All programming and configuration for the work under this Contract must be consistent with the existing programming to guarantee consistent functionality of the system and all of its components across the Region.
- .2 The Contractor is only responsible for the work related to this Contract and shall NOT adjust or alter the existing configuration for any other facilities within the system without written authorization from the Region. The Contractor shall NOT alter, modify, delete or interfere in any way with any settings, configuration or variables that may affect the functionality of the existing facilities, systems or their components without prior written authorization from the Region.
- .3 The installed Security Access Control system must be configured to meet all existing Regional standards (Security, Operational, IT). The Contractor shall be responsible for identifying the requirements, developing a custom solution to meet those requirements, and presenting available options in the form of an implementation plan to the Region for approval before implementing the proposed solution.
- .4 All software licencing must be detailed, supplied and installed to operate the security solution. The Contractor shall supply and install all of the necessary proprietary integration licences, card reader licences and workstation licences, as may be required. It is the Contractor's responsibility to quantify and provide the number of licences required based on the Drawings and Specifications provided in the Contract Documents. All costs associated with provision of the required licences shall be included in the Contract Price including any modifications to the Contract Price.
- .5 The Contractor shall work with the Region's IT department to perform application or database server programming and configuration and network device security penetration testing. The contractor shall supply copies of all network device specifications and data

sheets to IT when requested in preparation for the penetration testing. All work requiring access to the database and/or application servers must be coordinated with the Region a minimum of one week in advance.

- .6 All changes to the network configuration and network attached devices must be approved by the ITS department to ensure that the network complies with ITS's "penetration" resistance requirements. It is noted that IT maintains a list of approved devices which may therefore not require individual testing. In the event that penetration testing is required, the costs of the testing incurred by the Contractor, and of any remediation which may be required by IT, will be borne by the Region if the deficiency is encountered after the award of contract.
- .7 All server, network, and other requirements shall be coordinated with the Regional IT Services department and validated by the security system manufacturer prior to installation. All servers and network switches shall be provided by the Region unless otherwise specified in the Contract Documents.
- .8 The software and/or system deployment and configuration shall be overseen and validated by the Regional representative(s) from the Capital Delivery Coordinator department. The Contractor shall use manufacturer provided software applications to program, configure and test the system. No configuration shall be completed utilizing any client applications on the client servers.
- .9 There shall be a single, integrated, Audit Trail log which records all of the actions and activities for the entire site. The integration of the activities at each site shall be similar, subject only to the configuration of the site, and shall include:
 - a. Local date and time (using Canadian - ISO style and 24 hour clock);
 - b. All access card activities including name, action granted or denied and reason;
 - c. Logging in and out of operators;
 - d. Schedule activations and deactivations;
 - e. Trouble and alarm reports;
 - f. All failures, arming and disarming of systems; and
 - g. System resets and restarts.
- .10 The intrusion detection system at each Facility (or group of buildings) must be armed by using a card swipe on the card reader on the secure side of the door followed by pressing a button which is labelled for this purpose. The intrusion detection system must disarm automatically when access is granted at a perimeter door, i.e., an access which is granted, at a perimeter door will disarm the intrusion detection system unless otherwise specified. Note that the door does not have to be opened for the alarm system to be disarmed. The intrusion detection system shall not permit arming until all intrusion points are "fault free", i.e., closed. This arming process may proceed if trouble alarms, which generally are not operational, are present. All relevant information related to the current status of the area shall be displayed on the local intrusion detection system keypad(s). The same information shall also be displayed by means of dynamic icons on the local and the central, access control interface Alarm Monitoring software client interactive map. Integration between the access control hardware, the access control software and the

intrusion system must be seamless in both online and offline modes. The contractor shall create custom alarms for each facility which shall properly display any intrusion events using the access control Alarm Monitoring application.

- .11 The intrusion detection system Alarm Keypads shall display the name of the facility and the nature of any faults in the system but shall not be used for “Arming” the system, “Disarming” the system or clearing any faults. All the keypads in each facility shall also annunciate any active alarms occurring in that facility using its internal sounder, e.g., intrusion alarms, panic alarm, system failure.
- .12 Arming shall be implemented locally by a valid card swipe on an adjacent, dedicated, internal card reader followed by a button press or, alternatively, through the access control system Interactive Map utilizing dynamic icons.
- .13 Disarming shall be performed locally by a valid card swipe on any of the external, perimeter readers or, alternatively, through the access control Interactive Map utilizing dynamic icons.
- .14 The intrusion detection system shall allow persons to exit from the facility without triggering an event until and after the system is fully armed after the exit delay time. The system shall alarm instantaneously when any intrusion zone is faulted while the system is in the armed state and shall record details in the Audit Trail log. All intrusion alarms shall be annunciated:
 - a. Locally on all the keypad(s) at the corresponding Facility;
 - b. On the local access control system graphic map(s) where available;
 - c. Remotely on the access control system Alarm Monitor client application;
 - d. To the 3rd party Central Monitoring Station; and
 - e. To the SCADA Control Panel for ENV OMM facilities.
- .15 The Contractor shall create or update a graphical map interface for the system reflecting any work performed under the current contract, making it the same or similar in appearance and functionality to the existing graphical maps (see Appendix W: “Graphic Maps”). The graphical map interface shall be implemented as a multilayer hierarchy with the highest level or main map displayed as a map of York Region identifying all the municipal boundaries.
- .16 The Regional facilities shall be represented on the display using distinct icons depicting corporate, environmental, transportation, paramedic and other departments (see Appendix W). Each facility shall be represented by the applicable architectural floor plan, (multilayered, if necessary), to identify the areas, floors and buildings. The facility graphical map shall be created by the Contractor from the CAD or PDF files which are provided by the Region, in a resolution which displays properly on a typical 24” display configured at 1920 x 1080 PPI resolution unless otherwise specified. Pixilated, blurred and/or illegible maps shall not be accepted. See Appendix W: “Graphic Maps”, for further information.
- .17 The graphical interface shall show all field devices together with their associated status dispositions. Typical status options shall include but are not limited to Armed, Disarmed,

Normal, Alarmed, Forced, Held Open, Locked, Unlocked, Tamper, Faulted, Active, On schedule, Offline, AC Fail, Battery Trouble, etc. (see Appendix C for meaning of foregoing terms). All required status symbols are already available and may be reused for this project. Some of the symbols developed specifically for York Region are shown in Appendix W: "Graphic Maps".

- .18 Each facility's graphical map shall contain a displayed control /status panel allowing direct control with functions, such as Arm, Disarm, Door control operations, intrusion area operations, map navigation, etc., and at all times displaying the real-time status of the facility, such as Armed/Disarmed Status, Ready to Arm Status, Intrusion Alarm Status, System Components Status etc. (see Appendix C for meaning of terms). The Contractor shall use the existing custom dynamic icons to populate the graphical interface or, if necessary, create additional icons. The existing custom icons will be provided to the contractor on request.
- .19 Whenever a panic alarm is activated, the local graphic map display and the central graphic map display (as may be available) will immediately both be updated to identify the location of the active alarm by showing a flashing red icon at the alarm location and display a text message on the keypad which will also be sounding. The screen will have an icon "Panic Clear" which both clears the map display and also silences the keypad.
- .20 The Contractor shall create new and update existing Schedules (Time Zones), Access Levels and Monitor Zones (to enable remote monitoring by system administrators), as may be required for each contract. The Region shall provide the Contractor with the initial configurations for these options.
- .21 All system components shall be configured using the Regional Security System Naming Conventions Standards as outlined in Appendix A. Naming conventions shall be consistent throughout the system.
- .22 All security panels shall report AC Fail, AC Restore, Battery Trouble and enclosure tamper events to the Access Control System Software by using the Alarm Monitoring application and this information shall be displayed on the graphical maps by means of the corresponding dynamic icons.
- .23 Batteries included in any panels or modules which are supplied or installed in the course of the Contract, shall be labelled identifying the date of initial deployment using the ISO 8601 format, i.e., YYYYMMDD or YYYY-MM-DD.
- .24 The Contractor shall update all system hardware components with the latest manufacturer approved firmware versions prior to final commissioning. The Contractor shall ensure that any firmware updates are fully compatible with the existing software releases prior to performing such upgrades. Where firmware versions are indicated by the manufacturer on the devices or in the devices, updates performed by the Contractor shall be reflected by modifying the original labelling so as to show the installed version or release of the firmware.

1.5 SUBMITTALS

A. GENERAL

- .1 All submittals to the Region will be reviewed by the Region and must be accepted by the Region before any construction is permitted.
- .2 Submissions shall be made in accordance with the schedule developed and approved for each project and shall comply with all of the requirements as stated in this document and in the Contract Documents.
- .3 All submissions shall be in English and spell checked in accordance with normal Canadian spelling and grammatical practices. The text documents shall use Times Roman font in 11 point as the body font with a minimum of single line spacing.
- .4 As described in Section 1.2 the submission shall be provided in at least one hard copy and one electronic copy. The former shall be printed single sided and suitably bound and indexed on 8.5 x 11 ins. Drawings shall be printed in a size to be agreed to between the parties and provided with a suitable cover page and index page. The electronic copy shall be provided both in an editable format using Microsoft Word for text and AutoCAD for drawings and also in Adobe PDF. These files may be transferred via a secure link or on a portable storage medium. The Contractor is responsible to certify that all of the electronic files are free of any malware and the files shall have no electronic locks, encryption or restrictions.
- .5 York Region shall review the documents and provide comments to the Contractor indicating in particular if the Contractor may or may not proceed with the project and if a modified submittal is required. These comments shall be provided to the Contractor within 15 working days, unless an alternative schedule is agreed to by all parties.
- .6 York Region and its agents shall be the final arbiter with regard to the suitability of the submissions.

B. SHOP DRAWINGS:

- .1 Prior to the start of construction, the Contractor shall submit a complete set of:
 - a. all relevant technical documentation, and
 - b. technical shop drawings and specificationsfor approval by the Region and also for review by the Security Installation Contractor prior to the implementation phase of the project.
- .2 The Contractor shall provide one full hardcopy and one digital copy of shop drawings (see Section 1.5.1 and Appendix D) which shall cover the entire scope of the Work as defined by the Contract Documents, including but not limited to:
 - i. System riser diagram(s)
 - ii. System layout/floorplan
 - iii. Network connectivity diagrams
 - iv. Vertical and horizontal wiring diagrams

- v. Point-to-point wiring diagrams
- vi. Typical and site-specific termination/wiring schematic(s) and diagrams
- vii. DIP Switch and similar configurations
- viii. Device landing schedule(s)
- ix. System integration schematic(s) and wiring diagrams
- x. Intrusion detection point schedule(s)
- xi. Tub/enclosure layout diagram(s)
- xii. Electrical connections and wiring diagrams
- xiii. Explanation of the sequence of operation
- xiv. Integration techniques and operational scenarios
- xv. Addressing charts
- xvi. Product specifications and cut-sheets
- xvii. Complete Bill of Materials
- xviii. Proposed testing and acceptance activities
- xix. Other relevant information required for the installation

C. AS-BUILT DOCUMENTATION

- .1 The as-built drawings, documents and materials as described here shall be submitted no later than 15 Working Days after the substantial completion of Work, i.e., after the commissioning of the system has been completed and any identified deficiencies have been resolved.
- .2 All as-built documentation must use the Region defined naming convention for all system components and must be consistent with the naming convention used in the software.
- .3 The Contractor shall submit detailed documentation describing the entire scope and extent of the Work which has been performed in accordance with the Contract Documents, in compliance with the requirements identified in Appendix D and in a form acceptable to the Region. The requirement is that this documentation shall be sufficient for “a person knowledgeable in the industry and familiar with the technology to have the ability to perform the work described in the Contract Documents without the need for further instruction”. These documents shall include, as may be appropriate, some or all of the following but are not limited to:
 - a. As-built drawings, documents and materials: In conformity with the requirements noted in Appendix D, the documentation shall cover the entire scope of work, including but not limited to the items listed below and detailed commissioning documentation, as well as other relevant information, e.g., firmware versions, warranty details. In practice the Contractor is expected to resubmit the shop drawings, which were submitted earlier, with the incorporation of the modifications to reflect the actual work which has been completed.
 - i. System riser diagram(s)
 - ii. System layout/floorplan
 - iii. Network connectivity diagrams
 - iv. Vertical and horizontal wiring diagrams
 - v. Point-to-point wiring diagrams

- vi. Typical and site-specific termination/wiring schematic(s) and diagrams
 - vii. DIP Switch and similar configurations
 - viii. Device landing schedule(s)
 - ix. System integration schematic(s) and wiring diagrams
 - x. Intrusion detection point schedule(s)
 - xi. Tub/enclosure layout diagram(s)
 - xii. Electrical connections and wiring diagrams
 - xiii. Explanation of the sequence of operation
 - xiv. Integration techniques and operational scenarios
 - xv. Addressing charts
 - xvi. Product specifications and cut-sheets
 - xvii. Complete Bill of Material
 - xviii. Documents recorded during the testing and acceptance activities
 - xix. Other relevant information
- b. One additional hard copy of the as-built drawings with all relevant drawings and documentation shall be provided by the Contractor and stored on-site inside or near to the main system enclosure along with warranty/contact information.
- c. All technical notes, software scripts, firmware details and other documentation covering the IT portion of the Work covered under this Contract. All configuration modifications and configuration backup files shall be documented as a part of the as-built package.
- d. Lists of all passwords, keywords, serial numbers, licences and/or configurations that are encountered during the installation and configuration of the system.
- e. Complete set of manufacturers' installation manuals, maintenance manuals and specifications for all system software and hardware components by make and model. This information shall include comprehensive, descriptive data sheets, brochures, installation, and technical manuals for all systems and equipment forming part of the contract. The manuals shall include operational and schematic diagrams for the System and all related components.
- f. Detailed commissioning documentation in the format approved by the Region (see Appendix B), populated with all relevant information and worksheets identifying all testing and commissioning procedures which were undertaken. The commissioning documentation must be completed by the Contractor and signed by the Regional representative. An example of the Region approved commissioning form is presented in Appendix B.
- g. Theory of Operation – system outline and overview.
- h. Operational manuals explaining the system operator's available features, functions and capabilities.
- i. System administration manuals including operational and maintenance requirements and procedures associated with the proposed solution. Description

of administrative functions required to supervise and manage the integrated system(s).

- j. Full schedule of maintenance which is to be carried out on each system component during the warranty period of 24 months after the date of Total Performance of the Work and for the entire lifetime of the system and its components.
- k. The Contractor shall commit to the Region that the Contractor will meet the Region's requirements for response time and return to service time in regard to any service calls made during the Warranty period and that suitable spare parts will be readily available to meet those commitments.
- l. The contractor shall propose an inventory of spare parts which the Region may wish to acquire for the system following expiry of the Warranty period.

1.6 Testing and Quality Assurance

- .1 The Contractor shall ensure that, upon completion of the contract, all hardware and software components are functioning as intended within the Region's IT and the security network environments.
- .2 At the discretion of the Region, final acceptance testing shall be carried out at any or all of the following defined levels:
 - a. per point basis;
 - b. per system component basis;
 - c. per software function basis; and
 - d. per total system basis.
- .3 The Contractor shall document, test and verify the proper installation and functionality of the system and all of its components including integration to the systems described in this Section, application and database integration as well as online and offline operation. Upon request, these functionalities shall be demonstrated to the satisfaction of the Region which shall be performed without extra cost to the Region.
- .4 The Contractor shall inspect all installed devices and equipment to ensure that all of these devices will achieve the intended system functionality. Any devices which are not capable of fulfilling the required system functionality shall be documented to the Region in writing. Any corrective measures which are required shall be approved by the Region and the Contractor. The costs for any modifications are to be borne by the Contractor unless the equipment configuration was selected by the Region.
- .5 The Contractor shall test all field devices and system components which are configurable or adjustable to ensure that they achieve optimal performance and fulfill the performance requirements as installed. All configurable settings must be approved by the Region prior to installation and shall be documented for the Region. Upon request, this shall be demonstrated to the satisfaction of the Region without extra cost to the Region.
- .6 All tests shall be performed to the satisfaction of the Region and, if any tests are repeated and then achieve different results, the Region has the option of requesting device

replacement. If any adjustments are made in order to achieve the required test results, the Region or the Contractor shall identify if other tests need to be repeated to ensure that the adjustment does not prejudice any other test results. All such retesting and adjustments shall be performed without extra costs to the Region.

- .7 Once the Contractor has established that the System is operating as required, on-site commissioning shall be scheduled with the Regional representative(s). The contractor shall demonstrate to the satisfaction of the Region that the system and all of its components are functioning, as intended by the approved design. This approval process shall be performed in 2 phases:
 - a. A pre-commissioning demonstration with the Region's Security System Administrator who may be reached at (905) 830-4444 ext.76900 and:
 - b. A final commissioning with the Region's Capital Delivery Project Coordinator.
- .8 The testing and commissioning shall be completed and accepted both by the on-site Regional Project Coordinator and by the remote Regional Security and York Region System Administrators. It is the responsibility of the Contractor to arrange and carry out commissioning sessions with the Region and to provide all parties with suitable records of the commissioning and minutes of the activities.
- .9 In the event that the testing and commissioning activities do not meet with the approval of any of the Regional representatives, the Contractor is required to address the matters that led to the rejection of the system. Such alterations and repeating of the test and commissioning processes, in part or in whole, shall be performed expeditiously and without extra charges to the Region.
- .10 The Contractor shall assist the Region in configuring, and/or reconfiguring, and populating, and/or repopulating all System related databases. As may be required, the Contractor shall also assist with any modifications which may be required to the existing integrations, configuring and/or reconfiguring all the system parameters to the Region's satisfaction. All the procedures and activities required to accomplish such changes shall be fully documented and shall, as may be applicable, follow existing procedures.
- .11 The Contractor's assistance shall continue until initial configurations and integrations are complete and functional, and/or until all affected systems are working to the Region's satisfaction and the related documentation has been accepted by the Region. In the event of any matters arising during the 12 months immediately following the acceptance of the system by the Region, the Contractor shall provide suitable assistance to achieve resolution under the terms of the Warranty.
- .12 The assistance, referenced in the above paragraphs, shall be provided by a single technician working physically side by side with the Region's representative(s) assisting and instructing the Region's representative(s) step by step in configuring system parameters and integration configurations to the systems outlined in the Contract Documents.

1.7 Training

- .1 The purpose of the training is to allow the local and the Regional staff to safely and reliably:

- a. Perform all routine operations and maintenance functions required for the systems;
 - b. Make minor changes to the system configurations;
 - c. Address any intrusions, access card management issues, emergencies, accommodate visitors, manage issues related to parking and deliveries; and
 - d. Recognise when more expert advice is required and to identify the nature of that requirement.
- .2 Training of the Regional staff shall be provided by Contractor staff familiar with the project and equipment and experienced in delivering such training courses in English. If the training is considered inadequate by the Region, it shall be repeated without extra charges to the Region.
- .3 All necessary supplies and documentation for the training course shall be supplied by the Contractor. The Region shall provide a location with basic audio-visual equipment, i.e., a screen, tables, chairs and internet accessibility. Other equipment and network access can be requested but might not be provided by the Region.
- .4 The training program shall provide suitable training for those at the Region responsible for operation, the administration and the supporting of the “security systems”. The scope of the training shall cover the entire scope of work defined by the Contract Documents as well as its interaction with previously existing systems.
- .5 The Contractor shall provide a detailed description and syllabus of the training program to the Region for review at least 2 weeks ahead of the proposed training session. This description shall identify:
 - a. The intended audience for the upcoming training session, i.e., system operators, system administrators or support staff;
 - b. The material to be presented;
 - c. The supplies being provided by the Contractor;
 - d. Any supplies (other than the training room) to be provided by the Region; and
 - e. The anticipated duration of the training program.
- .6 The Region shall review the proposed training program and provide comments to the Contractor. If the comments are significant the Region may elect, without incurring any extra charges to delay the training program and to undertake a further review of the edited training program.
- .7 The Region shall identify the number of individuals anticipated at the planned training session at least 1 week prior to the start of the training session.
- .8 Training documentation shall be developed by the Contractor in adequate quantities to satisfy the requirements of the training; and shall be submitted by the Contractor for future reference by the Region in printed and digital formats (see Appendix D). At the discretion of the Region, the training session may be recorded. Such a recording shall be

used only by the Region and its employees for internal training purposes, e.g., additional employees.

- .9 Training may not take place using the Region's live system but the Contractor may, by mutual agreement between the Contractor and the Region, use the Region's live system to show the reality of a "live system".
- .10 The Contractor shall ask the attendees partaking in the training session to complete an evaluation of the training program to help with improvements to future training sessions. The results of this survey shall be provided to the Region.

1.8 Network TCP/IP Coordination

- .1 The Region's Project Manager will coordinate the installation of any required network system components or modifications with ITS (Information Technology Services) Department and the appropriate BSA (Business System Analyst) at the Site. Such changes may be required to allow for communications between the new security installation and the database server(s) which are located at Region's Data Centre so as to provide the requisite tie in and commissioning of the security system.
- .2 The Contractor is reminded that all equipment which is being installed to the network must comply with ITS's penetration approval requirements (see Section 1.4.6).
- .3 If local, wired, IT Wide Area Network infrastructure is not present on a site, Wireless or DSL VPN network equipment shall be used. York Region ITS will supply the contractor with the pre-configured Wireless or DSL Modem/Router and network switch as well as specific installation instructions.
- .4 The Contractor shall install all required conduits and junction boxes as well as the exterior antenna for the Wireless equipment, in a location which has been identified by ITS to provide suitable network performance for this application. If required, the Contractor shall provide such additional infrastructure as may be required to ensure that the complete communications system performs in accordance with the design. Note that, in accordance with Code requirements, conductive data and high power cables (120 V or higher) cannot be placed in the same conduits.
- .5 The wide area network data switch shall be located within the following separate dedicated cabinet, 'Nema4 Hammond ERP Series Eclipse Rack Panel, complete with EHLPL Padlock Handle, Eclipse Rack Panel (ERP) and compatible Rack Rail Mounting Rails'. Both the modem and the data switch shall be powered from the UPS power supplies being used by the access control system.

1.9 SHOP DRAWINGS

- .1 Submit shop drawings showing the proposed location of all equipment to be installed under this Contract.
- .2 Shop drawings submission shall include, as may be appropriate, some or all of the following:
 - i. System riser diagram(s)

- ii. System layout/floorplan
- iii. Network connectivity diagrams
- iv. Vertical and horizontal wiring diagrams
- v. Typical and site-specific termination/wiring schematic(s) and diagrams
- vi. DIP Switch and similar configurations
- vii. Device landing schedule(s)
- viii. System integration schematic(s) and wiring diagrams
- ix. Intrusion detection point schedule(s)
- x. Tub/enclosure layout diagram(s)
- xi. Electrical connections and wiring diagrams
- xii. Explanation of the sequence of operation
- xiii. Integration techniques and operational scenarios
- xiv. Addressing charts
- xv. Product specifications and cut-sheets
- xvi. Complete Bill of Material
- xvii. Description of test methodology
- xviii. Other relevant information required for the installation

.3 Additional Shop Drawing Requirements:

- a. For devices containing DIP switches, jumpers or programming keypads include with the shop drawings, as appropriate:
 - i. Functional description.
 - ii. Performance data.
 - iii. Physical, electrical and environmental requirements.
 - iv. Location drawing.
 - v. Equipment descriptive literature.
 - vi. Wiring details.
- b. For programmable equipment, communication links and networks, submit a Bill of Materials. Include the hardware documentation with the Bill of Materials.
 - i. For hardware items include and clearly identify: Description, make, model, part number and serial number (once this available).
 - ii. For documentation include: Title, version, date and publisher for each item.
- c. For Programmable Hardware Equipment include:
 - i. Product description for each item including:
 - a) Wiring and installation instructions.
 - b) Functional description.
 - c) Performance data.
 - d) Physical, electrical and environmental requirements.
 - e) Adapters and controllers.
 - ii. Equipment layout drawings showing location of hardware, boards, jacks, cables and terminals.

- iii. Related field tag numbers and wire numbers, module tag assignment, rack module assignment, and terminal numbers.
 - iv. Location, identifier and pin assignment of plugs, jacks, and cables.
 - v. Switch settings and addresses, firmware.
 - vi. Interconnection Diagrams including wiring, cables, jacks between internal and external components, power supplies, processors, communications modules, racks, input/output modules and peripherals. Label terminals, jacks and pins. Show settings for jumpers and switches. Show address for each hardware module and point.
 - vii. Any backup or other maintenance requirements.
 - viii. Listing (hard and digital copies) of all programming details.
- .4 The review of shop drawings shall only be in reference to general design. The review of the shop drawings shall not, in any way, relieve the Contractor of responsibility for errors, omissions or physical interference, or from the necessity of furnishing such work and materials as may be required for the completion of the work at any time prior to formal acceptance. The Contractor shall be cognisant that the shop drawings may require resubmission before the contractor may proceed to the next phase of the project (see submission of Shop Drawings under General Requirements).

2. PRODUCTS

2.1 Security, Access Control and Intrusion Detection

- .1 Because of the deployment of existing devices which have all been designed to provide a uniform security solution for all properties belonging to York Region, there are pre-approved devices and solutions which shall be used wherever possible.
- .2 These pre approved security devices are listed in the Appendices J, K, L, M, N and O.
- | | | |
|----|------------|--|
| a. | Appendix J | List of Approved Security Equipment |
| b. | Appendix K | Approved Access Control Equipment |
| c. | Appendix L | Approved Intrusion Detection Equipment |
| d. | Appendix M | Intercom Equipment |
| e. | Appendix N | Approved Card Reader Equipment |
| f. | Appendix O | Miscellaneous Security Devices |
- .3 Typical installation configurations in which these devices are used may be found in the sample “assembly drawings” which are shown in Appendix E “Standardized Security Configurations”.
- .4 The Contractor shall ensure that all supplied systems which are to be deployed are compatible with the existing security installation. Hence the general industry guideline of using the most recent versions of software, firmware and hardware may lead to unsatisfactory performance due to incompatibility. It should be noted that the existing

installation may not have been updated to the latest versions because of prior, known incompatibilities. The contractor is responsible to validate all such equipment and ensure full compatibility between newly supplied equipment and the already installed components. Any proposed firmware or software updates must therefore be reviewed with the Region before any updates are undertaken. If any modifications or upgrades are required, these changes must be included in the project budget and identified in the proposal.

- .5 The contractor may request that the Region consider use of devices other than those pre-approved by the Region. The procedure and the form to be submitted when requesting such a substitution is set forth in Appendix F “Procedure for Equipment Substitution”. It should be noted that the decision of the Region in regard to any such request is final.
- .6 The use of any equipment which is not approved by the Region shall constitute a Breach of Contract and grounds for terminating the Contract in progress and lead to an Action to complete the contract in accordance with the approved design as well as consequential damages.

2.2 Performance Criteria

- .1 Contractors shall recognise that the purpose of installing any Security System is to ensure that intruders cannot enter and that any attempt to bypass or otherwise defeat the hardening which has also been installed in order to deter intruders must successfully report all details of this attempt.
- .2 The Region is therefore adopting suitable criteria which they will use to determine the effectiveness of the Security Systems.
- .3 The Probability Of Detection (POD) is a measure which is described in Appendix C -- Standardised Abbreviations and, as its title implies, recognizes that some Security Systems do not detect every attempt at compromise. The Region expects however that the POD shall meet or exceed 97% with suitable information being provided in a timely manner to the security staff for them to investigate.
- .4 The corollary to an effective detection system is that the system must have a very low False Alarm Rate (FAR). It is well known in the industry that false alarms are a major cause of the failure to detect intrusion attempts. When an alarm is reported and the security patrol determines that this was caused by “acceptable events” it is either classified as a false alarm or as a “nuisance alarm”. Both of these situations generate distrust in the alarm system ultimately leading to the failure of responders to pay attention to alarms. (See further discussion in Appendix C – Standardised Terminology.)
- .5 The Region will not accept a false alarm rate which exceeds 2% i.e., no more than two out of every hundred reported alarms may be classified as a false alarm or as a nuisance alarm.

2.3 Surveillance

- .1 Because of the existing deployment of devices which have been designed to provide a uniform surveillance solution for all properties belonging to York Region, there are pre-approved devices and solutions which should be used wherever possible.
- .2 Surveillance cameras shall be installed so that they can observe locations which would otherwise require regular security guard patrols. The images stored on the DVMS system must be of sufficient quality to fulfill the expectations of the designer. There are many factors which affect the quality of the image and these need to be clearly defined for a satisfactory outcome of the Contract. The following identifies a number of the key factors which may need consideration:

i. Stability

If a surveillance camera is mounted on an unstable base, the image may be very hard to interpret. This applies much more to outdoor cameras where the camera may be mounted on a pole or a building roof and wind plays a major role. Indoors there can be issues related to a wall in which there is a frequently used door which may slam shut with vibrations affecting the stability of the camera. It is clear that a minor vibration on a wide-angle lens may be barely perceived at an image distance of 15 m (50 ft) but if the same installation is used with a telephoto lens looking at an image distance of 1,500 m (~5,000 ft) the same deflection caused by the vibration will cause 100 times the distortion of the image. There are different forms of stabilization which can reduce the impact of any vibration transmitted to the images if the source of the vibration cannot be eliminated.

ii. Pixels on Target

The effectiveness of an image by which to identify an intruder when using a surveillance camera is determined by the number of image pixels used to provide the image of the topic of interest. In security surveillance applications this is usually defined in terms of a requirement, such as the resolution of the viewing screen, the resolution of the camera, the size of the screen, the height of the “target human intruder” and the minimum acceptable image size, e.g., “the minimum height of the human who is 1.8 m (~6 ft) at a distance of 30 m (~100ft) shall be 7.5 cms (~3 ins) on a 21 inch screen. This may be calculated for a particular configuration such as an 18 mm lens with a 15 μ pixel pitch to have a “Detection” range of 537 m (~1,750 ft), a “Recognition” range of 134 m (~440 ft) and an “Identification” range of 84 m (~275 ft).

iii. Recognition vs Detection

The camera designer must answer the question as to the purpose of any surveillance camera installation. The criteria for an acceptable surveillance image are often based, at least in part, Johnson’s Criteria. Generally, the purpose of surveillance in a security setting may be defined as one of the following:

- a. Detection: an object is present – 2 pixels on target.
- b. Recognition: discern the type of object, a human versus a vehicle – 8 pixels on target.

- c. Identification: discern specific objects, a man versus a woman, a car model – 12.8 pixels on target.

The above examples are simplified and ignore the image quality which is affected by lighting, contrast and other issues such as moving trees which can provide additional challenges.

iv. CIF vs Frame Rate

When recording images there are a number of terms which are used and which should be understood;

- a. CIF is Common Intermediate Format (360 x 240 pixels) and is a common format used for recording digital images to be played back in any standard format.
- b. 4CIF is an enhanced quality image over CIF and provides data at 704 x 480 pixels.
- c. Frames per second reflects the rate at which images are refreshed and is the term which was widely used with Analog(ue) Cameras which are now no longer current. Common values are 30 or 60 fps (the latter of consequence with high-speed action). This is of course the speed at which the older film technology moved the “celluloid” through the projector.

v. Illumination and Shadows

Illumination by artificial sources always generates shadows in the same place whereas illumination by the sun or even the moon causes shadows which vary by time of day and also by season. From a security perspective the shadows are a potential hiding place for any malfeasant. Hence great care is required to ensure that shading hiding places are minimised as is the basis of CPTED.

vi. Infra Red

Many security cameras are now available with integrated IR illuminators which allow the cameras to “see in the dark”. Infra red illuminators are harmless to humans and animals and are invisible without technological aids so that such surveillance can be considered “covert”. The images provided by these cameras are monochrome (generally appearing as black and white) as the lighting source is a single frequency.

vii. Thermal Cameras

Thermal cameras, which are sometimes incorrectly referred to as infra red cameras because they detect “heat” (which is related to infra red waves), will display images based on the heat signature of any item in the field of view which differs from the background. These cameras can provide very effective imaging with no artificial light during any time of day and are oblivious to the shadows or glare caused by natural or artificial lighting. Generally, because of optical considerations, zoom lenses are not available for thermal cameras. One popular option is to co-locate a thermal camera with an optical camera thereby providing versatile and reliable imaging at any time of day.

viii. Direct Sunlight

The glare caused by direct or reflected sunlight will cause optical camera images to “be blinded” and therefore the images to be unsuitable for surveillance use. Placement of the outdoor cameras can possibly reduce the impact but in some instances, thermal cameras provide an alternative because the sensor does not respond to “visible light” of any kind.

ix. Colour v Black & White Images

To an ever-increasing extent, surveillance cameras of all kinds are being offered with colour imaging. Such images are very attractive and make recognition much more convenient. There are challenges for colour imaging under low light conditions and some colour cameras change automatically to black and white images when the light conditions are reduced. If artificial lighting is used it must have frequency spectrum and colour temperature representative of sunlight to ensure that the images are comparable with day lighting. Sodium (HPS) or mercury (HID) lights, which have long been used in outdoor applications, make colour recognition essentially impossible.

x. PTZ v fixed lens v multi unit cameras v 360° cameras

PTZ (Pan, Tilt and Zoom) cameras are attractive to some designers but are an anathema to other designers. Such cameras can cover a very large field of view using pre-programmed “tours” in which they move automatically through a pre-configured inspection of the landscape being surveyed. As the image is being recorded it is clear that only the current image is recorded and depending on the frequency and nature of the tour, coverage of the landscape will be far from continuous. In other situations, PTZ cameras are used by staff who may have reason to steer the camera image to look carefully to an aspect of an image observed on a fixed camera, e.g., a fixed camera image shows an apparent moving shadow along a security fence line which can be observed in greater detail by directing the PTZ camera to the same place at a much longer focal length (telephoto). Some address situations of this kind by using multiple, single lens, fixed cameras instead of a PTZ cameras and manufacturers are now manufacturing single camera housings which include multiple imaging devices which can be configured independently or as a single defined group. There is one other group of cameras which also have a very special feature in that they can provide a single 360° image. Such cameras often include recording playback software allowing, for example, tracking of a person walking through an art gallery. It is clear that selecting the correct camera configuration for any job is crucial.

xi. Analogue v Digital Cameras

The cameras which are currently being used are digital, meaning that they include a direct connection on to the available LAN and no transformation of the video data is required. Analogue Cameras are also defined by their encoding systems, such as NTSC and PAL. The older, now largely outdated, cameras use analog signals which need to be converted to a digit signal to be transmitted over the LAN which is generally used as the means of interconnecting buildings and equipment.

- .2 The design should be evaluated by using a camera simulation package to ensure that the resulting images meet all of the design intent before the construction is completed.

- .3 These pre-approved surveillance devices are listed in the Appendix P “Digital Video Management System”.
- .4 The Digital Video Management System (“DVMS”) is now, and shall continue to be, capable of supporting a further future expansion of the reconfigured system by a further 20% of cameras following completion of the current project.
- .5 As a minimum, the system must support the most recent, currently available network cameras, encoders and camera streamers as may be available and are being used during the project execution.
- .6 The Contractor shall use the latest generation of the equipment listed in Appendix P. The contractor must ensure that all equipment which is being supplied will be compatible with the existing and previously installed components. If any modifications or upgrades are required, these changes must be included in the project budget and identified in the proposal.
- .7 It is the responsibility of the contractor to ensure that any upgrades or modifications of any kind to the existing equipment which is being proposed to accommodate the current project will in no way degrade or modify the performance of the existing installation.
- .8 Hence the general industry guideline of using the most recent versions of software, firmware and hardware may lead to unsatisfactory performance due to incompatibility. It should be noted that the existing installation may not have been updated to the latest versions because of prior, known incompatibilities. The contractor is responsible to validate all such equipment and ensure full compatibility between newly supplied equipment and the already installed components. Any proposed firmware or software updates must therefore be reviewed with the Region before any updates are undertaken.
- .9 The DVMS shall, as a minimum, support the industry-standard Motion JPEG (MJPEG), MPEG-4, H.264, and H.265 as well as Axis’s proprietary Zipstream video compression technology formats.
- .10 The DVMS system shall continue to be fully integrated with the Access Control system version currently in use by York Region and shall also be fully compatible with all announced updates to that system at the time of installation. This system is being used as the primary user interface to monitor all surveillance cameras.
- .11 York Region uses fixed lens cameras for surveillance unless otherwise stated. All design decisions shall be made in consultation with York Region Capital Projects.

2.4 Video Recording Requirements

- .1 The recording system must provide faithful and reliable recordings of all the cameras which are connected to it. The recording system must use some form of RAID technology or equivalent technology so as to ensure that in the event of any drive failure the data will continue to be available. Redundancy and fail over options must be included in the network to ensure that recording cameras is never at risk.

- .2 Recording of a camera image is generally performed if there is motion in the field of view, although in some cases, recording can be performed continuously at a very slow rate until there is motion at which time the frame rate accelerates. The recording is intended to analyse events after they have occurred and therefore it is important that the time prior to an incident can be recorded. Such recording from before the event is often configurable to allow for the 2 minutes or for the 15 seconds before the “alarm went off”. This is generally achieved by continuously recording to volatile memory. Typically, recording is at a fixed rate, e.g., 15 fps and continuously erasing the data which is older than the configured time “before the incident”. While cameras are continuously increasing their resolution, the current trend is to generally record at “1080” resolution for most surveillance applications. The higher the resolution, the quicker the disks will fill when recording.
- .3 It is by no means unusual to upgrade street or other lighting when surveillance is implemented. Cameras are using more and more sensitive detectors but for high contrast and high quality images there may be a strong justification to provide lighting to eliminate shadows.
- .4 Care must be taken when allowing for the amount of power which is required and the distance to the power source is mostly provided by POE data switches.
- .5 While the recording of up to 300 cameras per NVR is normal, there can of course be unlimited numbers of NVRs. The NVRs must have an accurate source of time so that images can be synchronised across the network. Typically, the recorded image from each camera includes a burn-in, i.e., an image which is configured to show the date and time and the camera description on every frame of the recording.
- .6 The recordings should be “searchable”, i.e., the NVR has an interface which allows for searching for specific images using a number of different criteria, such as:
 - a. Date and time
 - b. Alarms
 - c. Facial recognition
 - d. Location
 - e. Analytics, such as when a car drove into the driveway etc.
- .7 While reviewing recordings to perform an investigation, security staff may review many images from many cameras and there needs to be mechanism to quickly return to the most useful images. A good NVR will provide a “bookmarking” tool to effectively allow for the storage of particular scenes.
- .8 Archiving of the recorded images should be performed automatically from the live NVRs several times (e.g., 4 times) during the day in order to offload the recorders to ensure optimal hardware performance. The archived data can remain on the network where it is readily accessible for a limited period.
- .9 The use of surveillance cameras and the retention of the recordings should be reviewed for compliance with the requirements of the FIPPA and MFIPPA which may have limitations on these activities.

- .10 While it is commonplace to erase recordings which have “no significance” after a period such as 30 days, there are also situation such as a pending investigation which may take months to unfold. The recordings associated with that investigation may need to be kept, protected and not available for review by any “unauthorised” person. Such evidence will be secured with an “evidence lock”.
- .11 If a recording is required by a law enforcement authority in order to prosecute a case, there may be a requirement to apply a digital signature so that, it can be shown in court, that the recording has not been modified or “contaminated”.
- .12 There should be tools allowing for the security staff at the main control centre to forward the image of an incident which has occurred to “mobile colleagues” via their cell phones or tablets. A similar operation must be available to send video images as files in e-mail messages.
- .13 The NVR and its related components should not use proprietary hardware but adhere to industry standard configurations so that all computers used by the Region, can be maintained and procured from a single source.
- .14 It is almost universal to incorporate an LPR program in the surveillance management software, with the ability to recognise any licence plate from Canada or the USA. This function should provide for searching the recordings or monitoring for the appearance of a particular vehicle. Note that the inconsistent requirement of one or two licence plates on a car can make such applications relatively challenging.
- .15 The video system manufacturer should be able to supply an API or and an SDK. These tools will allow developers to create tools to facilitate the use of the video recordings, e.g., transfer a video clip to a specific security guard or to notify a security officer each time when a particular entrance is used.
- .16 The foregoing list is intended to identify the manner in which a modern video surveillance recorder can be configured and implemented. The options are not exhaustive and have omitted the questions of reliability and ease of use which is taken for granted.

2.5 Elevator Access Control Integration

- .1 There are a number of options which come into play when the decision to install elevator access control is made. This section will identify the most common topics and issues. Among such issues is the requirement that the designers understand some of the serious limitations which are discussed below.
- .2 Basic elevator control is commonly achieved by installing a card reader in each elevator car. When a user swipes their access card at the card reader, the floors that they have access to are unlocked for a short period of time, e.g., 7 seconds. During this time, the user is able to select a floor by pressing the “floor button” inside the cab.
- .3 The interface between the access control system and the elevator can be achieved in two very different ways. Both require the card reader installed in the elevator car (cab) to communicate with the access control system electronics (typically a controller) which is

generally located in the elevator machine room close to where the elevator controller is also installed.

- .4 Access to the elevator control room is heavily regulated by the Elevator Code, the Elevator technician Union and the TSSA because of the inherent dangers of that location and it is common practice that an elevator technician may have to be present just to ensure safety and compliance.
- .5 The approval of the floor control may require that the TSSA be involved. The installation of the card readers in the elevator cab may involve the elevator technician's presence because the work and the wiring are interpreted as "elevator work" although, again, this work is often performed by the security technician under the watchful eye of the elevator technician.
- .6 In an emergency, such as power failure or a building fire alarm activation the elevator may need some special functions. In the event of a power failure, it is commonplace for a standby emergency generator to power each car in a bank of elevators in turn so as to return all cars and their passengers to a particular floor, generally the ground floor. In the event of a fire alarm the process is similar except that as long as there is regular power available, the cars will return to an exit floor expeditiously so as to provide subsequent availability for fire fighters. It is recommended that in such circumstances the access control be automatically disabled to allow the first responders free access to all areas of the building.
- .7 The vagaries of the Elevator Code require that the main exit floor is not normally a controlled floor, meaning that anybody in the building can freely use the elevator to reach the Ground floor from where there is an exit to the street.
- .8 The concept of placing a card reader in the elevator cars and then locking some or all of the floors is not very "reliable" for a number of reasons. The general situation in an elevator is that there may be a dozen or maybe more, passengers in the car as it heads upwards from the ground floor. Often the passengers do not know each other and some will recognise that they do not need to press a particular floor because it has already been activated as shown by the illumination of that floor button. Hence, an intruder just has to keep discretely quiet and then be taken to the "locked" floor to which he wishes access. When this person wishes to leave, the departure generally requires no access card. Note further that, when an authorised user is granted access during a brief time window to multiple floors, either the authorised user or a miscreant can press multiple buttons, thus directing the elevator to stop at multiple "locked" floors.
- .9 The functionality which is described here can be implemented by interrupting all of the floor buttons which are to be controlled for each of the cars with a normally open relay contact. The use of the card will cause the relays to change status for the permitted floors and to thereby allow the selection signal to pass through the contacts while they are briefly closed. Once the timed process is complete the relays return to their open state which inhibits selection of any controlled floor from that elevator. In almost all cases, all the elevators in a bank of elevators will be programmed identically.
- .10 When the audit trail log is reviewed with regard to the elevator activity, there are 2 possibilities in regard to the amount of data which can be found.

- a. Most commonly there is no “destination reporting” which means that the initial card swipe will unlock all the floors allowed by the access level accorded to that user, for example, floors 3, 4, 5, 6 and 7. The user will swipe this card and the audit trail log will report that user “John Doe was granted access to floors 3, 4, 5, 6 and 7 in Car 5”. When the user selects a floor there is no data capture of this information and therefore the audit trail log has no means of knowing to which floor this user was travelling.
 - b. A further complication which arises is that the other passengers on the elevator can press any of the other “unlocked” floors during the “unlock time”. It is obvious that the unlock time has to be short, but it is equally clear that if it is too short, there will be complaints and if it is too long the security is weakened. The recommendation is about 5 to 7 seconds as a practical compromise.
 - c. Many elevators have dual sets of floor buttons to simplify life for the passengers when the elevator is relatively crowded or to increase overall elevator reliability. Since the panels work together, the single card swipe will unlock both floor button panels, thereby allowing selection of floors simultaneously from both sets of floor buttons.
 - d. With more sophisticated configurations it is possible to ensure that the destination floor which is selected is written to the audit trail log. This then requires inputs to the elevator controller from the access control system. The use of the relays as described above is combined with the detection of the current flowing in the one floor button circuit which is interpreted as the floor to which the elevator is being dispatched. Clearly more wiring is required for this option and also more equipment. Hence this option is more expensive and less frequently used. In some situations, the functionality is achieved by using an elevator lobby which includes access control on all the entrances/exits from the lobby.
- .11 Low level elevator integration with the access control system, as described above, enables cost effective access control of almost any elevator system, regardless of age or capability. Basic integration is achieved by wiring the access control controller outputs directly to elevator floor relays, thereby allowing the access control system to control the “locking and unlocking” of floors.
- .12 As an alternative, where required, elevator floor buttons can be connected to the access control controller inputs, enabling the controller to record which floor a user has selected when they are given access to the authorised call buttons in the elevator. The access control system monitors the inputs from the car buttons and activates the selected floor relay to mimic the function of the floor button in the elevator. By performing this function, the access control is responding to the floor call button and can record which floor that individual has selected. Note that this does not prevent the person alighting from the elevator on any floor where the elevator stops. The security system does not have any record of the floor to which the elevator is called. This process is usually referred to as Destination Reporting.
- .13 Some access control systems can also achieve high level interface (HLI) integration with selected manufacturer’s elevator systems. In such installations the access control controller communicates with an elevator server or controller over the TCP/IP network (or other communications protocol such as BACnet) rather than using individual physical

outputs and inputs. Because each elevator system is proprietary, it is not really possible to provide more details in a generic format. As is evident, many of the previously noted considerations still apply and the only major difference is that the integration between the elevator control system and the access control system is significantly less complex.

- .14 Generally, when implementing an access control system for a new elevator installation, the card reader will communicate over a special cable incorporated in the “travelling cable” which travels with the cab and provides many conductors for the power, signalling, card reader, surveillance camera, ventilation and screen in the cab. While this sounds straightforward, this process may not be trivial in high rise buildings where the cable length can grow rapidly. For an approximate example, a building of 50 stories will typically have the travelling cable terminated at the 25th floor. The cable itself has to reach up and down 25 floors and the link to the elevator control room from the termination is another 25 floors, i.e., the overall length of the cable will be about 60 floors of approximately 4.5 m each for a total of 270 m (890 ft). As is obvious this length is significant and for much of the distance the communications cable is bound integrally with cables which may be carrying “dirty” electrical power.
- .15 When installing a “retrofit” elevator access control system the recommendation is often to replace the travelling cable which is extremely costly and time consuming. There are signal conditioning and signal amplification devices which are recommended as an alternative (see Appendix R -- Cabling, Conductors and Miscellaneous Accessories). Since the elevator industry has long had the practice to equip the travelling cables with a generous number of spare conductors, there is generally no difficulty in negotiating for permission to use the spare power conductors in the travelling cable. These conductors can be used in conjunction with the signal conditioner to connect the card reader placed in the elevator to the access control controller in the elevator room (which is where the travelling cable is terminated. This link will then provide reliable card data from the elevator cab to the access control controller.
- .16 The elevator technicians can provide suitable terminals in the elevator machine room for each elevator car where the security technician can connect the access control output relays to complete the control circuit.
- .17 Control relays can be wired in either a normally open connection (fail secure) or a normally closed connection (fail safe). The particular selection should be reviewed with the Region in order to determine which of these is more appropriate for any given project. Depending on the cause of a power failure, the elevators may not be moving in the event of a power failure.
 - a. Fail Safe: When power is interrupted (fails), the electronic locking device is released (unlocked). This is recommended for most “regular” applications and is mandatory if the installation is to comply with UL specifications.
 - b. Fail Secure: When power is interrupted (fails), the electronic locking device is secured (locked). This option may be preferred in an environment where individuals are at risk if they have freedom, e.g., protective custody.
- .18 The floor call buttons for the access control function must be interrupted on all the elevator cars independently and programming is then configured to allow the same

functionalities on all the cars in the group. The card swipe identifies the car which is being used and only the call buttons in that elevator will be activated.

- .19 Although breaking either side of the call button wiring will provide the same functionality, it is recommended that the elevator company, break the “control signal” and not the “common supply” for the button. This method allows a simple migration to destination reporting if required in the future.
- .20 Because the elevator “service mode” generally does not use the floor call buttons, the access control does not generally affect the service mode. Thus, when the elevator service technicians use a key to activate the “service mode” there is no inconvenience for them. The janitorial staff often use the service mode so that they can keep control of the elevator which will not respond to any “regular passenger dispatch requirements”.
- .21 The service mode will then not record who is using the elevator or where the elevator is travelling and there are no restrictions on the floors to which the elevator may be taken. A modification can be incorporated whereby use of the key to activate or deactivate the service mode in each cab is associated with a unique “input” and the change of state is logged. This change of state is best identified at the elevator controller.
- .22 If the card reader loses contact with the controller, it causes a communication failure but not necessarily a system notification. Suitable programming allows an option of choosing whether to automatically allow or prevent access to all controlled floors in this situation, i.e., to fail safe or fail secure.
- .23 Optional programming of the access control cards can provide the ability to lock floors based on a suitable schedule. Thus, for example, schedules can be defined so that guests who do not have suitable cards can access the floor with the office reception between 9:00 am and 5:00 pm, staff can access certain floors including the reception from 7:00 am to 7:00 pm and the security guards can have 24 hour access. The freight elevator can of course have an independent set of schedules and access privileges.
- .24 The elevator access control does not offer the concept of “door forced” or “held open” as managed by the security system. All elevator operational alarms are routed to the elevator controllers and are unrelated to the security system.
- .25 In some buildings there will be multiple tenants who do not use the same access cards or even use the same security system. Such situations can generally be resolved successfully while using a single card reader providing there is cooperation between the tenants and the landlord. The details are beyond the scope of this document. In brief, the card reader (which may be multi-technology capable) output is sent simultaneously to each of the associated security systems i.e., the security system for each tenant, and providing that the card numbers (including the facility code) are unique no more than a single system should grant access to any given card. Clearly precautions are required to electrically isolate the inputs and outputs but even this is readily achieved.
- .26 In some cases, multiple tenants may have the security of their office space managed for them by the a single, landlord managed access control / intrusion detection system. The foregoing description provides an alternative and offers some potential advantages:
 - a. No personal or personnel information is divulged to the landlord;

- b. Multi branch operations can use a single card for all offices across its available networks;
 - c. Updating of cards etc are under the company control, meaning fewer delays to implementing changes; and
 - d. The tenant can determine their own security policies and equipment selections.
- .27 It is strongly recommended that there shall be a simple toggle switch (or key switch) associated with the relay bank for each car which is controlled by the access control system. This will avoid any disputes between the elevator contractor and the security system contractor and accelerate problem identification, if or when, there is any problem related to the elevator call buttons. This switch will have 2 positions, namely “normal operation” where the access cards allow access to the locked floors and “bypass” where all the relays permit free access to all floors and the elevator operates as if there was no access control system. In this way, the building staff can unequivocally identify if a problem lies with the security system or with the elevator controls.
- .28 In most elevator access control applications, the fire alarm system has to have the ability to “recall” the elevators to the “main” floor where the fire department can readily access and use the elevators as they may require. In the presence of an access control system the fire alarm system should also “bypass” the access control function to ensure that the fire department can travel freely through the building as may be required. The extent of the “fire alarm induced bypass action” will need to be considered and this may be a Code related matter. In particular the locking of floors in the elevator may be irrelevant when the elevator is being used in fire fighting mode (see service mode above) although using an addressable relay on the fire alarm system to “bypass the relay bank” as described above is a very simple procedure.
- .29 The access levels with permission for the users’ access cards must include the floors to which the users require access. This can be achieved either by creating new access levels for the floors or by adding the elevator floors to the existing access levels which already span different floors.
- .30 The access control (security system) does not in any way alter the requirement for emergency voice communications for passengers in the elevator as required by the Elevator Code. There is currently no requirement to place surveillance cameras in elevator cars but, increasingly, such cameras are being installed to ensure the safety of passengers.

2.6 Network and Video Cabling

- .1 Network and Video Cabling devices are not defined specifically for a particular project and shall adhere to the industry standards and performance criteria as identified in Appendix D “Standards Applicable to Regional Security Projects” or, as may be otherwise defined by the Region and by the ITS department as in its Corporate ITS Cabling & Wiring Standard (February 8, 2021). The information cited here is, in part, extracted from that document.
- .2 The form of communications between the proprietary components of the security system is not mandated by this section but shall address the requirements of the security system.

The cabling for such communications will generally be based on similar standards to those advocated here. Sharing of any pathways, labelling and termination considerations shall follow the same guidelines as for the Local or Wide Area Networks as described here.

- .3 A Local Area Network (LAN) shall be provided for communication as may be required between the security system elements and the existing ITS infrastructure. All interfaces which are attached to the LAN shall be configured, where possible, for a minimum of 1000BaseTX Ethernet (1Gbps). It is noted that some security equipment functions with lower data rates and all high-speed equipment can operate at lower interface speeds. The LAN may need to use additional technologies within the backbone for greater speed or distance. Acceptable technologies are:
 - a. FDDI (Fibre Distributed Data Interface)
 - b. 1000BaseSX or 1000BaseLX Gigabit Ethernet (fibre)
 - c. Asynchronous Transfer Mode (ATM)
 - d. 1000BASE-TX UTP
- .4 The LAN shall use industry standard network cables. Acceptable cable types are:
 - a. OM4 Optical Multi-Mode, 50 μ Core diameter / 125 μ cladding diameter, Class 1a, graded index optical waveguide Fibre. All connectors shall be LC compliant and conform to ANSI/TIA-492AAAC.
 - b. Category 6A (250 MHz) or better, Unshielded Twisted Pair (UTP) terminated using TIA 568A configuration.
- .5 Each fibre backbone cable shall have a minimum of 12 strands OM4 distribution type fibre. The OM4 distribution type fibre shall perform as per industry standards over the required distances defined for the site.
- .6 Where there is a requirement for backbone interconnection between wiring closets on the same floor or multiple floors, such interconnection shall use a minimum of a 6 fibre strand, duplex, multi-mode 50 / 125 μ (OM4) rated fibre optic backbone terminated with:
 - a. 1 U x 19 ins rack mounted fibre patch panel
 - b. Connectors shall be OM4 (minimum), LC style;
 - c. $\frac{3}{4}$ inch fibre inner duct (corrugated) rated at FT-6 for ceiling plenum or FT-4 if the plenum is not used as a return air plenum;
 - d. Pulling force shall be limited to the maximum force permitted by the manufacturer;
 - e. Bend radius of the conduit and inner duct shall not be smaller than permitted by manufacturer's specifications; and
 - f. The inner duct shall be restrained so that the fibre inside of it is protected and not unnecessarily stressed.
- .7 Cable Distances in excess of 100 m (330 ft) shall use multi-mode fibre (as opposed to UTP).

- .8 All connectors for the termination of fibre optic backbone cables shall use duplex LC connectors.
- .9 Fibre optic enclosures shall meet the following requirements:
 - a. Enclosures shall include a slide out drawer for frontal access of the terminations.
 - b. Enclosures shall be compatible with LC connectors.
- .10 For multi-mode fibre optic terminations inside access closets fibre patch panels the connectors shall be preloaded adapters configured with LC duplex, multimode, adapters.
- .11 The LAN used for surveillance and security applications shall be logically and/or physically separate from any other existing LAN infrastructure. Interconnection to other LANs shall only be through one of the following:
 - a. A router;
 - b. A Layer 3 capable network switch; or
 - c. As an additional VLAN to the existing LAN equipment.
- .12 Where the design requires an interconnection between VLANs, a router or a Layer 3 capable switch shall be provided by the Contractor and be approved by the ITS department.
- .13 Network video cables shall not be connected individually to the Camera Server. All communications with the Camera (DVMS) Server shall use the LAN. Each network camera or video streamer shall have a single Ethernet network connection which is to be used both for video and also for camera control, e.g., for Pan/Tilt/Zoom (PTZ) communications.
- .14 Cameras shall be powered using POE switches and, only in exceptional cases, will power injectors or local power sources be approved by the Region.
- .15 Supply a complete and working Closed-Circuit Television System (CCTV) System and Digital Video Management System (DVMS).
- .16 All camera passwords shall be changed from their factory defaults to a password provided by the Region.

2.7 Conduits, Pathways, Fittings, Cables and Miscellaneous Accessories

- .1 The construction of all conduits and associated components shall comply with the requirements of the Ontario Electrical Safety Code (OESC) and with other requirements as stated in Appendix Q: "Conduits, Fittings and Accessories" and in the Contract Documents. This compliance requirement applies even if the conduit is not being used for electrical applications.
- .2 All new communications conduits are limited to a fill capacity of 30% of the cross-sectional area. The industry practice and Codes allow for 40% fill but new conduits shall allow for a future expansion in cable occupancy to 40% fill. Where existing conduits are

being reused by addition of new cables the conduits may not exceed 40% fill upon completion of the construction.

- .3 All cabling, wiring and conductors shall comply with the requirements set forth in Appendix R: “Cabling, Conductors and Miscellaneous Accessories” and, as applicable, are also subject to the specifications as defined in the OESC including the fire rating FT-4 or FT-6 and CSA or equivalent certification.

2.8 Parking Controls

- .1 Details pertaining to the specific equipment for Parking Control may be found in Appendix S: “Parking Barriers”.
- .2 The Parking Control Devices are activated through and also, largely report, all status information through the use of dry contacts. Therefore, unlike many of the network connected security devices, the Region is largely agnostic to the choice of parking equipment supplied by the contractor.
- .3 Because York Region does not have pre-approved equipment for Parking Barriers it will evaluate and approve submissions for specific products on an individual case basis. Submissions for each project must include the Gate Manufacturer and proposed model, reference to existing operating installations and provide assurance of parts and maintenance availability.
- .4 Barrier arms shall break away readily and shall be readily replaced. As applicable, the barrier arms shall be illuminated to allow high visibility when available illumination is poor.
- .5 All control functions for the operation of barriers are to be controlled through the Access Control security system.
- .6 Where supply and installation of high-speed automatic rising barrier for vehicles is required for access control, the barrier arm is to open via authorisation given in response to valid card reads using a multi technology card reader compatible with the access control system.
- .7 The pedestal on which the card reader and intercom are installed will generally be designed to facilitate use by trucks or passenger vehicles by providing suitable readers at 2 different heights. Further details are provided in Appendix S, “Parking Barriers”. There is to be a long-range card reader for use by truck drivers which is mounted so that the driver can hold the access card in line with, but distant from the long-range reader (up to 24 inches). There will be a second, traditional reader, keypad and intercom installed at a suitable height for use by passenger vehicle drivers who are able to reach the reader, the keypad and the intercom directly from the “driver’s window”. The actual geometry and distances may vary by project but must be approved by the Region.
- .8 Alternatively, “visitors” wishing to enter the parking area may use the intercom to ask for remote release of the entrance barrier which will be provided through a manual operation from the Central Operations Centre by using the access control system.

- .9 Suitably placed cameras should be associated with the audio intercom to capture the driver's face and the vehicle identification.
- .10 The access control system will provide a NO, momentary, dry contact closure to activate the entrance barrier arm, whether activated by the use of a card swipe or via the operator response to an Intercom request.
- .11 There will be 2 vehicle detector loops in the entrance lane to streamline the barrier operation:
 - a. The first loop will ensure that the barrier arm will only open when there is a vehicle at the reader location, i.e., a pedestrian cannot open the barrier arm and then allow an "unauthorised" vehicle to have access.
 - b. The second loop will be triggered as any entering vehicle passes beyond the raised entrance barrier so that the barrier will then lower.
 - c. These loops will not function in reverse, i.e., the barrier will remain down if a vehicle attempts to exit via the entrance.
- .12 The barrier arm is to open on vehicle exit by means of a vehicle departure sensing loop and a reset loop. The departure loop senses the vehicle and opens the arm which recloses when the "reset" loop detects the departing vehicle. These loops should be designed to prevent and detect illegal entry and are more fully described in the Appendix S.
- .13 The barrier arms shall be designed only for passenger cars or small trucks, or for both passenger and commercial vehicles as may be required by the Contract Documents.
- .14 Lighting shall be integrated into the barrier arms to ensure clear visibility during night time conditions.
- .15 All barrier arms shall incorporate breakaway features.
- .16 Provisions shall be incorporated to allow for the configuration of the barrier arms to permit anti-passback operation if required by the Contract documents. This configuration would require the use of a card reader instead of a detection loop to activate the exit barrier arm. The exit lane would therefore also have to be equipped with a pedestal allowing for dual height readers (as in the entrance lane) and an intercom to facilitate any calls for help.
- .17 The gate shall also be able to open and close with a configurable timer or through a maintained contact from the access control system. The timer will enable the barrier arm to be closed during certain hours, e.g., parking lot closed after 8:00 pm until 7:00 am or the barrier arm can be open continuously from 9:00 am until 5:00 pm.
- .18 Security system installer to ensure that the barrier arm is integrated with security system, i.e., barrier arm status information is provided to the access control system where it shall be logged.
- .19 Provisions shall be included to ensure that the entrance and exit barrier arms cannot close onto a vehicle which is either stationery under the barrier arm or moving through either the entrance or the exit lanes. However, should the situation arise where the barrier arm

encounters an “object” such as a car while it closing, the barrier arm shall immediately signal an alarm to the access control system and reverse direction and stop operation when it is completely open. The barrier arm shall provide sufficient information so that all of its operations, i.e., open, close and close followed by “hit an obstacle and open” shall be logged by the access control system. Time stamps from these logs shall be synchronised with the recorded surveillance images thereby allowing detailed information about the arrivals and departures from the parking areas.

- .20 Provisions shall be included so that the barrier arm can be manually operated locally in the event of a power or communications failure. Usually this is achieved by key operated, weatherproof switches on the pedestal. Such manual operation will not respect the signals from the detection loops.
- .21 The parking system as proposed shall include any required options necessary to ensure that the system shall operate reliably under any and all anticipated environmental conditions (see Appendix H: “Environmental Requirements”).
- .22 All civil, electrical and communications requirements shall be identified in the proposed implementation and submissions.
- .23 Provisions shall be included in the design to provide physical protection of the barrier arms, e.g., posts to protect against vehicular collision, warning lights to identify the barrier arms and kerbs to control vehicle location.
- .24 As described above, the parking barriers shall use detector loops and loop amplifiers to control the entrance and exit activities which depend on vehicle presence detection. Apart from the requirement that these loops be reliable for all types of vehicles, i.e., large, small, multi-axle, high bed or low slung, aluminum, steel or plastic bodies and that the amplifiers be readily integrated into the access control system, York Region will evaluate the suitability of any properly proposed submission.
- .25 The vehicle detection loops shall be placed in the travelled lanes to provide the required functionalities and to assure the Region of reliable performance in the environmental conditions as described in Appendix H. Note that the Region has no preference as to whether the loops are pre-formed or are formed in situ. The loops shall however withstand the technologies used to keep the roadway clear of ice and snow as well as sun and rain.

2.9 Locksmithing and Door Hardware

- .1 Details pertaining to the specific requirements applicable to keys and locks may be found in Appendix T “Locks”.
- .2 All doors are to be equipped as outlined in the associated Security Device Summary document. Where specific details regarding locks are not available, doors should be equipped in accordance with the requirements laid out in Appendix T: “Locks”.

- .3 Interior exiting through any door (not overhead doors) should involve the use of a push paddle or panic crash bar exit device installed at a standard height not exceeding 1,200 mm (approximately 48 ins) AFF as required by the OBC.
- .4 York Region does not have a registered keyway or a dedicated locksmith.
- .5 During the construction phase, the Contractor shall supply temporary cylinders keyed to any convenient, secure combination. The Region shall be given five copies of the keys providing access to the area under construction for emergency and security patrol use.
- .6 There is no general policy regarding provision of grandmaster or sub master keying of locks and the Contractor shall comply with the requirements as defined in the Contract Documents.
- .7 Upon completion of the construction, three passkeys shall be provided for each door on which a final lock cylinder has been installed and the combination of each shall be recorded by the Contract Administrator.
- .8 The final lock cylinders or cylinder core shall be installed only after the final commissioning has been successfully completed.
- .9 Details of the locksmith providing the cylinders and keys as described in this section shall be furnished to the Region as part of the required As-Built Documentation.
- .10 Door hardware which is not defined in Appendix T: "Locks" shall meet all required standards and specifications as provided in the architectural specification and is therefore not specified in this security document.

2.10 Universal Washroom Requirements

- .1 A **universal washroom** is an enclosed space with a barrier free toilet, sink and turning space so that a wheeled mobility device may be accommodated. These **washrooms** aim to provide privacy and dignity for people with a disability, including for those who require an assistant.
- .2 The details of the washroom requirements are generally specified in the Ontario Building Code, particularly in Section "3.8.3.12. Universal Washrooms" but only those portions related to control of the door and those functions related to the "emergency button" are being addressed in this document. All other aspects of the washroom construction fall under the General Contractor and the Architect's mandates.

.3 OBC 3.8.3.12.2 states that:

A universal washroom shall have,

- (a) an emergency call system that consists of audible and visual signal devices inside and outside of the washroom that are activated by a control device inside the washroom, and*
- (b) an emergency sign that contains the words “IN THE EVENT OF AN EMERGENCY PUSH EMERGENCY BUTTON AND AUDIBLE AND VISUAL SIGNAL WILL ACTIVATE” in letters at least 25 mm high with a 5 mm stroke and that is posted above the emergency button.*

Additionally, the OBC states the following requirement:

Ensure emergency alarms are linked to a centrally monitored switchboard for facilities that have the capability. If third party monitoring is not available, alarms will remain local.

- .4 The security Contractor is to ensure that the emergency button alarms are reporting to the access control system. Monitoring of the washroom alarm will be implemented both locally, i.e., by the Region, and also by an off-site, 3rd party monitoring station.
- .5 All devices identified in Appendix U: “Universal Washroom” are to be purchased and installed under the General Contractor’s Contract or through any designated subcontractors.
- .6 Note that there are Code compliant kits available from some key manufacturers which provide all the required devices to provide the control functions for the washroom door. Such kits are outside the scope of this security document.
- .7 Details of the approved hardware to implement the control and monitoring of the Universal Washroom can be found in Appendix U: “Universal Washroom”.

3. EXECUTION

3.1 Electrical Installation

- .1 The Electrical work required under this contract shall conform to the requirements of the OESC and meet with the approval of the ESA.
- .2 Electricians working on the site shall adhere to the requisite safety procedures and Best Practices required to protect themselves from any risks arising from potential Arc Flash sources.
- .3 Electricians shall not work on “hot circuits” without special permission from the Region.

3.2 Installation – Wires and Cables

- .1 Provide wires of number and gauge (including corresponding raceways) as required, with sufficient space for conductors as indicated in the Drawings. Provide adequate wiring for the actual equipment which is being installed. There is no requirement to make allowance for future expansion by using oversized conductors or excess numbers of conductors. As noted, conduits shall have spare capacity.
- .2 Provide wire and cable according to the drawings and security system requirements. This includes consideration of wire types (related to environmental criteria) colours, conductor types, jacketing, conductor type and gauge.
- .3 Pull cable into ducts, conduits and cable trays in accordance with cable manufacturer's recommendations. Use specialised cable grips suitable for cable type, or pulling eyes fastened directly onto cable conductors.
- .4 Limit pulling tension and minimum bending radii to those recommended by manufacturer. Also observe that the conduits which are being used must adhere to the Code limitations regarding numbers of bends, lengths of pulls and provision of pull boxes.
- .5 Prevent damage to cable jackets by utilizing adequate amount of approved lubricant when pulling cables through ducts and conduits.
- .6 Support cables in manholes and utility tunnels on cable trays or cable racks.
- .7 Arrange cables in parallel rows on cable trays. Maintain cable spacing by fastening cables, with Velcro, a minimum of every 2000 mm on straight horizontal runs and to each rung at bends, including two rungs of adjoining straight sections. Fasten cables on vertical tray runs every 1000 mm. Limit the number of cables in each bundle of cables in accordance with best practices.
- .8 Connect cables to electrical boxes and equipment enclosures located in outdoor, wet or sprinklered areas with watertight cable connectors.
- .9 Provide cable grips for vertical and horizontal (catenary) cable suspension installations to reduce cable tension at connectors and at cable bends. Provide supporting messenger cables in accordance with best practices.
- .10 Install through wiring in junction boxes and pull boxes having no connection within the box. Leave a minimum of 300 mm (12 ins) of slack inside box or follow best practices in accordance with the type of cable and the location.
- .11 Facilitate making of splices and connections by leaving sufficient slack length of each conductor at panel boards, outlet boxes and other devices. Typically, the conductors should allow for 3 m (10 ft) of spare cable during the cable pulling process prior to the termination and dressing of each cable.
- .12 Where suitable, e.g., outdoor or below ground, seal the conduits after completing the cable installation to mitigate the risk of rodent damage to the cable jackets. The sealant being used shall be designated for this purpose and shall be approved by the Region.

- .13 Install instrumentation/system (low voltage) conductive signal wires in separate raceways from power and control wiring as is required by Code.
- .14 Identify each cable by attaching a cable marker at each end, in all intermediate manholes, junction boxes and pull boxes. (See Appendix V: "Labelling Requirements".
- .15 Install cables so as to conserve headroom in exposed locations and to minimize the amount of interference in spaces through which they pass.
- .16 Where exposed, install raceways, conduits and cables parallel or perpendicular to building lines and group neatly.
- .17 Maintain the integrity of all fire separations by sealing around all cables, trays or conduits where they pass through such fire separations. Generally, this includes all floors, ceilings and concrete or masonry walls. Fire stopping may be performed with approved materials meeting the NFPA requirements or by means of manufactured systems which may more readily permit later additions. In all cases the resulting installation must meet or exceed that of the existing barrier.
- .18 As far as is practicable, all feeder wiring shall be continuous from origin to panel termination without installing splices in intermediate pull boxes or splicing chambers. Sufficient slack (typically 3 m or 10 ft) shall be left at the termination point to make proper connections to the equipment. Any splices must be in accordance with the requirements of the Code and best practices. The communication cables may have specific length restrictions and splices or intermediate connections are generally not permitted. All splices or junctions must be readily accessible, i.e., must be visible and accessible subsequent to completion of the project.

3.3 Installation – All Security System Devices

- .1 Supply, install, configure, test, and commission all the access control system and intrusion detection system components, communications equipment and all system components to ensure the functionality of complete security system and network. All of the pre-approved equipment which is used to create these systems are listed in Appendices J, K, L, M, N and O. The contractor shall identify and report all pre-existing or related construction defects which will affect the progress of the Work to the Region and the Consultant before commencing construction.
- .2 The Drawings included with the project Specifications have been developed on a conceptual basis. The Contractor is responsible for providing/verifying the quantities and part numbers contained in these documents which are based on the pre-approved products as listed in the above-mentioned Appendices. The Contractor shall also itemise all additional components, cables, etc. which are required to complete the Work as defined in the Specifications and on the Drawings. The Contractor shall also itemise the Bill of Materials in a logical, per building, per floor, and per area manner. The detailed design shall be done by the Contractor who shall verify the part numbers and quantities which are required. The contractor shall include any recommended spare parts as may be appropriate. In particular, the contractor shall also identify any compatibility issues, should these exist, between the existing installation and the proposed new equipment.

- .3 Please refer to the drawings provided with the Contract Documents which identify the project requirements, the security device summary document, the Specifications and the Appendices for the specific security, locksmithing requirements and any other needs related to this project.
- .4 A minimum quantity of 20% of inputs and 20% of relay outputs are to remain available for use in all systems which are being affected by the project unless otherwise stated. Unless otherwise noted in the Contract Drawings and Documents, the total quantity of inputs and outputs in the security system shall be less than 80% full, leaving a minimum of 20% capacity available for future use.
- .5 All of the security system hardware and devices and additional nodes, as may be identified during the detailed design, are to be housed in NEMA 2 (IP11), NEMA 3 (IP54), or NEMA 4 (IP66) rated enclosures as listed in Appendix J or approved equivalent to suit the application. All enclosures are to be wall mounted and located as shown on the drawings. The Region will review and, as appropriate, approve the recommendations proposed by the Contractor.
- .6 The enclosure sizes shall be sufficient to ensure ease of maintenance, adequate ventilation, and space for the elsewhere defined potential for 20% expansion.
- .7 Where cabinets are exposed to the environment (see Appendix H “Environmental Requirements”), the Contractor is responsible for ensuring that the cabinet incorporates sufficient ventilation to ensure that the temperature inside the cabinet remains within acceptable tolerances, even when considering direct sunlight or winter storms. Such ventilation may require heaters, fans or air conditioning along with suitable thermostats. While some equipment to be housed in such cabinets may, for example, be rated for operation to -20°C, the condensation which occurs at temperatures below 5°C is of itself damaging and is therefore to be avoided. The Contractor shall provide suitable calculations and design information to justify the solution which is being proposed for such cabinets.
- .8 Equipment location and other mounting locations may be modified with prior approval from the Region.
- .9 The pre-approved Power Supplies are listed in Appendix J: “List of Approved Security Equipment” and shall be installed with a back plate. Only the approved power distribution modules are to be used for the system design.
- .10 Enclosure and Power Supply solutions are to be presented to the Region for approval.
- .11 All control panels, where applicable, are to be equipped with local battery backup power. Control panel batteries are to consist of 12V, 7Ah sealed lead acid batteries. Batteries shall be labelled with the installation contractor name and the date when initially installed and this information is to be updated when the batteries are replaced (see Section 1.4.22).
- .12 All equipment is to be installed according to the manufacturer’s recommendations and the Region shall be informed whenever such recommendations are not being followed. The Region shall receive an explanation or justification when such conditions occur and direct the Contractor accordingly. If any instances are identified by the Region where the

manufacturer's recommendations have been disregarded, corrective measures may be required by the Region. Any such modifications shall be at the Contractor's costs.

- .13 All security system control panel enclosures must include:
 - a. Tamper switches on the cabinet door(s);
 - b. UPS back up (as may be required by the Region);
 - c. Key operated lock on the cabinet door(s);
 - d. Battery backup;
 - e. Switched LED light inside panel to facilitate maintenance (as may be required);
 - f. Clear and approved label on the outside;
 - g. Internally stored configuration documentation etc;
 - h. A dedicated network jack for maintenance purposes; and
 - i. A dedicated 120VAC power circuit.
- .14 The Contractor shall supply all necessary wiring, termination equipment/devices and other necessary miscellaneous components which are not specified in the Contract Documents but which are necessary to implement a fully functional access control, intrusion detection and security system as well as mechanical/electromechanical key locking system. Details for lock placement, function and keying can be found in the associated Security Device Summary document. The door lock override key shall be the Medeco Intelligent Key Systems – M3 & X4 CLIQ (see also Appendix T: "Locks").
- .15 All cables and wires shall be CSA or equivalent approved and have a flame test rating equal to, or greater than, that required by the local building or fire code where it is being used, including the OBC and OESC and be clearly marked with the seal of approval by the testing agency.
- .16 End of Line (EOL) supervision shall be used on all sensor connections monitoring door status or other conditions. End of line resistor packs shall always be installed at the remote end of the detection line and not at the control panel. The Contractor shall install resistor packs using either one resistor (2 state monitoring) or using two resistors to provide 4 state monitoring. Resistance values are determined by the manufacturer of the equipment which is being used and the Region will define where and how such supervision implementation is to be installed. Both of these "supervision" configurations will alert the intrusion detection system when the connection wires are cut or short circuited and signal a "tamper trouble" status.
- .17 All cable runs should, where possible, be installed using a continuous, splice free cable run.
- .18 If splices are required, the splices shall be made in CSA or other approved junction boxes utilizing DIN rail-mounted terminal blocks. Splice box locations shall be marked on the wiring diagram and included in as-built documentation. All splice locations shall be clearly marked in accordance with the requirements identified in Appendix V "Labelling Requirements" and shown on the drawings.
- .19 Wiring lists shall be permanently affixed inside all cabinets where splices, or control components are installed.

- .20 Security wiring should not be run in parallel within 30 cms (12”) of 110 VAC or higher voltage electrical wiring or conduit.
- .21 All wiring shall adhere to applicable local, Provincial and Federal Codes and industry Best Practices shall be followed (also see Appendix D: “Standards Applicable to Regional Security Projects” for a partial list).
- .22 The location of equipment shown on the Drawings may be revised during construction prior to its installation and the Contractor shall not be entitled to any additional costs for the relocation of equipment if the new location is within 10 metres (33 ft) of the original location.
- .23 The contractor shall provide unit costing for each item in the Contract Documents which shall apply for all quantity changes of increase or decrease within +/- 5% of the quantities specified in the original documents. If the change exceeds this limit, then the job shall be repriced.
- .24 Install transformers complete with mounting brackets and hardware in positions in accordance with the manufacturer’s instructions and where approved by the Region.
- .25 The Contractor shall provide all necessary lugs and mounting equipment which are not already provided with transformers and which are not individually specified.
- .26 For the Regional Water and Wastewater facilities, the Control Panel relay outputs are to be wired to a local facility field controller so as to provide security system discrete dry contact inputs to the SCADA system. Inputs which are to be wired in a fail-safe mode include:
 - a. Intrusion Alarm
 - b. Security System Armed
 - c. Security System Disarmed
 - d. Spare
- .27 Communications between all of the distributed security devices and the York Regional Security servers shall use TCP/IP. The internal communication between the security devices and the prime security system interface port will use a protocol determined by the equipment manufacturer and, as long as it is does not involve the Region’s networks, does not need to be documented or approved by ITS. Configuration and activation of switch/hub ports on networking equipment maintained by the Region’s Information Technology Services Group (“ITS”) is to be co-ordinated by the Region. The Contractor shall provide one (1) week advance notification to the Region’s ITS Group for configuration of network ports.
- .28 IP addresses shall be provided by the Region’s ITS department on request.
- .29 If local IT Network infrastructure linking from the remote site to the Regional security servers is not present, Wireless network equipment shall be used. York Region ITS will supply the pre-configured Wireless Modem and network switch as well as the installation guidelines, (see Section 1.8 “Network TCP/IP Coordination”).

- .30 The Network switch which is being used to communicate between a remote location and the security server shall be housed within the security system enclosure at the remote location. Both the modem and the switch should be powered from UPS power supplies.
- .31 All replaced or surplus equipment is to be delivered to the Region upon completion of this Contract for possible re-use.
- .32 Where magnetic locking devices are to be used, and where permitted by Federal, Provincial, Local Municipal or Town/City Codes, all necessary permits, engineered drawings and fire alarm interconnection shall be completed by the Contractor. Modification of the fire alarm system, signage and security systems, as may be required, shall be performed by the Fire Alarm System contractor of record for that location and by the Contractor as appropriate.
- .33 Pre-Approved magnetic locks are shown in the Appendix T, "Locks". Such locks shall be Plate Magnet style locks with a minimum of 1200 lbf (540 kgs) holding force. In addition, they shall have indicator LED's showing if they are closed or open and have integral Hold Force Sensors (HFS) (Bond Sensors) and Door Contacts.
- .34 Where electro-magnets are being installed for a double door entrance, the magnetic lock shall be equipped with 2 electromagnets and 2 "plates" enclosed in a single housing. Door status monitoring may interpret the 2 doors as a single "opening".
- .35 The installation of the electromagnet may depend on the direction of "emergency egress" and wherever possible must be on the secure side of the door opening to reduce the risk of malicious attacks.
- .36 The final inspection regarding permit approval of the magnetic lock inspection shall be coordinated by the Contractor and shall take place in the presence of the Region's Project Coordinator. Presence of other required participants shall be coordinated by the Contractor.
- .37 All manufacturers' requirements and electrical Code requirements for grounding and bonding, including the requirements of the OESC and OBC, shall be followed. For larger projects there shall be 2 independent grounds, the power system ground and the telecommunications ground. Ground wires, ground lugs, grounding bolts and ground bars shall all be made of copper or bronze.
- .38 Concealed magnetic door contacts are to be installed on all exterior access doors and interior doors, as identified on the Device Summary Chart as well as on the Contract drawing.
- .39 Electric door strikes are to be installed on all doors which are identified within the Device Summary Chart as well as the Contract drawings. The electric strike shall be fire rated where these doors are a part of a fire separation. The strikes shall be configured to fail secure, i.e., when there is no applied power, the door shall be locked. Door key cylinders and locks shall be installed in every such door to allow key override of door strikes in all doors equipped with electric strikes. A message will be generated by the security system noting that the door has been "forced" when the door is opened using an "override" key.

- .40 The Contractor shall install snubbing diodes in all security devices incorporating electro-magnetic devices to minimize the induced reverse voltage which occurs when such devices are deactivated. Such diodes shall, for example, be installed close to all electric strikes and electro magnetic locks to maximise protection.
- .41 Installation of all electric strikes shall incorporate use of an “in-line power controller” to reduce the voltage supplied to the electric strike after the initial voltage surge activates the device. This device must be rated for the electric strike which is being installed and is intended to protect strikes which remain powered for long durations, such as an office entrance which may be opened by a schedule at 9:00 am and then powered until the office closes at end of the day. This is to be installed on all strikes to facilitate future applications of any door. The Contractor shall certify the use of such “in-line power controllers” so that the Region may exploit the doubling of the factory warranty period on such installations.
- .42 The Contractor shall label all enclosures containing security equipment identifying the nature of the equipment and the addresses of the enclosed nodes. All networked equipment is to be labelled with the corresponding IP information. Main alarm outputs and relays shall be labelled accordingly. All alarm points, card readers and other system components shall be labelled in accordance with the door numbering and description syntax. All labelling shall be consistent on site, in the as-built documentation and in the software. Labels shall be weather/environment resistant type (see Appendix V: “Labelling Requirements”).
- .43 The contractor shall post warranty/contact information on the inside of the main control enclosure for each facility. Where possible this information should identify contact information which is operational 24/7.
- .44 Dedicated security system alarm outputs shall be provided for all Environmental Services facilities and connected to the SCADA control panel so as to provide integrated monitoring of intrusion detection alarm and arming status (see Section 3.2.26). The SCADA system accepts only dry form C relay contacts, i.e., NO and NC contacts. Integration with the Region’s SCADA system must be coordinated with the Region, 2 weeks in advance of the integration so as to have a representative from Environmental Services scheduled to be present and assist with the integration. All work undertaken in chemical rooms (chlorine, ammonia rooms) at Environmental Water and Wastewater facilities must also be coordinated with the Region in advance to have a representative from Environmental Services scheduled to be present.
- .45 The Contractor is responsible for programming and testing of the intrusion reporting component if it is to be monitored by a 3rd party Central Station. The Contractor is to coordinate with the central monitoring station for configuration and testing of the system for all relevant signals. The intrusion reporting system at the Region’s sites shall be equipped with both Wireless and IP-Wired communication modules. The Contractor shall supply, install, configure, test and commission a compatible cellular communication module(s) complete with an active SIM card and an application appropriate antenna, i.e., the contractor shall enroll the security system as a subscriber. This antenna is to be installed on the inside or outside of the building so as to ensure a consistent and reliable signal and shall be in accordance with the requirements of applicable laws, including municipal, Provincial and Federal legislation and regulations. The contractor shall

coordinate the subscription with the Region and establish the appropriate response plan for each of the alarm points. If there is an existing contract with a local monitoring service, the Contractor shall modify the existing contract to allow for the added service.

- .46 The Contractor shall ensure that the cellular service and the monitoring service are so configured that the billing and other communications from the carrier are routed as requested by the Region.
- .47 All Alarms shall be the only notifications communicated to the 3rd Party Monitoring Service. No pre-alarms (as are associated with the Door Held Open alarms) shall be communicated to the 3rd Party Monitoring service.
- .48 The Contractor shall configure a routine test alarm transmission to the 3rd Party Monitoring Service which shall be set up to independently confirm the operation of both the wireless and the IP communications links during the silent night hours e.g., 2:00 am and 2:15 am every 24 hours unless otherwise instructed.
- .49 The Contractor shall work with the Region to confirm the:
 - a. Unique and unambiguous naming of all the alarm points;
 - b. Name and contact information of three contacts for each alarm point; and
 - c. A suitable Response plan for each alarm point.
- .50 The Contractor shall ensure that the response plan and contact information is confirmed with the 3rd Party Monitoring Service and shall test the system response by tripping each of the alarm points in turn and validating the 3rd Party Monitoring Service logs with those recorded by the Central Operations Audit Trail log in conjunction with the Region's representative.

3.4 Installation – Enterprise Software Integration

- .1 Integrate or modify the configuration for the facility which being modified into the Region's existing Enterprise software database.
- .2 The Contractor shall co-ordinate the Work to incorporate the facility into the existing Enterprise system with the Region.
- .3 This work shall be completed a minimum of 15 Working Days prior to the date of Substantial Performance of the Work. The Contractor shall coordinate this integration effort with the Region's Security and Life Safety Coordinator at 1-877-464-9675 ext. 76900 unless informed otherwise.

3.5 OPERATION - GENERAL

- .1 Operation of the new security system is to function similarly to existing systems installed at other Regional facilities of a similar type. The Contractor shall confirm all security system functions and operation with the Region of York Security and Life Safety Coordinator at 1-877-464-9675 ext.76900 prior to undertaking any programming unless otherwise informed.

- .2 Overview: A general overview of the intended operation of the system is as follows:
- a. The system shall allow for the monitoring of intrusion detection alarms inside the system alarm monitoring module, in addition to giving command and control of supported intrusion detection devices. Once alarms are brought in to the system, they shall be stored in the system Audit Trail log.
 - b. All system events either designated as alarm conditions or not designated as alarm conditions shall be stored in the system Audit Trail log.
 - c. Panic alarms both from wired and wireless buttons/devices are to annunciate on the security systems graphic map via alarm pop up which includes a floor plan showing the exact panic alarm location. This alarm will remain active until the event has been investigated by security staff who can then acknowledge the alarm using the 'panic all clear' button on the associated graphic.
 - d. Each door shall be programmed to generate "Door Forced" and "Door Held Open" alarms. These alarms shall have a user-definable, independent time delay which if not otherwise specified should be:
 - i. Time to trigger a "door held open" pre-alarm is 45 seconds;
 - ii. Additional time for a "door held open" alarm is 10 seconds; and
 - iii. Time to trigger "door forced" alarm is immediate.
 - e. Request to exit ("RTE") motion sensors are to be installed on the interior of all perimeter exit doors which are equipped with door contacts in order to prevent false "forced entry" alarms caused by egress of personnel even when the security system is armed. RTE's (motion sensors) are to be configured to only shunt egress detection for 45 seconds unless otherwise specified. RTEs shall not be configured to release the electric strike. These RTE's shall be aimed carefully so that the sensor is not triggered by individuals or activities not related to exiting through the door, such as by individuals using a stairwell or a coffee machine close to the exit door. The RTE described here will require a different configuration if the door is locked by an electro magnet.
 - f. Where access control and intrusion detection systems are installed on doors which also have automatic operators (also referred to as handicapped door operators), there are a number of special requirements. In order to achieve these added functions, there needs to be a door interface relay / sequence board which can integrate and schedule operation of the inputs and outputs in a way that the security system cannot. This device is normally installed in the ceiling above the handicapped door. This device integrates some of the functions identified below and introduces delays as may be required to ensure that the door lock and the handicapped operator function in sequence and not simultaneously. The usual sequence of operations is as follows.
 - i. The card reader on the insecure side of the door is always active.
 - ii. The insecure side handicapped paddle is normally inactive.
 - iii. The door is normally closed and locked unless there is a schedule during which the lock is disengaged.
 - iv. The secure side handicapped paddle is normally active and there is also an RTE device (typically a motion sensor)

- v. When entering the secure space from the insecure side:

The user will swipe a valid card on the reader which will enable the insecure side handicapped paddle and unlock the door. Those who are capable of doing so may open the door manually and enter through the door which will automatically close and relock behind that person. Mobility challenged individuals may press the handicapped paddle which will activate the handicapped operator by activating the REN (Request to Enter) on the access control system. Once the operator completes its cycle and closes the door the insecure side handicapped paddle will be inactive and the door will relock.
 - vi. When leaving the secure space and going to the insecure side:

The user will approach the door thereby activating the RTE device, thereby unlocking the door. The door can be opened by pulling on the handle or by pressing the handicapped paddle to activate the door operator. Once the operator completes its cycle and closes the door the secure side handicapped paddle will be active and the door will relock.
 - g. The security system shall automatically upload/download information to/from the control panels while the control panels are in communication with the host server application. A data download/upload may also be initiated manually by a technician should this be required. This transfer of data may consist of either controller database information or alarms and events.
 - h. Data transfer shall not interfere with normal daily operations. The local system shall be capable of working for at least 24 hours or 5,000 events written to local logs without communications to the central system. Alarms will sound locally and they and the events will be recorded locally when such downloads/uploads are unavailable. Should the local storage capacity be exceeded the oldest records will be overwritten. Once the downloads/uploads resume, these records will be transferred and will then appear in the Central Audit Trail log.
- .3 Authentication to the security System shall be via programmed Access Levels, e.g., all users will have only the access levels which are predicted to be relevant to their responsibilities, and these may relate to only one site for a local responsibility such as a librarian, or to many sites for an ITS trainer. When new sites are brought on-line, existing access levels may need to be augmented or new ones may need to be approved. Such access levels can be further customised by using schedules to allow for the accesses to be limited by time of day or day of week, thereby providing more control and greater security.
- .4 Proximity Card Reader and combination “Proximity Card Reader and Arming Button” shall function as a method of disarming and arming the security system respectively.
- .5 When a valid card is presented to the Card Reader on the insecure side of the door, the system of which that reader is a part will disarm immediately and temporarily unlock the door. The door does not need to be opened and even if the door is not opened the system will remain disarmed and the lock will relock after the timer expires.

- .6 The security system shall only Arm if there are no open contacts, open areas, or alarms in the system. Troubles will generally not inhibit Arming of the system, e.g., a low battery voltage causes a trouble signal which will not prevent arming of the system. When the system is “secure”, i.e., “ready to arm” (as shown on the keypad), swiping the card at the Card reader on the secure side of the door and then pressing the arming button which incorporates a 45 second delay and will result in the system commencing a countdown timer, which will be set to 1 minute unless otherwise specified. During this “Exit Delay” the keypad display will beep slowly and display “Exit Delay in Progress”. When the “Exit Delay” is complete, the sounder will become silent and the “Ready to Arm” indication will be replaced with the “armed” LED status indicator at the keypad will be illuminated on the keypad.
- .7 Upon presentation of proximity card with the correct Access Level, i.e., a valid access card, to a card reader, the security system shall activate the unlocking mechanism on the corresponding door, allowing that door to be opened. As noted above this will happen when the security system area is armed or not.
- .8 Upon authorized entry through a door (Access Granted) the system shall automatically disarm the security system area related to that door if it was previously armed. “Security System Disarmed” status shall be indicated as an input to the access control and intrusion system.
- .9 Prior to exiting from a facility, personnel shall arm the security system by presenting their card to the secure side “Arming” card reader and then pushing the adjacent push button (Arming Button). This sequence of events will initiate arming of the security system. “Security System Armed” input shall be signalled to field controller. The system shall only Arm if there are no alarms or “open contacts” in the system.
- .10 The use of a manual, “override” key entry to an armed facility, (or any other means of opening the door except for the use of an approved access card) shall cause “Intrusion Alarm” input to be signalled to the access control system and to the intrusion detection system.
- .11 Upon a forced entry to the facility, “Intrusion Alarm” input will be signalled to the local access control system and the intrusion detection system. The Central System maintains “Security System Armed” input signal to the access control system and intrusion detection system.

3.6 Security Wiring Field Quality Control

- .1 Sensor and other signal wiring should be tested for continuity of each conductor using ohmmeter or DC buzzer. Resistance values shall not exceed 5 ohms. Megger or 120 Volt filament lamp testing is not acceptable.
- .2 Carry out functional tests with the Region’s Representative to confirm field wiring, interconnections, and device functionality.
- .3 Depending upon the magnitude and the complexity of the system, the Contractor may elect to divide the security system into logical sections, and activate one section at a time so as to sequentially verify the operation of each selected section.

- .4 Upon completion of the sectional tests, the Contractor shall undertake testing of the integrated system comprised of all the sections.
- .5 The Contractor shall verify operation of the complete system for operational sequencing.
- .6 For local testing, each device/sensor should be tested and marked off one by one until all devices/sensors are tested. Each sensor shall be verified to the intended zone.
- .7 Submit one copy of all signed and dated test results to the Consultant. This shall only be done after any aberrations uncovered during the testing have been rectified.

3.7 Network Wiring Field Quality Control

- .1 The network cabling requires certification in order to achieve full acceptance by both the Region and the Manufacturer.
- .2 The Region requires that the performance of the entire LAN infrastructure be certified to Category 6a performance which shall include at least the following parameters as defined in the ANSI/TIA/EIA-568-B.1 and other compatible standards by using a calibrated tester.
- .3 Cable installers will generally provide these results for each cable link in tabular and graphical format which should be generated by the test equipment. These results will automatically flag those measurements which do not meet the performance standards which were selected, e.g., Category 5, Category 5e Category 6, Category 6a etc.
 - a. Wire map
 - b. Propagation delay
 - c. Delay Skew
 - d. Cable Length
 - e. Insertion Loss
 - f. Return Loss
 - g. Near-End Crosstalk (NEXT)
 - h. Power Sum NEXT (PSNEXT)
 - i. The Equal-Level Far-End Crosstalk (ELFEXT)
 - j. Power Sum ELFEXT (PSELFEXT)
 - k. Attenuation-to-Crosstalk ratio (ACR)
 - l. Power sum ACR (PSACR)
 - m. DC Loop Resistance
- .4 Naturally for the entire network to perform satisfactorily the components forming part of the network must all be certified to the same standard. Patch cords in particular are generally purchased pre-manufactured and are not normally a part of the “link testing”.

- .5 The system inspection shall include inspection of the labelling, the cable dressing, the terminations, the testing, patch panels, the jacks and the type of the insulation which has been used. All of these items shall be accepted by the Region only if all components are certified to the same standard.

3.8 Warranty

- .1 The entire passive network shall be accepted by the manufacturer after certification under its “lifetime warranty” program.
- .2 The beneficiary of the Warranty shall be the Regional Municipality of York.
- .3 The Contractor shall be responsible to ensure that installation complies with the warranty conditions. The general requirements are that:
 - a. All components shall be from a single manufacturer.
 - b. The installation is performed by Factory Trained installers.
 - c. The installation is tested and certified to meet the required standard.
- .4 During the Warranty period and as may be determined thereafter, the Region requires that the Contractor ensure that the service and repairs to the security system shall meet the following target service levels for the entire security system installed under the contract.
- .5 Response Time, Repair Time and Overall System Availability
 - a. The Contractor will respond to warranty work in reasonable time such that overall requirements for system availability are met. Availability of replacement components will support a reasonable response time. The Contractor shall be penalized when, during the warranty period, an incident involving a failure of any part of the system results in more than 48 hours of down-time or if the Contractor fails to commence warranty service within 12 consecutive hours from the first notification (being “Made Aware”) of the incident by York Region personnel or by system diagnostics.
 - b. “Made Aware” means when the Contractor has been advised by any party or when detected by or should have been detected by the Contractor. Additionally, the cumulative downtime shall not exceed 220 hours in any 6 month period or a penalty for each additional 24 hour period of downtime shall be applied.
 - c. Failure of any part of the system is defined as, but not limited to, any loss of functionality, malfunction of the security system or failure to attain the performance requirements as defined in this specification, in the Contract Documents or described in the training provided to the York Region staff or any on-line terminal malfunction, or communications failure which is not the result of a utility company to provide their service, under normal usage, vandalism, or traffic damage. These considerations clearly apply to the components which are referenced as the Security system or the surveillance camera system.
 - d. The following table summarizes incident response times, incident repair times, and cumulative downtimes:

Target Response	Response Time	Penalty Rate
Maximum Time to respond to an incident	24 hours	\$250.00 per 24-hour period or portion thereof.
Maximum Time to repair problem causing an incident	48 hours	\$250.00 per 24-hour period or portion thereof.
Cumulative down time during any 6-month period	220 hours	\$250.00 per 24-hour period or portion thereof.

- e. The Contractor shall submit system Diagnostic Reports to the York Region Security Coordinator on a monthly basis throughout the warranty period within 14 days of each month end. These reports shall validate the performance during the previous month and certify compliance with the performance and up time requirements.
- f. The Contractor shall make available qualified technical support during normal working hours and emergency support at all times 24 hours a day for each day throughout the warranty period.

3.9 Close Out

- .1 Close Out of the project shall require that the some or all of the following documents and miscellaneous items shall be provided to the Region, addressed to the Security Project Coordinator, via e-mail or to 145 Harry Walker Parkway, Newmarket, ON, L3Y 7C5.
 - a. One copy of all signed and dated test results as approved by the Consultant. This shall only be done after any aberrations uncovered during the testing have been rectified;
 - b. A written list of all passwords, keywords, serial numbers and/or configurations that were encountered during the installation of the operating system and application software;
 - c. Assignment of all warranties, licences and product registrations to the “Regional Municipality of York” and documentation to this effect;
 - d. Ensure that any permits or temporary configurations of any kind are returned to their permanent “operational” status and appropriate documentation is provided confirming this status;
 - e. All installation software, user manuals, accessory cables, calibration units and any other material accompanying the installed equipment; and
 - f. All keys, special tools, spare parts, unused components, permits, approvals, as-built drawings and project related documentation.
 - g. All documentation shall be provided in both hard copies and also in soft copies (using both source document format and PDF format). Source documents shall be in AutoCAD or Word format. There shall be no locks, keys or restrictions preventing the use of these documents by the Region and the documents shall be certified to be free of viruses or other malware of any kind.

3.10 Wiring Identification

- .1 Identify all wiring infrastructure including fibre optic cabling and conduits with wire markers in accordance with the requirements and guidelines of Appendix V: “Labelling Requirements”.
- .2 Identify each conductor, including any spares, with a unique alphanumeric designation to facilitate troubleshooting and maintenance as identified by Region of York standards.
- .3 Identify all controller wiring at terminal blocks and connection points with the controller terminal (I/O) address numbers.

3.11 Site Testing

- .1 Following installation or modification of the security System at a facility, Site testing shall be performed by the Contractor. Testing is to be co-ordinated with the Region.
- .2 Record test results in a log book and submit to the Consultant for reference and approval. Replace or repair circuits which do not meet requirements before submitting to the Consultant.
- .3 The Facility is to be tested to confirm/demonstrate the proper operation of the System in accordance with a test plan approved by the Consultant.
- .4 The Region’s representative is to be present for all final testing. The Region’s representative is to confirm that testing has been satisfactorily completed and that the system is ready for operational use as intended.
- .5 All exterior facility access doors are to be tested for valid access control functions and intrusion detection operation while using test proximity card(s). The corresponding inputs to the SCADA system are also to be verified when they are present. The security system is to be tested with both valid and invalid proximity cards in online and offline operating modes. The testing shall ensure that both the mechanical and electronic aspects of the doors as well as any other special features function correctly. The various trouble options shall also be shown to work properly. Any malfunctions must be corrected prior to the Region accepting the system.
- .6 Use of the “emergency” mechanical key override through all perimeter doors is to be tested by manually opening such doors. The key must readily provide access without any action by the access control system but must also report the key operation as a “Door Forced” event. Corresponding inputs to the SCADA system are to be confirmed as may be appropriate.
- .7 Since all arming is activated by use of a card and push button at one of the doors in each facility, there needs to be a careful verification of this function at each door which is equipped with this function. The testing shall ensure that any of the “faults” intended to inhibit the arming function do prevent the arming and that these situations are clearly identified on the keypad screens. Such faults include, door open, trouble events, inadequate credential access level, communications failure etc. The testing process

requires comparison of the Audit Trail log with the local record maintained by the testing team.

- .8 All event and alarm conditions are to be verified and logged to the system Audit Trail log. The activation of such alarms and associated events are to be logged using an accurate time source, e.g., a cell phone and then recorded. There are several different responses which should be initiated by this testing process and which therefore require testing:
 - a. A local response, e.g., siren at the door,
 - b. A facility wide response, e.g., an active icon on the alarm management screen in the facility,
 - c. A Regional central monitoring operation notification, e.g., an active icon on the alarm management screen; and
 - d. Notification to the 3rd Party, off site Monitoring Station.
- .9 Upon completion of the on-site testing, the “test team” records shall be compared with the system Audit Trail log report and with the notification log which shall be obtained from the 3rd Party Monitoring Station. Any evidence of a malfunction in this auditing process needs to be corrected before the Region will accept the system.
- .10 Following successful integration with the Region’s Security Server, “shift programming”, otherwise referred to as “access level adjustments” of the facility, if applicable, are to be coordinated through the Region’s Security and Security Systems Administrator who is available at 1-877-464-9675 ext.76900.

APPENDICES

4. LIST OF APPENDICES

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A	Regional Security System Naming Convention Standards
B	Regional Approved Commissioning Form
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D	Standards Applicable to Regional Security Projects
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G	Standardised Abbreviations
H	Environmental Requirements
I	Access Control System Value Added Resellers
J	List of Approved Security Equipment
K	Approved Access Control Equipment
L	Approved Intrusion Detection Equipment
M	Approved Intercom Equipment
N	Approved Credential and Credential Reading Equipment
O	Miscellaneous Security Devices
P	Digital Video Management System
Q	Conduits, Fittings and Accessories
R	Cabling, Conductors and Miscellaneous Accessories
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T	Locks
U	Universal Washroom
V	Labelling Requirements
W	Sample Graphic Map, Regional Layout and Icons

4.1 Appendix A – Regional Security System Naming Convention Standards

All components and interconnections are to be identified by a unique name which shall be used on drawings, documentation and labels.

These names are to be assigned in compliance with the following guidelines.

Labels are to be attached in a manner which is durable, can be readily read and are in accordance with these guidelines and is further documented in Appendix V.

A full list of the Sites and existing buildings can be provided on request. The Contractor is advised to obtain the latest listing to ensure that this contains any recent updates.

Site:

E005-B (Facility/Building Code)
followed by address
and/or building name

E = Municipality (example: East Gwillimbury)
005 = Building Site Sequential Number
B = Identifies site as an owned Building
Other options:
L = Leased Building
P = Property

System Controllers and Panels (Lenel LNL-2220, Bosch B9512G):

E005SS01 (LNL-2220)
E005SI01 (B9512G)

E005 = Site Number
S = Security controller
S = Intelligent System Controller (ISC)
I = Intrusion Alarm Panel (Bosch)
01 = ISC/Intrusion Panel Sequential Number

Door:

E005D001

E005 = Site Number
D = Card Reader/Door
001 = Matches Reader Port it is associated with.

4.2 Appendix B – Regional Approved Commissioning Form

The commissioning procedure is described in the Specification Document, Section 1.6 Testing and Quality Assurance.

The appropriate Commissioning Forms are to be completed and submitted to the York Region Project Manager for approval no later than 48 hours prior to the proposed commissioning. The Contractor is responsible to ensure that the forms correctly identify the quantity and description of the elements which are associated with a particular project. Note that the forms are available in Excel format and should be submitted in that format. There are 3 forms, one provides the Legend which is to be used and the Overall Project Summary, the second provides a record of the Individual Security Devices and the third form identifies changes to the video surveillance system. The sample forms are to be replaced by those included with the contract documents. Additional copies of these forms shall be created as may be required.

The contractor shall obtain copies of these forms directly from the Region so as to ensure that the forms being used reflect the latest version of the forms and incorporate the latest updates and reflect any technology changes.

SECURITY DEVICE LEGEND

DEVICE	DESCRIPTION	QUANTITY	MODEL NO.
DC	Door Contact		
MD	Motion Sensor		
CR	Card Reader		
REX	Request-To-Exit Motion Sensor		
GB	Glass Break Sensor		
PHB	PhotoBeam Detector		
ES	Electric Strike		
ML	Magnetic Lock		
OHD	Overhead Door Contact		
PB	Panic Button		
DU	Door Unlock/Lock Button		
FC	Fixed Camera		
PTZ	PTZ Camera		
KP	Keypad		
AB	Arming Button		
SS	Access Control Panel		
INTCOM	Aiphone Entry System		
SI	Intrusion System Panel		

SECURITY SYSTEM SUMMARY AND SIGN-OFFS

Building Name, Code, Address:	
120VAC Panel and Circuit Breaker Number for Security Panel:	
Network Information documented (ie.IP Addresses, Ports, switch etc.)	

General Inspections

YES

All devices and modules are labelled.
 All Graphic Devices/Design completed
 Access Levels, Cards/Schedules uploaded/functioning
 Batteries are hooked-up/ UPS test completed
 Tamper/Locks installed
 ESA Inspection passed
 OnGuard Panel notes complete with service information
 3rd party CMS connected and tested

yes
yes
yes
yes
yes
yes
yes
yes

Names of Personnel that performed the commissioning	Date	Signature
Names of York Region Personnel that performed the commissioning	Date	Signature
Warranty start:		

[illegible]

CCTV Commissioning document

Building Name:	
Project Number:	
Date:	

[illegible]

Notes:

- 1-Following parameters must be provided to Honeywell before starting the programming: **Camera name**, **Camera server name**, **Camera address**, **Location**, **Description**, **IP address**
- 2- Honeywell tech can suggest the **Camera name**. **Camera address**, **Location**, **Description**, and **VR** provides sign off if they are acceptable
- 3- Honeywell tech to create PTZ presets and tour based on VR's required field of view of a PTZ
- 4- Following are the VR standards for programming unless otherwise suggested by VR:

Live View frame rate	15 frame per second
Background recording duration	24 hours
Background record frame rate	Full frame-rate
Background delete after	1 month
compression format	H.264
compression Ratio	Medium
resolution for PTZ	1920 x 1080
resolution for Fixed	1280 x 720
PTZ preset Speed	20
PTZ Preset dwell Time	1s

Sign-Off Summary

	Name	Signature
	Honeywell tech performed the commissioning	
	YR personnel accepted the commissioning	

4.3 Appendix C – Standardised Terminology

ACCESS CARD is generally a plastic card, the size of a standard Credit card, with a chip or magnetic stripe containing encoded data that is read by passing the card through or over an electronic device which in turn transmits the encoded data to an electronic controller. From this data the controller identifies the card user and allows or denies access to restricted or secure areas or systems. There are many different forms of card encoding and card reading in common use.

ACCESS CONTROL see Access Control System.

ACCESS CONTROL SYSTEM is an electronic system which controls the status of control locations in accordance with the rules and inputs which have been programmed.

ACCEPTANCE is the process by which the security system is deemed to have passed the Commissioning test and when required the Burn-In testing. The Warranty period will then commence.

ALARM is the name given to the Intrusion Detection System status when a situation occurs which requires immediate on-site investigation, generally because of an unauthorised entry or because a sensor has notified the detection system of an unacceptable status. An Alarm may originate from either the Access Control System or from the Intrusion Detection System. The nature of the alarm notification is not defined and can be a loud siren, stroboscopic lights, electronic messaging or any combination of these and other alternatives. The IDS is normally expected to provide a sequential time stamped log to allow for forensic investigations following an alarm.

ALERT is a low priority notification which may originate from either the Access Control System or from the Intrusion Detection System. Alerts are normally activated in order to “alert” security staff that something is not “quite as expected” and may in some cases be followed by an Alarm when the status has extended from “not quite as expected” to “seriously out of order”. As examples consider that

- The temperature in a food freezer has warmed from -20°C to a threshold of -10°C at which temperature an alert is signalled and when the temperature rises to -3°C, an Alarm is signalled.
- An access-controlled door is held open for 2 minutes longer than the programmed “opening time” causing an Alert to be issued and sound locally but if the door remains open for 4 minutes longer than expected, the Alarm will be activated.
- If the “panic alarm” is activated by a staff member in a washroom or at a service counter there will be no alert, but the Alarm will immediately be activated.
- As soon as the power fails in a building an alert will be issued but the alarm will only be issued when the failure has lasted for, say 2 hours.

ASSETS are tangible or intangible things of the Region of York. Assets include but are not limited to information in all forms and media, networks, systems, material, real property, financial resources, employee trust, public confidence and reputation.

ATTACK is any action to execute a threat.

AUTOMATIC DOOR OPERATOR is a motorised device used to activate a door thereby allowing those with restricted strength or mobility to open doors which might otherwise be too heavy. These are also referred to as Handicapped Door Operators although this term is generally no longer used.

AVAILABILITY is the condition of being usable on demand to support operations, programs and services.

BACnet is a communication protocol for Building Automation and Control (BAC) networks that leverage the ASHRAE, ANSI, and ISO 16484-5 standard protocol. BACnet was designed to allow communication of building automation and control systems for applications such as heating, ventilating, and air-conditioning control (HVAC), lighting control, access control, and fire detection systems and their associated equipment.

BASE BUILDING SECURITY is a description of the security safeguards provided to protect a facility but not the necessarily the assets contained in the building. Basic building security provides a base or starting point for other security requirements (i.e., minimum and enhanced safeguards) to be added to protect the specific assets held by the facility. This is dependent on a TRA and a specific business requirement.

BASELINE SECURITY REQUIREMENTS are the mandatory provisions of the Region of York and its associated operational standards and technical documentation.

BINARY DIGIT is the smallest unit of data in a computer and is often abbreviated to “bit”. A bit has a single binary value, either 0 or 1 (see also Byte).

BITS PER SECOND is the speed of data transmission measured in bits per second and is often referred to as “baud”. Network speeds are generally measured in bps and have risen sharply with a tenfold increase for each new technology ranging from 1 Mbps through 10, 100 Mbps and 1Gbps and 10 Gbps.

BOND SENSOR see Hold Force Sensor.

BURN-IN TESTING is an extended form of “in service” System Integration Testing. For the period which has been defined for this test the system shall be left operational and shall endure all normal in-service characteristics. This may include power outages, weather extremes, etc. The Burn-In Test is designed to prove the operational capabilities of the entire system. This test may, therefore, require that the system function through a normal range of weather and perform in the manner which is expected for a minimum of 30 days. Thus, some burn-in tests can only be performed during the summer or during the winter seasons. No adjustments, configuration changes or maintenance of any kind should be performed during this period. The details of the BIT which is to be performed shall be noted in the Contract Documents.

BUSINESS CONTINUITY PLANNING is an all-encompassing term which includes the development and timely execution of plans, measures, procedures and arrangements to ensure minimal or no interruption to the availability of critical services and assets.

BY-PASS indicates that either one or more sensors or zones are by-passed or off-site monitoring has been “disabled”. While all of these options are generally invoked during testing, the purpose in all cases is to allow for the testing of an alarm system without activating a response from security agents responsible for such investigations. In some situations, if the security system is malfunctioning and the problem has been reduced to a particular sensor or zone, the sensor or zone may be bypassed to allow the remainder of the system to function normally pending the repair of the defect, a by-passed sensor or zone does not provide any signalling. If the entire security system is by-passed, the monitoring service will not activate any response plan for the duration of the “by-pass”. It is common practice, in these circumstances for the

monitoring service will provide a detailed listing of all the alarms received to the client so that the client or the security contractor can compare the report with the stimuli applied to the security system.

BYTE consists of a number of bits and has generally been associated with 8 bits leading to its common nomenclature of an “octet” and allowing for values from 0 to 255. Most modern computers use 4 or 8 bit “words” yielding 32-bit or 64-bit architectures.

BYTES PER SECOND or the number of bytes transmitted per second. There are commonly 8 bits per byte so that a speed of 110 baud is equivalent to approximately 10 characters per second when allowing for parity and other error correction bits.

COMMON ACCESS CARD is a term describing the particular form of access card used by all US Government and military personnel. It should not be confused with any other form of commonly used access cards.

CBRN a general term covering attacks using “Chemical”, “Biological”, “Radiological” or “Nuclear” weapons.

CBRNE this term adds “Explosives” to the possible threats (see CBRN).

CLOSED CIRCUIT TELEVISION, often referred to as “Surveillance”.

CENTRAL STATION see Monitoring Station.

CIVIL DISTURBANCES Means acts of violence and or disorder prejudicial to the public law and order. Civil disturbances most often arise from political grievances, urban economic conflicts, community unrest, terrorist acts, or foreign influences. They can range from peaceful picketing to full-blown riot situations.

CODE can refer to the most recent enacted version of any of a number of Codes which govern the construction and operation of buildings and systems. Typically, the pertinent Codes will include at least the Ontario Electrical Safety Code, the Ontario Building Code, the Elevator Code and the Fire Code.

COMMISSIONING describes the activity of commissioning which is the measured process of placing the security system into its initial operation and may include Proof of Performance and System Integration Tests sufficient to demonstrate the operational status of the entire system under operating conditions. Following the completion of the Commissioning process, the security system shall, if required, complete the Burn-In testing to qualify for Acceptance.

COMPROMISE is the unauthorized disclosure, destruction, removal, modification, interruption or use of assets. Also used to classify the unauthorised opening of a portal, door etc. i.e., an intrusion.

CONTACT ID is the number of the Monitoring Station information in the security system reference list of numbers and alternatives to be called when notification of an alarm is to be transmitted.

CONTINUOUS LIGHTING consists of a series of fixed lights arranged to flood an area continuously with overlapping cones of light.

CONTRACT DOCUMENTS are the documents describing the construction project and the responsibilities of the parties to the agreement. Generally, these documents will include either a detailed design including drawings or may define the performance requirements thereby requiring the contractor to perform the

detailed design. In some construction projects the contract documents may include work to be performed by more than one discipline and in other circumstances the project work relates to only a single discipline.

CONTROL OF ACCESS describes the process of ensuring authorized access to assets within a facility or restricted areas by screening visitors and material at entry points by personnel, guards or automated means and, where required, monitoring their movement within the facility or restricted access areas by escorting them.

CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN defines territories and how they are controlled and managed based on the use of “concentric rings of control and protection.” Outermost rings are supported by additional inner rings of protection. Each of these concentric rings will be addressed as layers of protection within these guidelines and are intended to sequentially deter, deny access to, and slow down possible malefactors.

CREDENTIALS are a means of identifying a user in to order to manage the “privileges” accorded to that individual. The most common credential is an access card but other credentials technically include keys (mechanical or electronic), fobs (with microchips), voice signatures, finger prints, retinal patterns, hand geometries and other evolving technologies. Credentials are used both in Physical Security settings (doors, windows etc) and in Cyber Security settings (remote access, banking etc).

CANADIAN STANDARDS ASSOCIATION is the Author and Authority who originate the standards, (including the Ontario Electrical Safety Code), which govern most of the devices, particularly the electrical devices used in Canada. The CSA symbol (or approved equivalent) must be permanently attached to every electrical device used with any regular power supply.

CATEGORY 4, 5, 5e, 6 etc define the performance of unshielded twisted pair (UTP) ethernet cables as specified by the Standards developed by the ISO/IEC and ANSI/TIA/EIA 568. These standards define the cable length as limited to 90m (300 ft), a characteristic impedance of 100 ohms. The cable Categories have increased in ordinal and in performance in response to network demands moving from 10 Mbps to 100 Mbps to 1 Gbps to 10 Gbps and rendering older wiring systems obsolete.

CYBER SECURITY is the practice of defending computers, servers, communications links, mobile devices, electronic systems, networks, and data from malicious attacks. It is also known as information technology security or electronic information security. This is quite distinct from Physical Security which is the focus of this document.

DETECTION refers to the use of appropriate devices, systems and procedures to signal that an attempted or actual unauthorized access has occurred.

DIN RAIL is a commonly used device for mounting many types of modules inside enclosures. It was originally specified by the Deutsches Institut für Normung (DIN) in 1928 and has since been adopted internationally (Top Hat Rail IEC/EN 60715).

DOCUMENTATION shall include shop drawings, catalogue sheets, calculations, drawings, diagrams, test print outs, photographs or/and text. Specific references may limit the particular documentation to specific criteria. All documentation submitted to the Owner shall be in English. The format of the Documentation shall be in accordance with the requirements as specified in the Contract Documents.

EMERGENCY LIGHTING depends on alternative power sources, and therefore, is reserved for times when regular lighting is not available. Typically, such lights are selected luminaires or fixtures which are selected from the continuous lighting fixtures and which are provided with an alternative source of power.

END OF LINE or END OF LINE RESISTOR refers to the placement of one or sometimes more than 1 resistor at the remote end of the sensor communications line. See Supervision for more details.

ENVIRONMENTAL THREATS refers to natural phenomena/disasters that have the potential to damage resources or services or to interrupt activities or operations, e.g., hurricanes, floods, heat waves.

EXPLOSION PROOF refers to the certification required of electrical and related safety devices used in hazardous locations. In electrical and safety engineering, hazardous locations are places where particular fire or explosion hazards may exist. Sources of such hazards include gases, vapours, dust, fibres, and airborne particles, which are combustible or flammable. Electrical equipment installed in such locations could provide an ignition source, due to electrical arcing, or high temperature. Standards and regulations exist to identify such locations, classify the hazards, and design equipment for safe use in such locations.

EXTERNAL THREATS refer to threats to the integrity and security brought about by individuals or circumstances outside of the Region of York.

FACILITY - a physical setting used to serve a specific purpose. A facility may be part of a building, a whole building, or a building plus its site; or it may be a construction that is not a building. The term encompasses both the physical object and its use (for example, weapons ranges, agriculture fields).

FAIL OPEN indicates that a failure of the control system will lead to the door or portal being uncontrolled and unlocked. See FAIL SAFE for a further discussion.

FAIL SAFE is a term which may be confusing to the casual user as the term “SAFE” may relate to a portal (door) being “safe for humans”, i.e., open or “safe for property”, i.e., closed. The terms, “FAIL OPEN” and “FAIL SECURE” are less ambiguous and therefore preferred. The reference to “FAIL” refers to the state assumed by the door or portal when control is lost, e.g., when the power has failed, a cable is cut or software malfunctions. It should be noted that while the establishing of a desirable “FAILURE” mode is desirable, unforeseen circumstances may prevent this mode being achieved, e.g., when a mechanical component seizes up or breaks.

FAIL SECURE indicates that a failure of the control system will lead to the door or portal being uncontrolled and locked. See FAIL SAFE for a further discussion.

FALSE ALARM refers to alarm systems being triggered by something other than the expected trigger-event. Examples of those applications include residential burglar alarms, smoke detectors, industrial alarms, and signal detection theory. False alarms are, correctly, limited to those alarms caused by a system not behaving in accordance with the system programming, e.g., a smoke detector activated by dust, a motion sensor activated by a mouse, a glass shock sensor activated by a tree branch hitting the window. (See Nuisance Alarm).

FALSE ALARM RATE, is defined as the number of false alarms (in which an alarm, or warning, is given in spite of a non-event) per the total number of ‘non-events’ (times the event didn’t happen). A false alarm rate is also known as the probability of false detection.

FALSE ALARM RATIO, is the number of false alarms (in which an alarm, or warning, is given in spite of a non-event) per the total number of warnings or alarms in a given study or situation.

HAZARDOUS LOCATIONS refer to electrical and safety engineering locations where fire or explosion hazards may exist. Sources of such hazards include gases, vapors, dust, fibers, and air borne particles, which are combustible or flammable. Electrical equipment installed in such locations could provide an ignition

source, due to electrical arcing, or high temperature. Standards and regulations exist to identify such locations, classify the hazards, and design equipment for safe use in such locations.

HOLD FORCE SENSOR (also referred to as a “Bond Sensor”) is a Hall Effect device mounted in an Electromagnetic lock to monitor the force between the solenoid (coil) and the armature (steel plate). This force which is frequently either 600 lbf (3,000 N) or 1,200 lbf (5,300 N) diminishes rapidly if there is an accumulation of dirt (e.g., rust) on the surface or any other obstacle which prevents the 2 components mating properly. The Hold Force Sensor (HFS) can detect any such holding force reduction and initiate an alarm indicating that the door is closed improperly.

INSIDER THREATS refers to trusted persons, possibly employees of the Region of York, who have been granted access to secured resources or services but could have ulterior motives.

INTERNATIONAL STANDARDS ORGANISATION which defines standards of many kinds and which are implicitly used by the national standards organisations such as CSA etc. These international standards are crucial for example to allow for communications or for manufacturing.

INTEGRITY refers to the accuracy and completeness of assets, and the authenticity of transactions.

INTRINSICALLY SAFE is a protection technique for safe operation of electrical equipment in hazardous areas by limiting the energy, electrical and thermal, available for ignition. In signal and control circuits that can operate with low currents and voltages, the intrinsic safety approach simplifies circuits and reduces installation cost over other protection methods. Areas with dangerous concentrations of flammable gases or dust are found in applications such as petrochemical refineries and mines. As a discipline, it is an application of inherent safety in instrumentation. The alternative to using Intrinsically Safe techniques is to use equipment which is certified as “Explosion Proof”. High-power circuits such as electric motors or lighting cannot use intrinsic safety methods for protection.

INTRUSION DETECTION SYSTEM is a system to monitor, detect and notify unauthorised access or the deviation of sensor observations from acceptable values, e.g., a door which has opened with the presentation of an approved credential or a motion sensor detecting movement in a room which is thought to be closed.

LATCH or LATCHING relates to a lock being set electronically to simulate a “latched door”. In this mode the door is insecure and can be opened without using credentials. The status change may be automated, as in the scheduled opening of an office main entrance, may occur as a result of a manual action at the system console or may be activated by a specially authorised credential.

LOCAL AREA NETWORK is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building. In such an environment the single network can be managed and it is often true that all of the computers belong to a single person or entity, thereby providing for enhanced security. Similarly, the network infrastructure generally all belongs to the same entity thereby ensuring adherence to the same technical criteria.

LOCKDOWN can be used to protect people inside a facility or, for example, a computing system, from a threat or other external event. In buildings, doors leading to the outside are usually locked so that no person may enter or exit. A “full lockdown” usually means that people must “stay where they are and may not enter or exit a building or rooms within it, needing to go to the nearest place designated safe if not already in such a place.” Lockdowns can be defined as “Exit permitted”, “Entrance permitted” or “Full lockdown” thereby defining how access cards will function during the emergency.

MAINTENANCE CONTRACTOR means the Contractor who, following the supply and installation of the Security System, will be responsible for the Maintenance or Modification of the system.

MATERIAL- any tangible object with the exclusion of those embodying information.

MATERIAL SAFETY DATA SHEETS, have been renamed to SDS, Safety Data Sheets (See Safety Data Sheets).

MEAN TIME BETWEEN FAILURES is the predicted, mean or average elapsed time between inherent failures of a mechanical or electronic system, during normal system operation. This is usually measured in hours, days or weeks. The term is used for repairable systems.

MEAN TIME TO FAILURE denotes the expected time to failure for a non-repairable system. Because Mean Time to Failure is relevant only for assets and equipment that cannot or should not be repaired, MTTF can also be thought of as the average lifespan of an asset. This is usually measured in hours, days or weeks.

MEAN TIME TO REPAIR is a measure of the maintainability of a repairable item, which tells the average time required to repair a specific item or component and return it to working status. It is a basic measure of the maintainability of equipment and parts. This includes the notification time, diagnosis and the time spent on actual repair as well as other activities required before the equipment can be returned to service. This is usually measured in hours, days or weeks.

MONITORED is to watch for or detect a breach of security.

MONITORED CONTINUOUSLY is to confirm on a continuous basis that there has not been a breach of security. Examples include electronic intrusion detection system, or someone guarding a particular point on a constant basis.

MONITORED PERIODICALLY is to confirm on a regular basis that there has not been a breach of security. The frequency and diligence of monitoring is based on the recommendations of a Threat and Risk Assessment. Examples of monitoring periodically include by means of a guard patrol, or through employees working at the location.

MONITORING STATION is the contracted agency to who all alarms which have been programmed for external notification are sent. The monitoring station will then follow the Response Plan provided by the customer for each Reporting ID which may include calling phone numbers until a contact is reached or dispatching suitable response personnel.

MULTI MODE FIBRE is a type of optical fibre mostly used for communication over short distances, such as within a building or on a campus. Multi-mode links can be used for data rates up to 100 Gbit/s. Multi-mode fibre has a fairly large core diameter that enables multiple light modes to be propagated and limits the maximum length of a transmission link because of modal dispersion. (See also Single Mode Fibre).

NORMALLY CLOSED identifies that when a momentary switch is not actuated, it is in its “normal” state. Similarly, a relay is in its “normal” state when it is NOT powered. Depending on how the device is constructed, its “normal” state can be either an “open” circuit or a “short” circuit. When a contact is “open” until the button is actuated, it's said to be “normally open” (abbreviated NO) and conversely when the contact is “closed” until the button is activated it is said to be “normally closed” (abbreviated NC). Unfortunately, the security industry has corrupted these explanations and, for example, a door contact's normal state is defined by the status of the door, i.e., the “normal state” of the door corresponds with the door being closed at which time the door contact is “energised” by the magnet or by the door and is referred

to as “normally closed” although, in its “at rest” or normal state, the contact will generally be “open”. The lesson is that the function of normally open and normally closed contacts must be reviewed with caution and varies by specific trades.

NORMALLY OPEN identifies that when a momentary switch is not actuated, it is in a “normal” state. Depending on how the button is constructed, its normal state can be either an “open circuit” or a “short circuit”. When a contact is open until actuated, it is said to be “normally open” (abbreviated NO). Unfortunately, the security industry has corrupted these explanations and, for example, a door contact’s normal state is defined by the status of the door, i.e., the “normal state” of the door corresponds with the door being closed at which time the door contact is “energised” by the magnet or by the door and is referred to as “normally closed” although, in its “at rest” or normal state, the contact will generally be “open”. The lesson is that the function of normally open and normally closed contacts must be reviewed with caution and varies by specific trades.

NUISANCE ALARM is intended to reflect the correct operation of a security system which is however triggered by the incorrect operation of the system without any malicious intent, e.g., furniture movers wedging doors open so that they can work more quickly, opening a window in an already secured area, i.e., such alarms are reporting correctly but the cause is generally “human error”.

ONTARIO ELECTRICAL SAFETY CODE, the Canadian Electrical Code as modified and approved for use in Ontario. This modification is generally enacted about 18 months following the issue of the CSA electrical code.

OPEN SYSTEMS INTERCONNECTION, (ISO 7498) a joint ISO and ITU-T standard for computer networks and communication protocols. The OSI model, is a 7 layered description for communications and computer network protocol design, (Physical, Data Link, Network, Transport, Session, Presentation, Application).

OPERATIONS AND MAINTENANCE shall mean all services and materials necessary for the functioning of the ACS and IDS Systems.

PHYSICAL SECURITY refers to the use of physical safeguards to prevent or delay unauthorized access to assets, to detect attempted and actual unauthorized access and to activate appropriate responses. This may be amplified to describe security measures that are designed to deny unauthorized access to facilities, equipment and resources and to protect personnel and property from damage or harm (such as espionage, theft, or [terrorist attacks](#)). Physical security involves the use of multiple layers of interdependent systems that can include CCTV surveillance, [security guards](#), [protective barriers](#), [locks](#), [access control](#), [perimeter intrusion detection](#), deterrent systems, fire, and other systems designed to protect persons and property.

PHYSICAL SECURITY ASSESSMENT REPORT which is essentially equivalent to a Threat and Risk Assessment report and is generally provided prior to designing a security solution.

PLENUM RATED is a designation used in conjunction with cable insulation. Code requirements demand that any cable placed without suitable conduit in an air return plenum, such as is commonly done, shall have a low smoke generation capability. Such cables are said to Plenum Rated, FT-6 or CMP certified. (See Riser Rated)

PRE-INSTALLATION TESTING includes all testing undertaken prior to the installation of equipment and may also include testing of mock-ups, prototypes and normal factory production testing. This is generally required for any New Equipment, i.e., equipment which is specially manufactured, but may be waived for Standard Equipment, i.e., equipment which is production manufactured.

PREVENTIVE MAINTENANCE (or preventative maintenance) is maintenance that is regularly performed on a piece of equipment or on a system to lessen the likelihood of failure. It is performed while the equipment is still working so that it does not break down unexpectedly. For example, door closers are required to ensure that doors close properly after a controlled entrance but may need inspection and adjustment to ensure that the air pressure from the HVAC system does not impact this function during seasonal changes.

PROBABILITY OF DETECTION is used in to establish the capability of a system to detect intrusions. The use of analytics in combination with CCTV and other sensors are known to have some limitations and therefore to sometimes fail to provide alarms or alerts when expected.

PROOF OF PERFORMANCE TESTING includes all testing undertaken following the field installation of equipment to verify the physical and operational features of each item of equipment and each sub system. This is required for all equipment.

PROTECTION in the context of physical security means the use of physical, procedural and psychological barriers to delay or deter unauthorized access, including visual and acoustic barriers.

PROVEN EQUIPMENT shall mean equipment, other than specified in the project specifications which has been supplied and installed by the vendor for a different but similar purpose. To comply with this definition, the equipment shall have been installed, in at least, five sites in the last ten years, currently be operational and references shall be available from such Agencies.

RACK UNIT is a commonly used measure of height or width when referencing 19 or 23 inch electronic equipment racks as well as the modular equipment installed in them. It is defined in the IEC 60297 as 1.75 inches (44.45 mm) so that a full height rack is often referred to as 42 RU or 42 U high, i.e., 6 ft 1.5 ins (1.8669m).

RECOVERY is the term used to describe the restoration of full levels of service delivery following an interruption in such service.

REPORTING ID is the internally programmed number identifying the location and nature of the alarm and which forms part of the information sent to the Monitoring Station.

RESPONSE is the implementation of measures to ensure that security incidents are reported to appropriate security officials and that immediate and long-term corrective action is taken.

RESPONSE PLAN is the document provided by the client to the Monitoring Station which identifies the action to be taken by the Monitoring Station for each of the Reporting ID's. Typically, the response plan will provide alternatives to address urgent situations if certain individuals are not available.

RESTRICTED, when applied to an Access Area, describes areas where access is limited to authorized individuals and generally includes Operations, Security and High Security Zones.

RISER RATED cables may be used without conduit in fire rated risers or riser rooms but may not be used in air return plenums where the smoke which the insulation would generate under fire conditions would be hazardous. Such cables are referred to as Riser Rated, FT-4 or CMR.

RISK is the measure of probability of a particular mode of "attack" by an intruder to be successful in gaining entry. It may also be summarised as the chance of a vulnerability being exploited.

SAFETY DATA SHEETS are required to provide information regarding all the potentially dangerous chemicals which may be on site as well as the required emergency procedures to be followed in the event of a misadventure. See Material Safety Data Sheets.

SECURITY CONTRACTOR will be the Contractor providing and installing the system described in this Specification and who is trained and certified on the equipment which is being installed under this project.

SENSOR is any device used to monitor a parameter which provides remotely monitored information, e.g., door contact, glass break sensor, water leakage sensor, power failure or motion sensor.

SIMPLE APPARATUS is considered not to appreciably affect the safety of an Intrinsically Safe system. This apparatus is exempted from the requirement for certification. The simple requirements are clearly specified in the apparatus standard. "Simple Apparatus" should always be readily demonstrable to be adequately safe. The usual examples of "Simple Apparatus" are switches, thermocouples, resistive temperature detectors and junction boxes

SINGLE MODE FIBRE is a fibre optic cable which has a smaller diameter core than the Multi-Mode Fibre and allows only one mode of light to propagate. Because of this, the number of light reflections occurring as the light passes through the core decreases, lowering attenuation and creating the ability for the signal to travel further. This application is typically used in long distance, higher bandwidth runs by Telco's, CATV companies, and Colleges and Universities. (See also Multi Mode Fibre).

STANDARD EQUIPMENT see PROVEN EQUIPMENT.

STAND-BY POWER is often a generic term referring to the availability of both a short term, battery-based power source designed to last for a brief period (see Uninterruptible Power Supply) and also a longer-term power source which may be from a local generator or an alternative feeder from a sub-station or transformer.

STRUCTURED CABLING is the communications cabling architecture defined by standards so that the cabling can be maintained and the associated networks can be modified and upgraded as may be required. This architecture defines 6 components, Entrance Facilities, Equipment Rooms, Backbone Cabling, Horizontal Cabling, Telecommunications Rooms (or Enclosures) and Work Area Components.

SUBSTITUTION is the process of requesting and justifying the use of equipment other than that specified by the project specifications. The contractor may request the substitution but must follow the process for submission and justification of the alternative equipment. The Region of York is the final arbiter with regard to the request for a substitution.

SUPERVISION is the term given to the use of resistors in different configurations to monitor the connections between remote sensors and the panels to which they are connected. Most sensors switch between "open" and "closed", i.e., between "infinite resistance" and "zero resistance", when they change state. By placing resistors in series and in parallel with the "sensor", the system will generate alerts if the wires are cut, shorted or the resistance measured by the terminating panel differs from the expected configuration. This supervision ensures that any "tampering" with the infrastructure will be identified and the alarms triggered by such situations are generally referred to as "tamper alarms". See TAMPER ALARMS.

SUPERVISORY CONTROL AND DATA ACQUISITION protocol and associated equipment which is used, particularly in association with the water and waste water equipment used by the Region and which is interconnected with the security system. Many of the devices or parameters associated with the

monitoring of water and waste water relate to analogue data such as temperature, pressure and flow rates as opposed to most security monitoring which is digital, i.e., the door is open or it is closed.

SURREPTITIOUS ATTACK is a secret unauthorized attack to breach or circumvent a defensive system or some of its components in such a manner that the custodians and/or security force cannot readily detect the attack.

SURVIVABILITY is the ability for the equipment to be subjected to the conditions which are referenced for an indefinite period without being operated and then returned to normal operation under different conditions without suffering any degradation or damage, e.g., keeping electronic equipment in a storage facility which is at -40°C when the operational requirement might call for a minimum to -20°C could affect the equipment survivability.

SYSTEM INTEGRATION TESTING includes all testing required to verify the harmonious operation of all designated subsystems. In the case where the larger system consists of individually approved sub components, partial testing shall be carried out on selected samples of equipment only.

TAMPER is the general process of attempting to make unauthorised modifications to a security system, generally in order to defeat the system's ability to detect a planned intrusion. The term "tamper" is often used colloquially to refer to a "tamper switch" which is contact attached to an equipment panel door to detect any unauthorised opening of the cabinet, i.e., tampering with the equipment.

TAMPER SWITCH see TAMPER

TEST REPORT is a pre-programmed call made from the Client site to the Monitoring Station, typically once per day and generally during "silent hours". The Reporting ID is defined as a "Test Report" and the Response Plan will confirm that no action is required. If the scheduled Test Report is not received, the Monitoring Station will typically generate a notification to the Client indicating the absence of the Test Report at the agreed upon scheduled time.

THREAT The perceived imminence of intended aggression by a capable entity to harm any aspect or all of a facility or its contents. **THREAT** can also be considered as any potential event or act, deliberate or accidental, that could cause injury to employees or assets.

THREAT AND RISK ASSESSMENT i.e., an evaluation of the vulnerability of a facility or asset which is generally provided as a report prior to designing a security solution.

TIME TO REPAIR is the time measured from informing the maintenance provider of a problem to the correction and the return to full service of the defective system.

TOGGLE generally refers to the ability to activate a control function repeatedly thereby changing the output state between 2 alternative conditions. This may be the control of lights, i.e., turning them on and then off, or the control of a door, i.e., latching a door open and closed. Such toggling may, for example, be activated by activating a button or by using a specially programmed access card

TROUBLE INPUTS are internal inputs defined within a security system which generate "alerts" to notify the system operators of an internal fault or "trouble". Such "troubles" need attention even if the reported problem does not appear to be causing any immediate concerns. Typical trouble inputs may include battery failure, AC power failure, power supply failure, LAN communications failure, phone line failure excess temperatures in the cabinet, system restart etc.

UNDERWRITERS LABORATORIES or UNDERWRITERS LABORATORIES OF CANADA is one of a number of global industry-based safety testing and certification laboratories which has been approved to perform tests of equipment where otherwise CSA testing would be required.

UNINTERRUPTIBLE POWER SUPPLY is an alternative source of main electrical power which is always available in the event that the primary source of power fails. Generally, the UPS power is on line at all times thereby ensuring that the power to the equipment never fails for even an instant. In many circumstances the UPS is associated with a Standby Generator which starts up and can generate power for a long time after about 1 minute thereby providing power for a long time if the Utility power is absent.

VLAN “virtual LAN” is any broadcast domain that is partitioned and isolated in a computer network at the data link layer (OSI layer 2). LAN is local area network and in this context virtual refers to a physical object recreated and altered by additional logic. VLANs work by applying tags to network frames and handling these tags in networking systems thereby creating the appearance and functionality of network traffic that is physically on a single network but acts as if it is split between separate networks.

VULNERABILITY - an inadequacy related to security that could permit a threat to cause injury.

WALK TEST is a method for testing sensors, generally in an operational security system, without causing false, system alarms. During a walk test, a person will go through each area and intentionally activate sensors so that they are recognized by the system. Arguably, the most important sensors to check during a Walk Test are motion sensors. This is because motion sensors are particularly prone to false alarms when they are mounted improperly. However, the testing process should also include all other sensors which are being monitored. During the Walk Test, the faulted zones will be displayed, but no alarms will be reported to the central station.

WARRANTY is the requirement for the contractor to provide a reliable system with an acceptable “return to service” response time. Typically, this requirement will define availability of parts and trained technicians for a specified period.

WHMIS The Workplace Hazardous Materials Information System are laws, created in 1988 to: give employers and workers information about the hazardous products or chemicals they may be exposed to at work. By international agreement this is now synonymous with a global system known as the Globally Harmonized System for the Classification and Labelling of Chemicals (GHS).

WIDE AREA NETWORK is a computer network spanning regions, countries, or even the world and which may be partially made of infrastructure belonging to many and possibly unknown partners. The application is generally to provide for sharing of data or for the networking of computers.

Wi-Fi is a family of wireless network protocols, based on the IEEE 802.11 family of standards, which are commonly used for area networking of devices and Internet access. *Wi-Fi* is a trademark of the non-profit Wi-Fi Alliance which restricts the use of the term *Wi-Fi Certified* to products that successfully complete interoperability certification testing. Communication using Wi-Fi allows for wireless local area networking (See Appendix D, Standards Applicable to Regional Security Projects, for details of 802.11)

ZONES defines a series of clearly discernible and securable spaces to progressively control access.

4.4 Appendix D – Standards Applicable to Regional Security Projects

This appendix lists the Standards which are generally applicable to portions of the security work specified by the York Region for Security related work. It is the contractor's responsibility to ensure that the most recent version of such Standards or Codes is being used. Should there be any conflicts which arise in the interpretation of such documents the Region of York shall be the final authority.

Standards are divided into distinct groupings and when enforced by Regulation or by Legal Statutes are generally referred to as Codes:

- Internal, i.e., York Region policy and experience-based policies
- Municipal, Provincial and National Standards
- Technology Standards

Any specific standards will be referenced for particular projects as required. Standards shall always be the most current commonly available version at the time the contract was awarded. This list is not intended to be exhaustive but is intended to guide contractors. Contractors are always responsible for adhering to all required and customary standards, best practices and are exclusively responsible for obtaining clarification if required. The primary authoring agencies of the Codes which may be encountered are identified below. It must be noted that these agencies are not necessarily respected or approved in Canadian jurisdictions and the list is not necessarily complete.:

ANSI	American National Standards Association,
BICSI	Building Industry Consulting Service International
CCIR	Consultative Committee for International Radio
CE	Conformity for Europe
CSA	Canadian Standards Association
EEMAC	Electrical Equipment Manufacturers Association of Canada
EIA	Electronic Industry Association
ETL	Electrical Testing Laboratories
FCC	Federal Communications Commission
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Organization for Standardization
JPEG	Joint Photographic Experts Group
MPEG	Moving Picture Experts Group
NFPA	National Fire Prevention Association
NRC	National Research Council (of Canada)
NTSC	National Television Systems Committee
PAL	Phase Alternating by Line
TIA	Telecommunications Industry Association, 568, 569, 606, 607 etc
UL	Underwriters Laboratories Inc.
ULC	Underwriter's Laboratories of Canada

The following Codes may be applicable to most projects

CEC	Canadian Electrical Code 2018, Part 1, C22.1-18
OESC	Ontario Electrical Safety Code 2018
OBC	Ontario Building Code 2012 updated 2020
NBC	National Building Code 2015
NFPA	National Fire Prevention Association 70E, 101, 2021
ULC	Underwriter's Laboratories of Canada, 437 etc
TIA	Telecommunications Industry Association, 568, 569, 606, 607 etc

EEMAC TC3 PVC Fittings for use with Rigid PVC Conduit and Tubing.

CSA C22.2 No. 211.2-06 Rigid PVC (Unplasticized) Conduit.

CAN/CSA C22.2 No. 18-06, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.

Canadian ICES-003 (Interference Causing Equipment Standard Policy)

ANSI / TIA-606-C Cable Labelling Standards (July 2017)

TIA-568.0-D Generic Telecommunications Cabling for Customer Premises

TIA-568.1-D Commercial Building Telecommunications Cabling Standard

TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard

TIA-568.3-D Optical Fibre Cabling Components

TIA-569-D Telecommunications Pathways and Spaces

TIA-606-C Administration Standard for Telecommunications Infrastructure

TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

TIA-862-B Building Automation Systems Cabling Standard

TIA-942-B Telecommunications Infrastructure Standard for Data Centers

TIA-1005-A Telecommunications Infrastructure Standard for Industrial Premises

TIA-1179-A Healthcare Facility Telecommunications Infrastructure Standard

ISO/IEC 11801 Generic Cabling for Customer Premises

IEEE 802.3 Standards

IEEE 802.3af Power over Ethernet (PoE) Standard

IEEE 802.3at Power over Ethernet+ (Plus) Standard

IEEE 802.3bt 4-Pair Power Over Ethernet (4PPoE) Standard

IEEE 802.3an Physical Layer and Management Parameters for 10 Gbps Operation Type 10GBASE-T

IEEE 802.3ba Media Access Control Parameters, Physical Layers and Management Parameters for 40 Gbps and 100 Gbps Operation

IEEE 802.11 Wireless Standard

IEEE 802.11 STANDARDS Wireless Standard

IEEE 802.11, the Wi-Fi standard, denotes a set of wireless LAN/WLAN standards developed by Working Group 11 of the IEEE LAN/MAN standards committee (IEEE 802). The term 802.11x is also used to denote this set of standards and is not to be mistaken for any one of its elements. There is no single 802.11x standard.

IEEE 802.11 details a wireless interface between devices to manage packet traffic (to avoid collisions, etc.). Some common specifications and their distinctive attributes include the following:

IEEE 802.11a – Operates in the 5 GHz frequency range (5.125 to 5.85 GHz) with a maximum 54 Mbps signalling rate. The 5 GHz frequency band isn't as crowded as the 2.4 GHz frequency because it offers

significantly more radio channels than the 802.11b and is used by fewer applications. It has a shorter range than 802.11g, is actually newer than 802.11b and is not compatible with 802.11b.

IEEE 802.11b – Operates in the 2.4 GHz Industrial, Scientific and Medical (ISM) band (2.4 to 2.4835 GHz) and provides signalling rates of up to 11 Mbps. This is a commonly used frequency. Microwave ovens, cordless phones, medical and scientific equipment, as well as Bluetooth devices, all work within the 2.4 GHz ISM band.

IEEE 802.11e – Ratified by the IEEE in late September 2005, the 802.11e quality-of-service specification is designed to guarantee the quality of voice and video traffic. It is particularly important for companies interested in using Wi-Fi phones.

IEEE 802.11g – Similar to 802.11b, this standard supports signalling rates of up to 54 Mbps. It also operates in the heavily used 2.4 GHz ISM band but uses a different radio technology to boost overall throughput. Compatible with older 802.11b.

IEEE 802.11i – Also sometimes called Wi-Fi Protected Access 2 (WPA 2), 802.11i was ratified in June 2004. WPA 2 supports the 128-bit-and-above Advanced Encryption Standard, along with 802.1x authentication and key management features.

IEEE 802.11k – Passed in June 2008, the 802.11k Radio Resource Management Standard will provide measurement information for access points and switches to make wireless LANs run more efficiently. It may, for example, better distribute traffic loads across access points or allow dynamic adjustments of transmission power to minimize interference.

IEEE 802.11n – Ratified in September 2009, 802.11n is a set of standards for wireless local area network (WLAN) communications, developed by the IEEE LAN/WAN Standards Committee (IEEE 802) in the 5 GHz and 2.4 GHz public spectrum bands. The proposed amendment improves upon the previous 802.11 standards by adding multiple-input multiple-output (MIMO) and many other newer features.

IEEE 802.11ac – Published in January 2014 by the IEEE 802.11 LAN/WAN Standards Committee, the standard increases WLAN multi-station throughput from the previous 802.11n standard to at least 1 gigabit per second and to a single link throughput of at least 500 megabits per second (500 Mbit/s). The increased throughput is achieved by utilizing wider RF bandwidth (up to 160 MHz), more MIMO spatial streams (up to eight), downlink multi-user MIMO (up to four clients), and high-density modulation (up to 256-QAM).

IEEE 802.11ad – This amendment defines modifications to both the IEEE 802.11 physical layers (PHYs) and the IEEE 802.11 medium access control layer (MAC) to enable operation in frequencies around 60 GHz and capable of very high throughput up to 7 Gbps.

For further information on cabling standards, please obtain the full versions of the original standards documents.

TIA-568.0-D (2009)	Generic Telecommunications Cabling for Customer Premises
TIA-568.1-D (2009)	Commercial Building Telecommunications Cabling Standard
TIA-568.2-D (2009)	Balanced Twisted-Pair Telecommunications Cabling and Components Standard
TIA-568.3-D (2009)	Optical Fibre Cabling Components
TIA-569-D (2015)	Telecommunications Pathways and Spaces
TIA-606-C (2012)	Administration Standard for Telecommunications Infrastructure
TIA-607-C (2015)	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

TIA-862-B (2011)	Building Automation Systems Cabling Standard
TIA-942-B (2012)	Telecommunications Infrastructure Standard for Data Centres
TIA-1005-A (2012)	Telecommunications Infrastructure Standard for Industrial Premises
TIA-1179-A (2010)	Healthcare Facility Telecommunications Infrastructure Standard
ISO/IEC 11801 (2002)	Generic Cabling for Customer Premises
IEEE 802.3af (2003)	Power over Ethernet (PoE) Standard
IEEE 802.3at (2009)	Power over Ethernet+ (Plus)
IEEE 802.3an (2006)	Physical Layer and Management Parameters for 10 Gbps Operation Type 10GBASE-T
IEEE 802.3ba (2010)	Media Access Control Parameters, Physical Layers and Management Parameters for 40 Gbps and 100 Gbps Operation
IEEE 802.3bm (2015)	Physical Layer specifications and management parameters for 40 Gbps operation over single-mode fibre (40GBASE-ER4) and for 100 Gbps operation over multimode fibre (100GBASE-SR4)
IEEE 802.3bq (2016)	Physical Coding Sublayer (PCS) interfaces and new Physical Medium Attachment (PMA) sublayer interfaces for 25 Gbps Ethernet and 40 Gbps Ethernet
IEEE 802.3bz (2016)	Physical Layer specifications, and management objects for the transfer of Ethernet format frames at 2.5 Gbps and 5 Gbps over balanced twisted-pair transmission media
IEEE 802.3bs (2017)	Physical Layer specifications, and management parameters for the transfer of IEEE 802.3 format frames at 200 Gbps and 400 Gbps.
IEEE 802.3bt (2018)	Physical Layer and Management Parameters for Power over Ethernet over 4 pairs
IEEE 802.11 Wireless Standard	
802.11ac (2014)	
802.11n (2009)	
802.11k (2008)	
802.11e (2005)	
802.11i (2004)	
802.11a (2003)	
802.11b (2003)	
802.11ac (2014)	
802.11ad (2012)	
802.11g (2003)	

Documentation submissions

All documents are to be submitted to York Region using:

- Microsoft Office 2019 or later as appropriate
- AutoCAD 2019 or later as appropriate
- Photographs shall be formatted in JPG but shall be no larger than 10 MB each.

Unless otherwise agreed to or documented in the Contract Documents, hardcopy submittals shall:

- Be printed single side, 8.5 x 11 inches and bound;
- The binding system which is used shall be sufficiently durable for the purpose, i.e., for review or for ongoing reference. Typical binding systems are 3 rings binders, Cerlox and Wire Binding Spines. Note that only the 3 rings binder can be easily updated;
- Pages shall be numbered in the format of “page 23 of 120”, i.e., indicating the total number of pages in the document; and
- Where colour is used to explain any aspect of the documentation the submittal must be printed in colour.

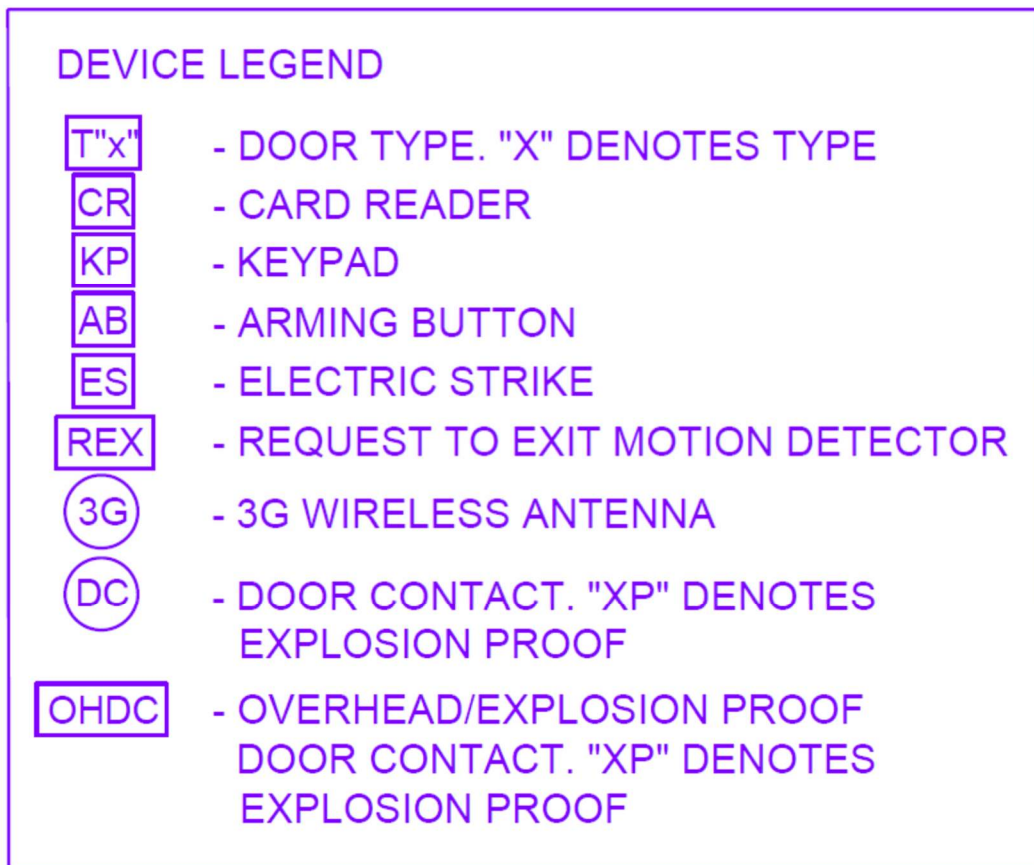
Unless otherwise agreed to or documented in the Contract Documents, Digital submittals shall:

- Be provided in both Adobe’s Portable Document Format (PDF) and in the source document editing format, e.g., Microsoft Word etc. using software and versions which comply with the Region’s Standards as defined in this Appendix;
- The submittal of the digital information may be provided on a portable media, e.g., a thumb drive or a Digital Video Disk (DVD), or through an e-mail or File Transfer Protocol (FTP) exchange;
- Be certified by the sender to be free of all forms of malware, including trojan horses, viruses, worms etc;
- Be free of any encryption, locks, passwords or devices to restrict access unless this is acknowledged and documented prior to the document transmission; and
- Not be subject to any form of proprietary restrictions or copyright.

4.5 Appendix E – Standardised Security Configurations

This section provides typical assemblies, components, drawing conventions and title blocks as used by York Region and which shall be used as the basis of all security contracts undertaken for York Region. If there is a requirement for a function which are not addressed by any of the supplied assemblies, the Contractor shall inform the York Region Project Manager and obtain suitable guidance.

The Contractor shall obtain the most up to date version of these diagrams from the Region prior to preparing the drawings so as to ensure that any updates or technology changes have been incorporated.



Notes:

1. Dedicated 120VAC circuit shall be installed by the contractor for the Security System.
2. The existing security wiring shall NOT be reused.
3. The existing security devices shall NOT be reused.
4. Integration with SCADA and 3rd party monitoring company shall be installed by the Contractor as per Security Specifications and tested in the presence of the Region's representative.
5. Wherever replacing an existing security system the Contractor shall limit the switchover time to one day, making sure there is minimum down time in security for the facility. No facility shall remain unsecured overnight.
6. The Contractor shall install all required conduit, junction boxes, cabling and devices for the Security System including Network (DSL/LTE/Fiber) and SCADA/3rd party monitoring integration.
7. The Contractor shall follow all relevant codes and regulations when installing conduit, wiring and devices in areas labeled as Explosion Proof (Class 1, Div 1(2)).
8. The Contractor shall perform installation conserving wall-space wherever possible.
9. The Contractor shall decommission an existing security system and turn over decommissioned parts to the Region undamaged for future use.
10. The Contractor shall integrate doors with Automatic Door Operators with the new security system using CX-12 module or similar.
11. The Contractor shall install DSL/Fiber/Cable/3G wireless network infrastructure and equipment as directed by the Region.
12. Devices indicated in purple already exist and need to be replaced.
13. Devices indicated in red are new devices. Infrastructure and devices shall be installed by the Contractor
14. For all doors secured with card access the Contractor shall supply and install Medeco CLIQ E-KEY System and all necessary door hardware.

10

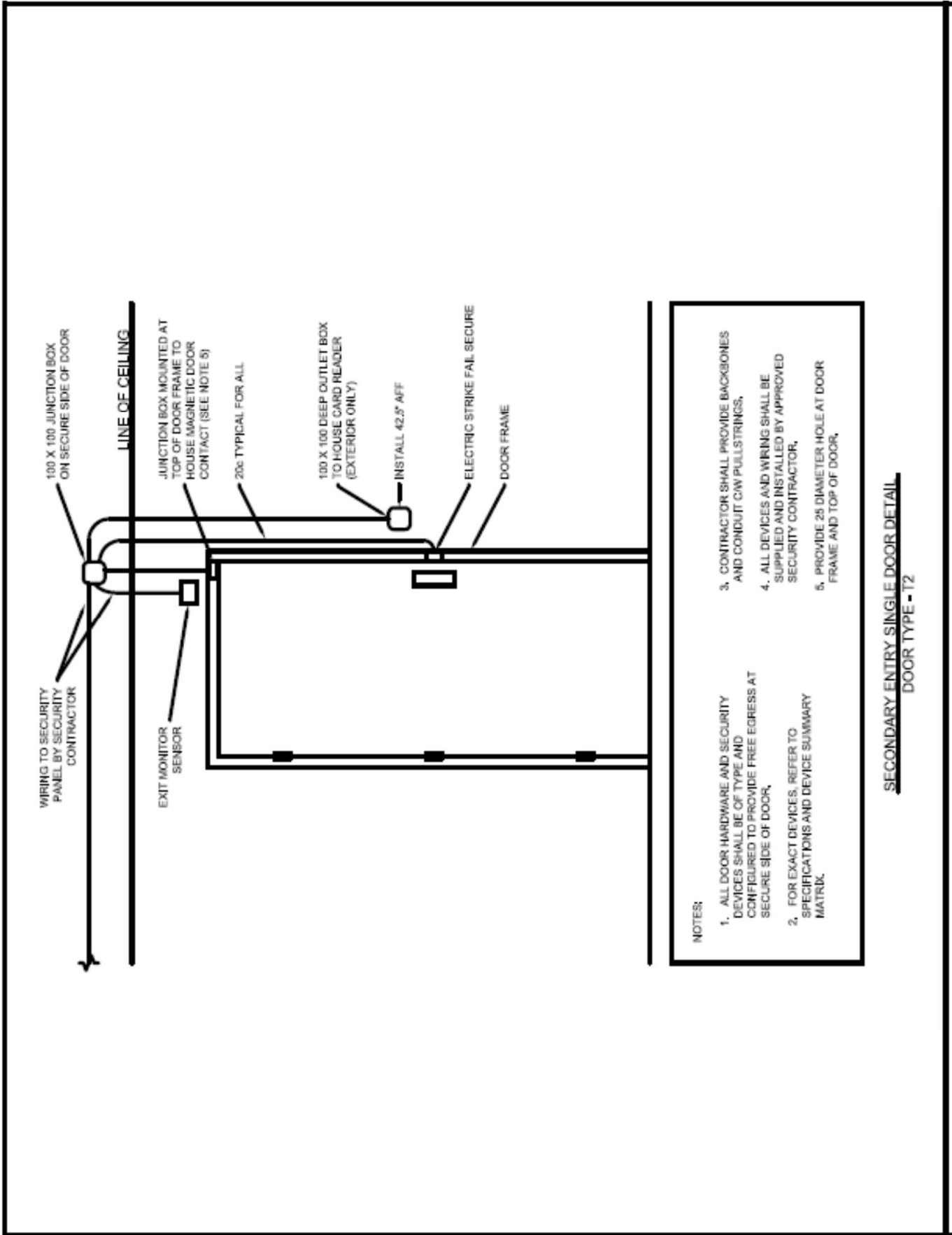
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1. ALL DOOR HARDWARE AND SECURITY DEVICES SHALL BE OF TYPE AND CONFIGURED TO PROVIDE FREE EGRESS AT SECURE SIDE OF DOOR.
2. FOR EXACT DEVICES, REFER TO SPECIFICATIONS AND DEVICE SUMMARY MATRIX.
3. CONTRACTOR SHALL PROVIDE BACKBONES AND CONDUIT C/W PULLSTRINGS.
4. ALL DEVICES AND WIRING SHALL BE SUPPLIED AND INSTALLED BY APPROVED SECURITY CONTRACTOR.
5. PROVIDE 25 DIAMETER HOLE AT DOOR FRAME AND TOP OF DOOR.

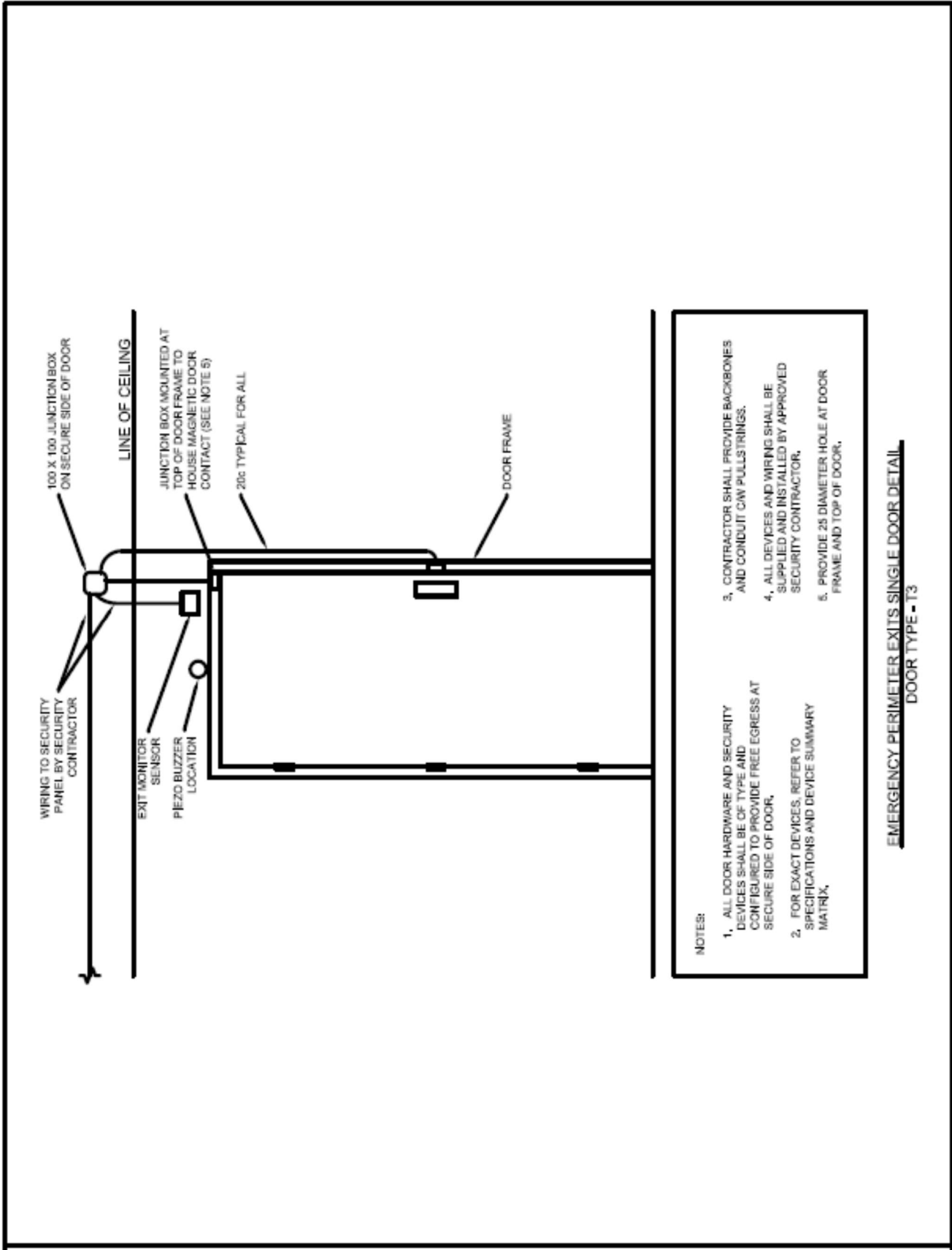
ARMING/ DISARMING ENTRY SINGLE DOOR DETAIL
DOOR TYPE - T1

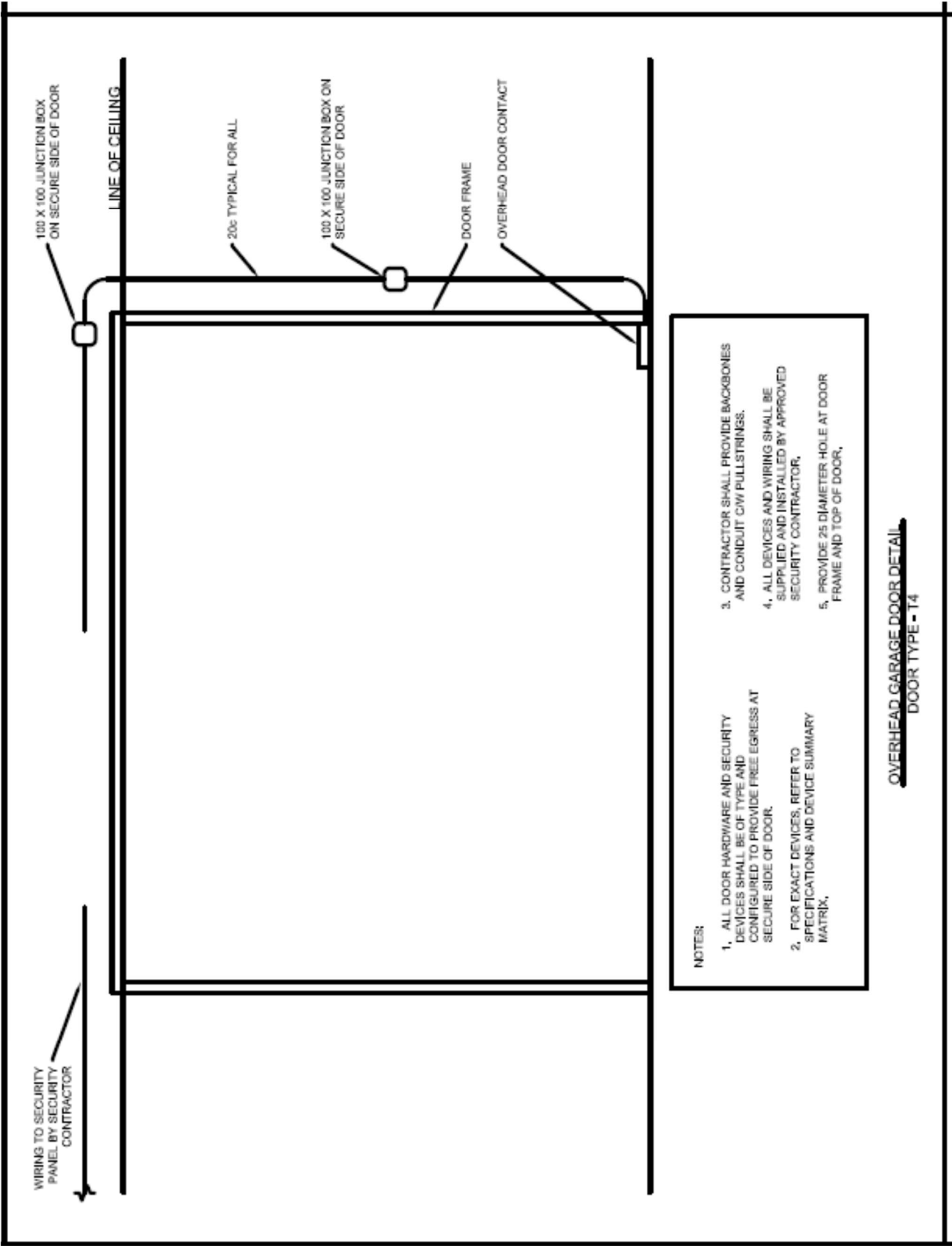


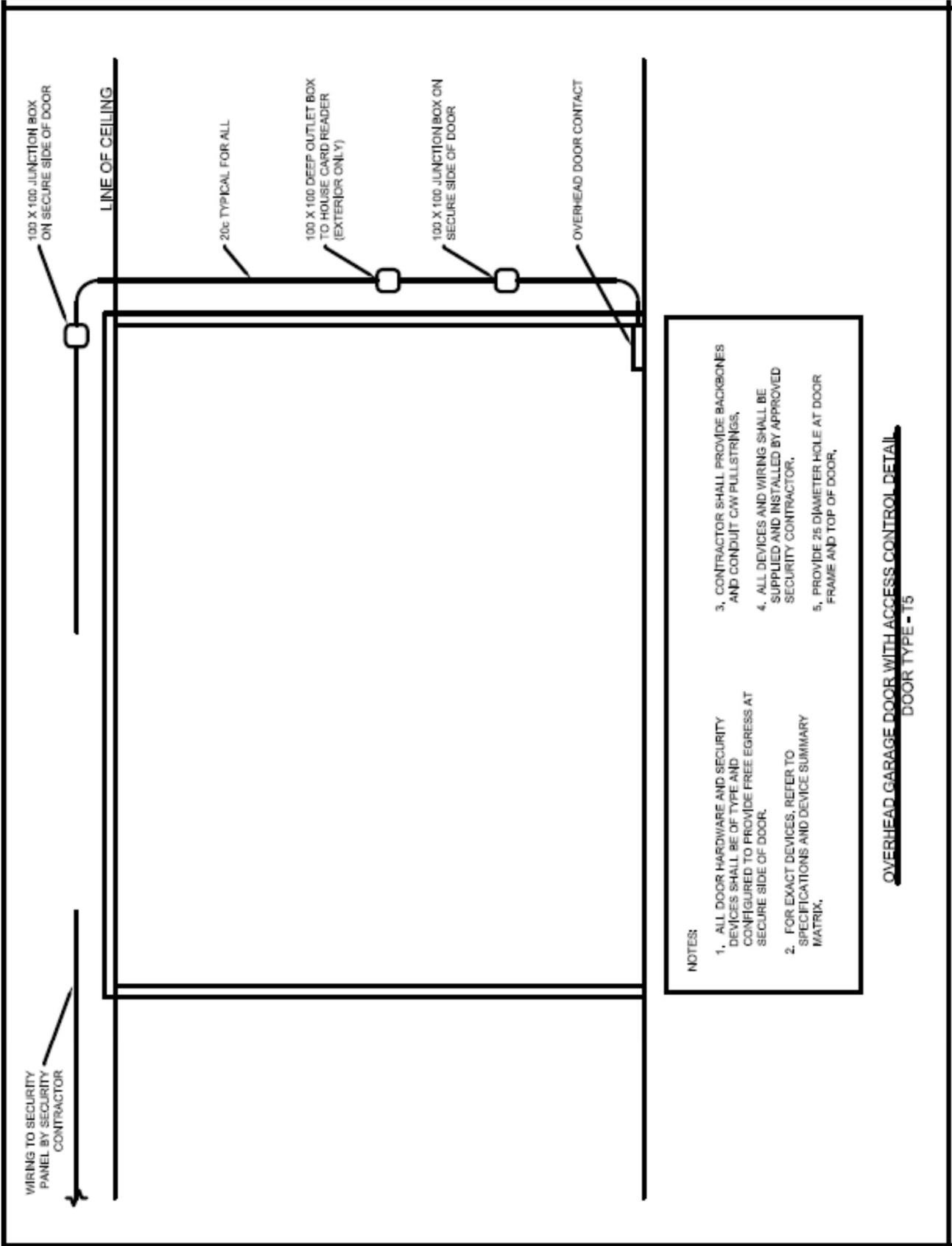
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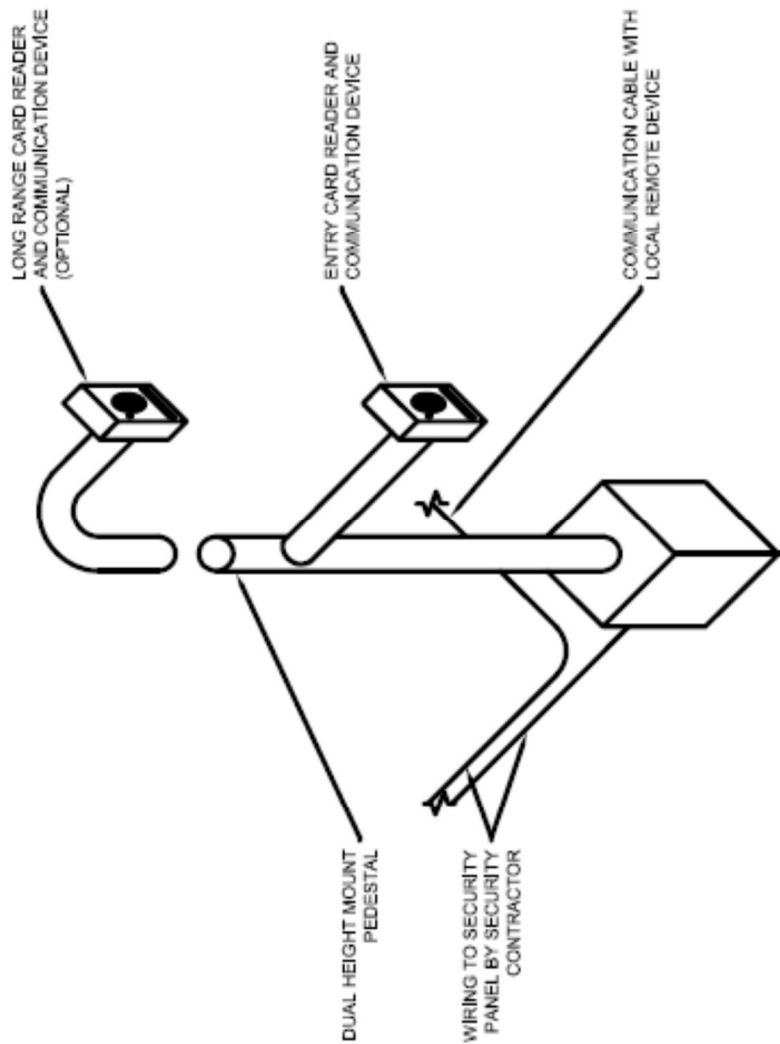
1. ALL DOOR HARDWARE AND SECURITY DEVICES SHALL BE OF TYPE AND CONFIGURED TO PROVIDE FREE EGRESS AT SECURE SIDE OF DOOR.
2. FOR EXACT DEVICES, REFER TO SPECIFICATIONS AND DEVICE SUMMARY MATRIX.
3. CONTRACTOR SHALL PROVIDE BACKBONES AND CONDUIT CAN PULLSTRINGS.
4. ALL DEVICES AND WIRING SHALL BE SUPPLIED AND INSTALLED BY APPROVED SECURITY CONTRACTOR.
5. PROVIDE 25 DIAMETER HOLE AT DOOR FRAME AND TOP OF DOOR.

SECONDARY ENTRY SINGLE DOOR DETAIL
DOOR TYPE - T2





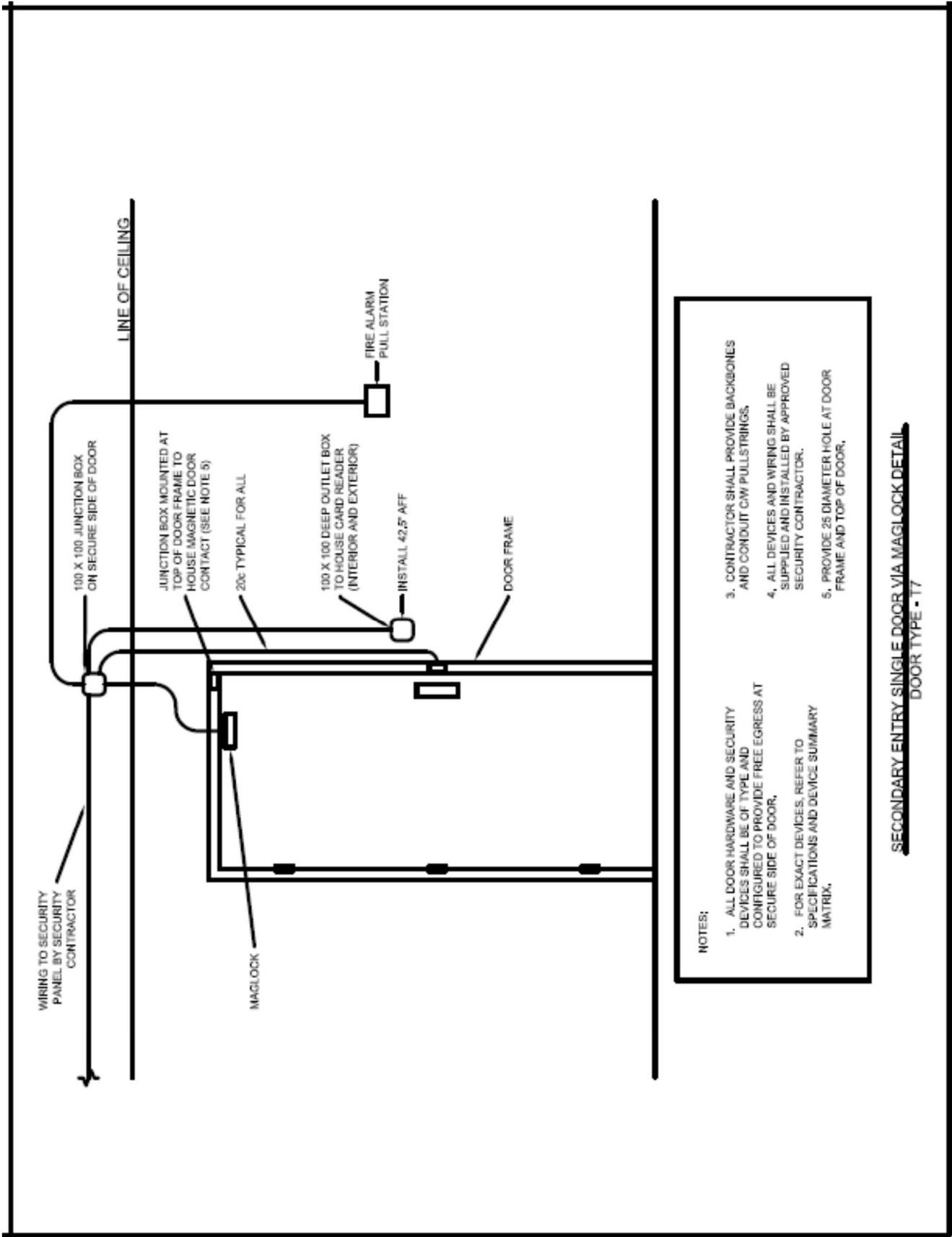


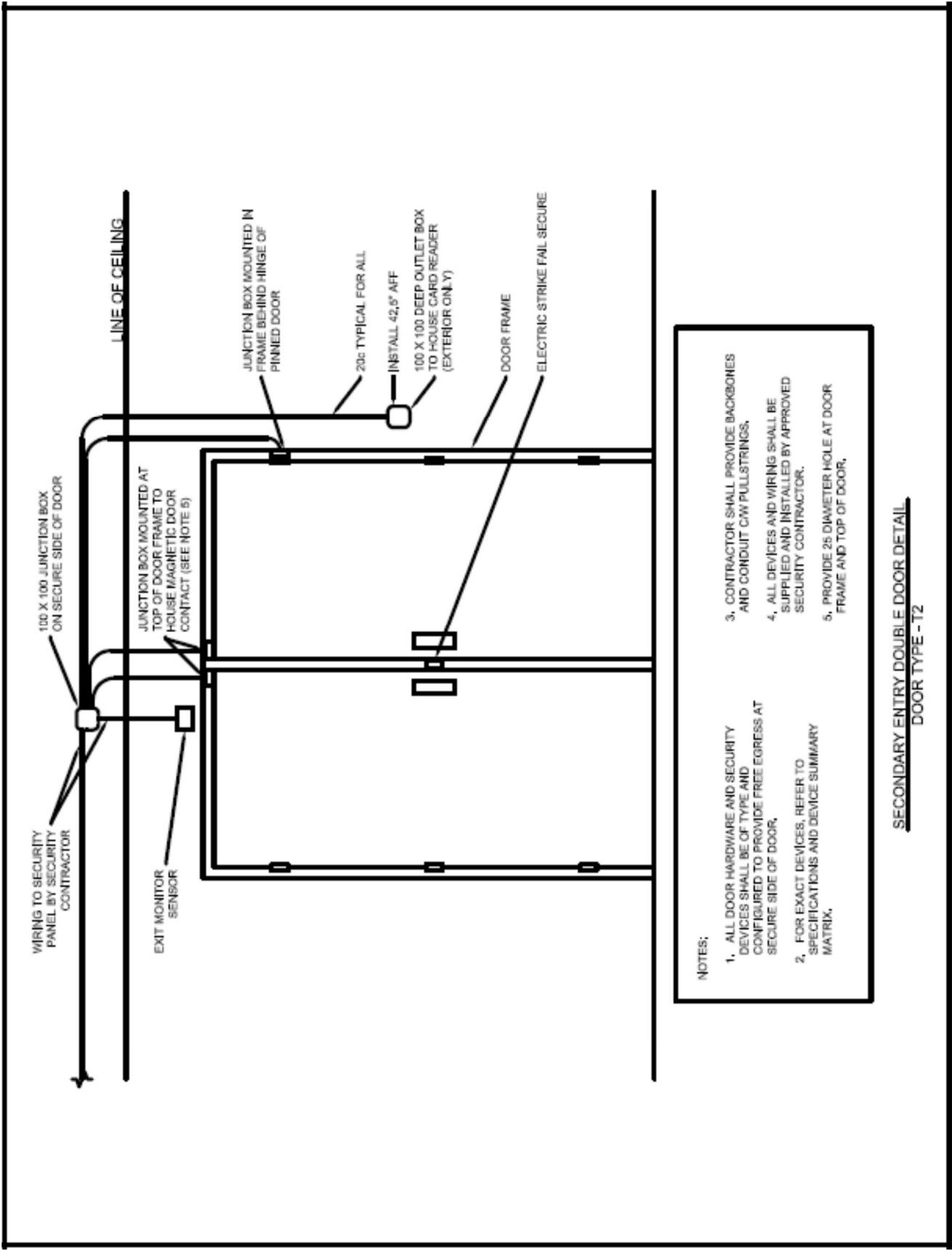


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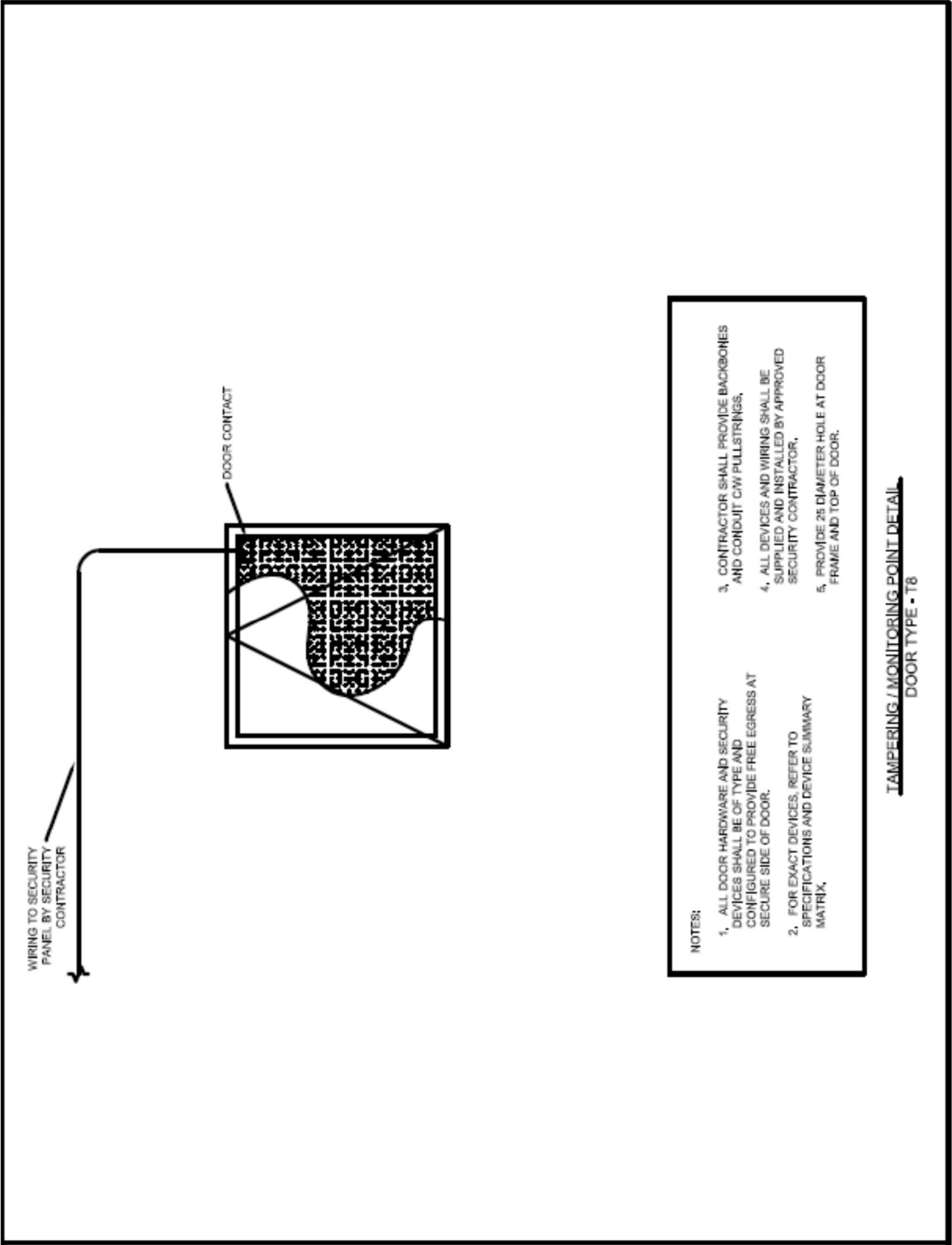
1. ALL DOOR HARDWARE AND SECURITY DEVICES SHALL BE OF TYPE AND CONFIGURED TO PROVIDE FREE EGRESS AT SECURE SIDE OF DOOR.
2. FOR EXACT DEVICES, REFER TO SPECIFICATIONS AND DEVICE SUMMARY MATRIX.
3. CONTRACTOR SHALL PROVIDE BACKBONES AND CONDUIT C/W PULLSTRINGS.
4. ALL DEVICES AND WIRING SHALL BE SUPPLIED AND INSTALLED BY APPROVED SECURITY CONTRACTOR.
5. PROVIDE 25 DIAMETER HOLE AT DOOR FRAME AND TOP OF DOOR.

REMOTE CARD READER / GATE ACCESS POINT DETAIL
DOOR TYPE - T6





SECONDARY ENTRY DOUBLE DOOR DETAIL
DOOR TYPE - T2



- NOTES:
1. ALL DOOR HARDWARE AND SECURITY DEVICES SHALL BE OF TYPE AND CONFIGURED TO PROVIDE FREE EGRESS AT SECURE SIDE OF DOOR.
 2. FOR EXACT DEVICES, REFER TO SPECIFICATIONS AND DEVICE SUMMARY MATRIX.
 3. CONTRACTOR SHALL PROVIDE BACKBONES AND CONDUIT C/W PULLSTRINGS.
 4. ALL DEVICES AND WIRING SHALL BE SUPPLIED AND INSTALLED BY APPROVED SECURITY CONTRACTOR.
 5. PROVIDE 25 DIAMETER HOLE AT DOOR FRAME AND TOP OF DOOR.

TAMPERING / MONITORING POINT DETAIL
DOOR TYPE - T8

4.6 Appendix F – Procedure for Equipment Substitution

.1 INTRODUCTION

The following procedures and forms are provided to the Contractor in order to ensure that if the pre-approved equipment is not going to be installed, there is a clear and fair process to be followed by all parties. The procedure and form require that the costs, quality, reliability as well as potential implications have all been identified and considered.

.2 SUBSTITUTION PROCEDURES

PART 1 GENERAL

.2.1.1 Definitions

Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

Architect: Reference to Architect in this Appendix is a reference to the authorised person overseeing the construction contract who may be an Architect, Engineer, Project Manager or a Consultant.

- a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
- b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Owner.

2.1.2 Submittals

Substitution Requests: Prepare and submit each substitution request for consideration using the procedures listed in Section “Submittal Procedures”. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

- .1 Substitution Request Form: Use copy of form provided in this Appendix.
- .2 Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate Contractors, that will be necessary to accommodate proposed substitution.

- c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- .3 *Architect's Action:* If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 10 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

- c. The architect shall identify costs which may be associated with the revisions to the Contract documents or Contract Drawings and identify who shall be responsible for paying such costs.

2.1.3 Quality Assurance

- .1 Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

2.1.4 Procedures

- .1 Coordination: Modify or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 PRODUCTS

3.1.1 Substitutions

Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- b. Substitution request is fully documented and properly submitted.
- c. Requested substitution will not adversely affect Contractor's construction schedule.
- d. Requested substitution has received necessary approvals of authorities having jurisdiction.
- e. Requested substitution is compatible with other portions of the Work.
- f. Requested substitution has been coordinated with other portions of the Work.
- g. Requested substitution provides specified warranty.
- h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Architect.

Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
- b. Requested substitution does not require extensive revisions to the Contract Documents.
- c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- d. Substitution request is fully documented and properly submitted.
- e. Requested substitution will not adversely affect Contractor's construction schedule.
- f. Requested substitution has received necessary approvals of authorities having jurisdiction.
- g. Requested substitution is compatible with other portions of the Work.
- h. Requested substitution has been coordinated with other portions of the Work.
- i. Requested substitution provides specified warranty.
- j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.



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Project Name:
Project No.:
Architect:

<<Insert Project Name Here>>
<<nnnnnnnn.nn>>
<<Designer's Firm Name>>

REQUEST FOR SUBSTITUTION FORM

Page 1 of 3

Dated: <<YYYY-MM-DD>>
Revised: <<YYYY-MM-DD>>

From: _____ RFS No: _____
To: _____ (RFS No. To be completed by Consultant)
Copies: _____ Issue Date: _____

Product, Material or Equipment Required of the Contract Documents:

Specification Section: _____ Drawing No./Detail: _____
Description: _____

Requested Substitute Product, Material or Equipment:

Description: _____

Attachments Included: ☐ Drawings ☐ Product Data ☐ Samples ☐ Test Reports
☐ Other: _____

Reason for Substitution: _____

Expected Lifespan: _____ Warranty Duration: _____

Maintenance Regime: _____

Has this item been used in a similar application? ☐ Yes ☐ No

Describe Application: _____

Describe Results: _____

Owner Contact and Location: _____

Comparisons of the Specified Item and the Proposed Substitution:

Compare significant qualities of size, weight, durability, performance and visual effect:

Describe any changes required in other elements of the Work to accommodate the proposed substitution, including work performed by the Owner and separate contractors:

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Project Name: <<Insert Project Name Here>>
Project No.: <<nn.nnnnnn.nn>>
Architect: <<Designer's Firm Name>>

REQUEST FOR SUBSTITUTION FORM

Page 2 of 3

Dated: <<YYYY-MM-DD>>
Revised: <<YYYY-MM-DD>>

What effect will the proposed substitution have on the work schedule in comparison to the work schedule without approval of the proposed substitution?

Cost comparison of the proposed substitution to the originally specified item, including correlating modifications required to other work:

Net cost to the Owner: _____

Changes in contract time: _____

Signatures:

Permission to make any substitution after award of contract shall be effected by Change Order. It shall not relieve the Contractor, any subcontractor, or manufacturer, fabricator, or supplier from the responsibility for any deficiency that may exist in the substituted product or any departures or deviations from the Contract Documents as modified by such Change Order.

Except as otherwise expressly specified by the Contractor in the Request for Substitution and expressly approved in such Change Order, the Contractor shall be deemed to warrant, by his request, that the proposed substitute will satisfy all standards and requirements satisfied by the original product, material or equipment specified and the Change Order shall not be deemed to modify the Contract Documents with respect thereto.

If any substitution will affect a correlated function, adjacent construction, or the work of other trades or contractors, the necessary changes and modifications to the affected work shall be considered as an essential part of the proposed substitution, to be accomplished by the Contractor without additional time or expense to the Owner if and when accepted.

Contractor's Signature: _____ Date: _____



Project Name:

<<Insert Project Name Here>>

Project No.:

<<nn.nnnnn.n>>

Architect:

<<Designer's Firm Name>>

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REQUEST FOR SUBSTITUTION FORM

Page 3 of 3

Dated:

<<YYYY-MM-DD>>

Revised:

<<YYYY-MM-DD>>

Consultants' Action:

Consultant's Name: _____

Consultant's Signature: _____ Date: _____

☐ Accepted ☐ Rejected ☐ More information required.

Comments: _____

Consultant's Name: _____

Consultant's Signature: _____ Date: _____

☐ Accepted ☐ Rejected ☐ More information required.

Comments: _____

Consultant's Name: _____

Consultant's Signature: _____ Date: _____

☐ Accepted ☐ Rejected ☐ More information required.

Comments: _____

Consultant's Name: _____

Consultant's Signature: _____ Date: _____

☐ Accepted ☐ Rejected ☐ More information required.

Comments: _____

Consultant's Name: _____

Consultant's Signature: _____ Date: _____

☐ Accepted ☐ Rejected ☐ More information required.

Comments: _____

End of Document 12870106-1.

4.7 Appendix G – Standardised Abbreviations

The following abbreviations are provided for the convenience of the reader. Note that some of the abbreviations are case sensitive and may be used in conjunction with other units.

A	Amps (Amperes)
AC	Access Control
AC	Alternating Current (see DC)
ACS	Access Control System
ADO	Automatic Door Operator
ADSL	Asymmetric Digital Subscriber Line
AM	Amplitude Modulation (as in broadcast radio)
ANSI	American National Standards Institute
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ATM	Asynchronous Transfer Mode
A to D	Analog to Digital conversion
b	bit (digital bit)
B	Byte
BCP	Business Continuity Plan
BICSI	Building Industry Consulting Service International
BIT	Burn-In Testing
BMP	Best Maintenance Practices
BSA	Business System Analyst)
bps	bits per second
C	Celsius, Degrees
C	Common (as in electrical connection)
C and D	Collection and Distribution
CA	Contract Administrator
CAC	Common Access Card
CBRN	Chemical, Biological, Radiological and Nuclear (as in threat)
CBRNE	Chemical, Biological, Radiological, Nuclear and Explosive (as in threat)
CCIR	Consultative Committee for International Radio
CCTV	Closed Circuit Television

CCVE	Closed Circuit Video Equipment
CE	Conformity for Europe (as in European Common Market)
CEC	Canadian Electrical Code
cm	Centimetre
CMMI	Capability Maturity Model Integration
CMP	Plenum Rated Cable
CMR	Riser Rated Cable
CPU	Central Processing Unit
CPTED	Crime Prevention Through Environmental Design
CSA	Canadian Standards Association
CSV	Comma Separated Values (Comma Separated Variables)
dB	decibels (logarithmic ratio of sound levels, usually relative to 1 mW)
DC	Direct Current (see AC)
DIN	Deutsche Institut für Normung i.e., German Institute for Standardisation
DSL	Digital Subscriber Line
DTMF	Dual Tone Multi-Frequency
D to A	Digital to Analog Conversion
DVMS	Digital Video Management System
DVR	Digital Video Recorder, a precursor to the NVR
EC	Environment Canada
EEMAC	Electrical Equipment Manufacturers Association of Canada
EIA	Electronic Industry Association
EN	European Standards (European Norms)
ENV	Environmental Department (York Region)
EOL	End of Line (Supervision Resistor)
ESA	Electrical Safety Authority (Ontario)
ETL	Electrical Testing Laboratories
F	Fahrenheit, Degrees
F	Farad, the unit of Capacitance
FAR	False Alarm Ratio
FAR	False Alarm Rate
FCC	Federal Communications Commission (US Government Agency)
FDDI	Fibre Distributed Data Interface

FIPPA	The Freedom of Information and Protection of Privacy Act provides individuals with a right of access to certain records and personal information under the custody or control of institutions covered by the Act.
FM	Frequency Modulation (as in broadcast radio)
FM	Facility Management
fps	frames per second, number of individual still images recorded or shown per second.
ft	Foot or Feet
FT-4	Flame Test Level 4 (Riser Rated Cable)
FT-6	Flame Test Level 6 (Plenum Rated Cable)
G	Abbreviation for Giga, see Giga
GFCI	Ground Fault Circuit Interrupter (see GFI)
GFI	Ground Fault Interrupter (see GFCI)
Giga	The prefix to a value meaning 1,000 000 000 or 10^9
HTML	Hyper Text Mark-up Language
H	Henry, the unit of inductance
Hz	Hertz (frequency in cycles/second)
IDS	Intrusion Detection System
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers (A standards organisation)
in or ins	Inch or Inches
IP	Internet Protocol, also Intellectual Property
IR	Infra-Red
IS	Intrinsically Safe
ISC	Intelligent System Controller
ISO	International Organization for Standardization
ISP	Internet Service Provider
IT	Information Technology
ITS	Information Technology Services
ITU	International Telecommunication Union (A UN Agency)
ITU-T	ITU Telecommunication Standardisation Sector
JPEG	Joint Photographic Experts Group
k	kilo (as in 1,000 of subsequent unit)
K	Kelvin, Degrees
LAN	Local Area Network

LPR	Licence Plate Recognition
LTE	Long Term Evolution
m	Metre
m	milli (as in 0.001 of subsequent unit)
M	Mega (as in 1,000,000 of subsequent unit)
MFIPPA	The Municipal Freedom of Information and Protection of Privacy Act provides individuals with a right of access to certain records and personal information under the custody or control of institutions covered by the Act.
micro	a value of 0.000 001 or a millionth of the subsequent unit (μ)
mm	millimetre
MPEG	Moving Picture Experts Group
MSDS	Material Safety Data Sheet (see SDS)
MTBF	Mean Time Between Failures
MTTF	Mean Time to Failure
MTTR	Mean Time To Repair
nano	a value of 0.000 000.001 or 10^{-9}
NBC	National Building Code (of Canada)
NC	Normally Closed
NEC	National Electrical Code (US Electrical Code)
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Prevention Association
NO	Normally Open
NPT	National Pipe Thread
NTSC	National Television Systems Committee (also form of TV encoding)
NVR	Network Video Recorder
O&M	Operations and Maintenance
OBC	Ontario Building Code
ODBC	Open Database Connectivity
OEM	Original Equipment Manufacturer
OESC	Ontario Electrical Safety Code
OHSA	Occupational Health and Safety Act (Ontario)
OHSS	Ontario Health and Safety Standards
OMM	Operations Maintenance Monitoring (York Region)
OSI	Open Systems Interconnection (model)
p	pico, the prefix to any unit to indicate 10^{-12} , i.e., 0.000 000 000 001

Pa	Pascal (Unit of Pressure - see PSI)
PAL	Phase Alternating by Line (form of TV encoding)
PDC	Power Distribution Centre
PIT	Pre-Installation Testing
PPI	Pixels per Inch
PPM	Preventive Maintenance (same as Preventative)
PMPP	Point to Multipoint Protocol
POD	Probability Of Detection
POE	Power Over Ethernet
POP	Proof Of Performance Testing
PPP	Point-to-Point Protocol
PSAR	Physical Security Assessment Report
PSI	Pounds per Square Inch (see Pascal)
PTZ	Pan, Tilt and Zoom (3 axes of motion for a surveillance camera)
QC / QA	Quality Control / Quality Assurance
QAM	Quadrature Amplitude Modulation (as in digital TV)
RAID	"Redundant Array of Inexpensive Disks" or "Redundant Array of Independent Disks" is a data storage virtualization technology that combines multiple physical disk drive components into one or more logical units for the purposes of data redundancy, performance improvement, or both.
RH	Relative Humidity, expressed as a percentage, indicates a present state of absolute humidity relative to a maximum humidity given the same temperature.
RTD	Resistive Temperature Detector
RU	Rack Unit, also abbreviated as "U".
SAE	Society of Automotive Engineers
SCADA	Supervisory Control And Data Acquisition
SDS	Safety Data Sheet (formerly MSDS)
SDK	Software Development Kit
SI	International System of Units (Metric system)
SIL	Safety Integrity Level, 1, 2, 3 or 4 (IEC 61508)
SIT	System Integration Test
SMTP	Simple Mail Transfer Protocol
SPICE	Software Process Improvement and Capability dEtermination
SQL	Structured Query Language

T	Temperature
T	Abbreviation for Tera (see Tera)
TCP/IP	Transmission Control Protocol (TCP) / Internet Protocol (IP)
Tera	is the prefix to indicate 10^{12}
TIA	Telecommunications Industry Association (standards agency)
TRA	Threat and Risk Assessment
TSSA	Technical Standards and Safety Authority. The Technical Standards and Safety Authority (TSSA) promotes and enforces public safety in Ontario.
TTR	Time To Repair
U	Rack Unit also abbreviated as “RU”.
UL	Underwriters Laboratories (USA)
ULC	Underwriters Laboratories of Canada
UPS	Uninterruptible Power Supply
UTP	Unshielded Twisted Pair, generally referring to Cat 4, Cat 5 or Cat 6 cables
UV	Ultra Violet
V	Volt
VAR	Value Added Reseller
VMS	Video Management System
WAN	Wide Area Network
WHMIS	Workplace Hazardous Materials Information System

4.8 Appendix H – Environmental Requirements

The following requirements are identified for all Security equipment provided to York Region unless otherwise identified.

Unless specifically identified all indoor and outdoor equipment should be capable of performing and or surviving the following operational conditions. Note that particularly in moist or wet locations the contractor has the responsibility to minimise or eliminate all electro chemical potentials which are a primary cause of corrosion. These specifications are intended to address only the requirements in “normal” spaces and do not extend to the special requirements which may exist in “special” locations, such as sewage or water treatment facilities.

Outdoor Operational Environments

Air Temperature Minimum:	-40 °C (-40 °F)
Air Temperature Maximum	+40 °C (105 °F)
Ambient Humidity	10% to 80% (RH)
Wind	240 km/hr (150 mph)
Rain / Snow	6 mm/min
Solar Radiation	1000 W/m ²
Vibration	1.5 mm displacement, 20 m/s ² acceleration, 2 – 200 Hz frequency)
Dust	3.0 mg / m ² h

Indoor Operational Environments

Air Temperature Minimum:	10 °C (50 °F)
Air Temperature Maximum	35 °C (95 °F)
Ambient Humidity	10% to 80% (RH)
Vibration	1.5 mm displacement, 20 m/s ² acceleration, 2 – 200 Hz frequency)

Storage Environments

Air Temperature Minimum:	-45 °C (-50 °F)
Air Temperature Maximum	45 °C (115 °F)
Ambient Humidity	10% to 90% (RH)

4.9 Appendix I – Access Control System Value Added Resellers

- .1 Security Systems shall be provided by one of the Value Added Resellers (VAR) prequalified under Request for Supplier Qualification Number RFSQ-755-22 as listed below (as of July 28, 2023):

360 Advanced Security Corporation	Andrew Pierce Andrew.p@360asc.com (647) 212-9654
Chubb, UTC Fire and Security Canada Inc.	Stephen Yates stephen.yates@chubbfs.com (416) 659-1754
Paladin Technologies Inc.	Greg Cowan gcowan@paladintechnologies.com (437) 684-7963
Securitas Electronic Security (Canada) Inc.	Tom Nanou Tom.nanou@securitasES.com (416) 678-7353

- .2 Installation of the Lenel security system(s) shall be completed by one of the Security System Installers pre-qualified under Request for Supplier Qualifications Number RFSQ-756-22 as listed below (as of October 31, 2023):

AC Electric	Chambers, Alex estimating@acelectricinc.ca (416) 939-0244
CEC Services Inc.	Kyle Feinstein estimating@beswickgroup.com (905) 713-3711
Electro-Works Ltd.	Dondi Keough dondi@tcsecure.ca (416) 529-7180
Ozz Electric	Michael Manias mmanias@ozzelectric.com (416) 989-7568

4.10 Appendix J – List of Approved Security Equipment

The following equipment is pre-approved and detailed equipment submission is not required. Note, however that the contractor is responsible to ensure that the version of equipment must be fully compatible with the environment currently in use or envisaged for imminent use at the York Region. Note that in those categories where multiple manufacturers and models are identified, the contractor is responsible to identify to York Region, the model and manufacturer which is to be used for any given project.

If the contractor requires to use equipment not shown in this listing, full details and justification shall be provided in accordance with the procedure set out in Appendix F “Procedure for Equipment Substitution”. The York Region has the authority to accept or to reject the use of the proposed substitute equipment.

If the function to be provided by the “proposed equipment” is addressed by any equipment which is not listed, then the proposed equipment must be processed through a “Procedure for Equipment Substitution” as documented in Appendix F.

Some of the door contacts used by York Region need to comply with the requirements of Hazardous Locations and therefore shall be certified for use in such areas (Explosion Proof). Even for use in such areas, an approach referred to as “Intrinsically Safe” may be used. This approach requires the use of a certified “barrier” which ensures very low current levels when used with devices which themselves comply with the requirements of a “simple apparatus” and do not need certification. For example, when using a SIL rated barrier, regular door contacts (not explosion proof) may be acceptable for use in a hazardous location. This document is not the place to undertake a detailed design or to recommend solutions. The list of approved equipment which follows includes alternative devices which may be considered for Hazardous Locations.

The information for the principal equipment is listed in Appendices K, L, M, N, O, P and Q and is summarised in the tables below.

.1 Access Control Components

Part#	Description
LNL-2220	Intelligent Dual Reader Controller
LNL-3300	Intelligent System Controller
LNL-4420	Advanced Dual Reader Controller
LNL-1300	Single Reader Interface Module
LNL-1320	Dual Reader Interface Module
LNL-1100	Input Control Module
LNL-1200	Output Control Module
Signo Reader 20/20k/40/40k	HID Corporation, HID® Signo™ Contactless smartcard reader, multi-technology, mobile ready, to suit application
NRP Series	NRP Series pre-fabricated resistor packs by Nascom
SD-80 Series	1" Steel Door Recessed Type Contacts by Tane Alarm
N78 Series	1" recessed wide gap door contact by Nascom
MSS Series	1" Steel Door Recessed Type Contacts by Magnasphere
MET-44 WG	Overhead Door Contact by Tane Alarm or equivalent by Nascom or Magnasphere
LSX Series Micro Switches	Explosion Proof Mechanical Door Contact by Honeywell
TA-4106-ES	Magnetic Door Contact, Manufacturer unknown; available from K M Thomas
EA800, EA880	Explosion Proof Limit Switches by NAMCO, Available from Galco
HSS-L25-800, HSS-L1.5-101	Simple Apparatus Contacts in an Intrinsically Safe Scheme, by Magnasphere
D5030 I.S. SIL3	Relay Out Repeater by GMInternational, available from Exloc Instruments
IS310/IS320	Request-to-Exit (RTE) motion sensors
2966906 Phoenix	SPST Relay 12VDC with base DIN rail-mount or equivalent
2900329 Phoenix	DPDT Relay 12VDC with base DIN rail-mount or equivalent
NP7-12	12V/7Ah Backup Battery
LSP MCLASS FlexPower power supplies and power distribution components	Life Safety Power MCLASS FlexPower Power Supply, Enclosure, Door with backplane/standoffs, no wire management.
Hoffman NEMA Enclosure	Hoffman Concept Series enclosure to suit application and to fit corresponding LSP Enclosure. Shall be lockable with Medeco AWP Padlock and to work with the Region owned Medeco Electronic Keys.
Hoffman Enclosure Accessories	Hoffman Enclosures shall be completed with ADP2, CWHPTO padlock handle, LED24V15 LED Enclosure Light, and full-conductive back panel or Hammond equivalent.
Hammond Eclipse Series Type 4 Steel Enclosure	Type 4 Mild Steel Wallmount Enclosure Eclipse Series to suit application and to fit corresponding LSP Enclosure; padlock handle and lockable with Medeco AWP Padlock and to work with the Region owned Medeco Electronic Keys.
Hammond ERP Eclipse Series Rack Panel	Complete with EHLPL Padlock Handle, Eclipse Rack Panel (ERP) and compatible Rack Rail Mounting Rails. Shall be lockable with Medeco AWP Padlock and to work with the Region owned Medeco Electronic Keys.
R991RBPTD9	Pneumatic delay arming Button, w/delay RED Blank by RCI (Dormakaba)
HES 1006 KD	HES 1006 KD 630 Electric Strike (provided by Locksmith)
HES 9600	HES 9600 The surface mounted, windstorm rated solution for rim exit devices (Provided by Locksmith)
Smart Pac III	In-Line Power Controller for electric strikes by HES (Assa-Abloy)

IN 4007	Snubbing (Snubber) Diodes (any manufacturer)
---------	--

.2 Intrusion Detection System Components

Part#	Description
B9512G	Bosch D9512G Control Panel Alarm Panel
B208 SDI2	Bosch B208 SDI2 8-Input Expansion Module
B308 SDI2	Bosch B308 SDI2 8-Output Expansion Module
B942	Bosch B942 Touch Screen Keypad
B930 ATM	Bosch B930 ATM Style-Alpha Numeric Keypad (SD12)
B56	B56 Keypad Surface Mount Box
B426	Bosch B426 Conettix Ethernet Communication Module
B444-A	Bosch Plug-in Cellular, LTE
FG-1625F or equivalent	Glass Break Detector
DS940Q, Optex DX40 or equivalent	Motion Detector

4.11 Appendix K – Approved Access Control Equipment

.1 Control Panel

Lenel Intelligent System Controllers (To be specified by the Contractor during the design of the security system).

- .1 LNL-2220 Intelligent Dual Reader Controller (IDRC) provides a single board solution for interfacing one or two doors to an OnGuard® system. On-board Ethernet 10/100Base-T port, 6 MB on-board, non-volatile flash memory, Battery-backed, non-volatile storage of 50,000 events, 16 different formats, 12 or 24 VDC input power, 32 downstream devices.
- .2 The LNL-3300 Intelligent System Controller (ISC) by Lenel is designed for advanced access control applications. On-board Ethernet 10/100Base-T port, 15 MB on-board, non-volatile flash memory, Battery-backed, non-volatile storage of 50,000 events, 16 different formats, 12 or 24 VDC input power, 64 downstream devices via two individual downstream RS-485 ports.
- .3 The LNL-4420 is an Advanced Dual Reader Controller by Lenel that provides a single-board solution for interfacing up to 64 doors, plus auxiliary inputs and outputs, to an OnGuard® system.

.2 Input/Output Modules

- .1 LNL-1100: Series 3 Lenel® Input Control Module (ICM) provides the access control system with high-speed acknowledgement of critical alarm points in monitored areas.
- .2 LNL-1200 Series 3: Lenel® Output Control Module (OCM). 16 Form-C 5 A, 30 VDC contacts for load switching, 2 dedicated digital inputs for tamper and power failure status, Elevator control, support for 128 floors, Advanced Encryption Standard (AES) 128-bit or 256-bit encryption.

.3 Reader Interface Unit

- .1 LNL-1300 Series 3: Single Reader Interface (SRI) Module. Access control card readers, keypads, or readers with keypads that use standard Wiegand Data1/Data0, Supervised or Unsupervised F2F, or Clock/Data communication are supported, as are those supporting the bidirectional RS-485 Open Supervised Device Protocol (OSDP™). 12 or 24 VDC power supply, Two Form-C relay outputs (5 A door strike and 1 A aux relays), Up to 16 different card formats, Door contact and REX open or closed, supervised or non-supervised, Strike control output.
- .2 LNL-1320 Series 3: Dual Reader Interface (DRI) Module: Access control card readers, keypads, or readers with keypads that use standard Wiegand Data1/Data0, Supervised or Unsupervised F2F, or Clock/Data communication are supported, as are those supporting the bidirectional RS-485 Open Supervised Device Protocol (OSDP™). 12 or 24 VDC power supply, six Form-C 5 A at 28 VDC relay outputs, up to 16 different formats, door contact and REX open or closed, supervised or non-supervised, strike control output, dedicated tamper and power failure circuits, on-board regulator allows 12 VDC reader support from 24 VDC power source

- .3 LNL-8000: The Star Multiplexer from Lenel is designed to implement star topology on a downstream port of any Lenel® Intelligent System Controller or on any host communication port of any OnGuard® server. Up to eight RS-485 (2-wire) connections or four RS-485 (4-wire) connections can be made downstream of the LNL-8000. Host communications - 38.4 kbps direct wire (RS-232/RS-485 multi-dropped), 12 VDC input power, Status LEDs for heartbeat, upstream and downstream communication.

4.12 Appendix L – Approved Intrusion Detection Equipment

.1 Control Panel

- .1 Bosch B9512G Control Panel Alarm Panel for intrusion devices: Burglary, Commercial Panel has 599 individually identified points, 32 areas. ULC listed. To be used in combination with Bosch B426 Conettix Ethernet Communication Module and/or application appropriate B44x cellular communicator module. Each Bosch panel shall have a minimum of 2 paths of communication to support 3rd party monitoring and integration with Lenel OnGuard.

.2 Keypad

- .1 Bosch B942 Touch Screen Keypad for office and corporate sites.
- .2 Bosch B930 ATM Style-Alphanumeric keypad (SD12) for environmental services non-office facilities.

.3 Input / Output Modules

- .1 Bosch B208 SDI2 8-Input Expansion Module connects to a control panel through the SDI2 bus. This module is supervised and communicates back to the control panel all point status changes. The module's expansion points operate the same as the points on the control panel.
- .2 Bosch B308 SDI2 8-Output Expansion Module. The B308 Octo-output Module provides eight programmable outputs. Each relay provides dry contact switching rated for 1.0 A at 5-24 VDC. The outputs are accessed through on-board screw terminal connections. The B308 is compatible with the SDI2 bus. The onboard switches are used to specify module addresses. Control panel programming will determine output response to specific events.

4.13 Appendix M – Approved Intercom Equipment

.1 Zenitel Stentofon

1. **Zenitel Stentofon** IP & SIP intercom system. Desktop video intercom station ITSV-2 with 5” capacitive touch screen and support for 720P HD Video and TCIV-2+outdoor video intercom. These devices are Power Over Ethernet (“POE”) and connect directly to the building LAN via POE network switch.
 - a. Facility main entrance security gates, card reader pedestal lower mount
 - b. Facility main entrance doors

4.14 Appendix N – Approved Credential and Credential Reading Equipment

.1 Multi-Technology Bluetooth Ready Reader

- .1 Card Readers: Provide multi-technology HID® Signo™ Contactless smartcard reader – multi-technology, mobile ready, proximity card readers where shown on the Drawings and/or where required by the Contract. Card Readers shall be rated for indoor and outdoor use, have multicolour LED with beeper for operator status indications and will operate on 5-16 V DC. Provide thin line mullion style readers where required to match door frame configuration.
- .2 HID Corporation, HID® Signo™ proximity card reader HID Signo Reader Model 20/20K/40/40K, configured to work with all Regional credentials.

.2 Proximity Card

- .1 Proximity Cards used by the Region are HID Corporation ProxCARD II, HU-1326LSSSV (i.e., 120 kHz, 26 bit).

The Contractor is not required to supply proximity cards to the Region unless otherwise indicated.

.3 Long Range Card Reader

- .1 Long range proximity card reader, typical read range 3 to 5 metres
- .2 HID® Proximity MaxiProx® 5375.
- .3 Nedap 9215689 TRANSIT Ultimate. To be utilized for motorized entrance gates at the following facilities (to be identified in the York Region design drawings) with the prior approval from the Region:
 - a. Transit Bus Storage Facilities
 - b. Roads and Traffic Operation Yards

.4 Long Range Proximity Tag

- .1 Long range proximity card, 860 – 960 MHz proximity active vehicle tag.
- .2 HID Corporation, SIO Enabled UHF/iCLASS Smart Card.
- .3 Nedap 9882650 Window Button R/O. To be utilized for motorized entrance gates at the following facilities (to be identified in the York Region design drawings) with the prior approval from the Region:
 - a. Transit Bus Storage Facilities
 - b. Roads and Traffic Operation Yards

4.15 Appendix O – Miscellaneous Security Devices

.1 Door Contacts

- .1 Magnetic door contacts.
- .2 1” recessed steel door approved door contact as shown in the list in Appendix J - List of Approved Security Equipment. Overhead door contact as shown in the list in Appendix J - List of Approved Security Equipment to be installed off the ground. Alternative solution might be required based on door type, mounting requirements, and environment.
- .3 Explosion Proof door contacts or Intrinsically Safe devices as shown in the list in Appendix J - List of Approved Security Equipment to be used in Class 1, Div.1 and Div.2 classified areas.
- .4 DPDT door contacts shall be used at facilities with Intrusion Detection integration requirements.

.2 Rechargeable Lead-Acid Batteries

- .1 12V 7Ah Sealed Non-Spillable Lead Acid Battery
- .2 Yuasa, Honeywell, Bosch-Canada, or approved equivalent.

.3 Exit Devices / Panic Bars

- .1 Push pad exit device, dull chrome finish, UL Listed Von Duprin Panic Hardware FVSR SA163 (N), tested in accordance to ANSI A156.3, 1989, Grade 1.
- .2 Von Duprin 99K-NL Series Panic Exit Devices, or approved equivalent.

.4 Electric Door Strikes

- .1 Heavy duty, stainless steel construction, 3000 lbs static strength, UL 1034, ANSI/BHMA Grade 1, 0.25 Amps @ 24 VDC.
- .2 HES 1006 Series Electric Strike or approved equivalent.
- .3 HES 9600 Series Electric Strike, or approved equivalent.

.5 Electrical Power Transfer

- .1 Transfer of electrical power from door frame to the edge of a swinging door; two (2) 18 AWG wiring, 24VDC, 2A continuous, 16A maximum surge.
- .2 Von Duprin EPT-2, or approved equivalent.

.6 Control Transformers

- .1 120V input, 16V output, 40VA, 60 Hz, single phase rating, copper conductors, dry type.
- .2 Transformers shall be designed, constructed and rated in accordance with UL, CSA and NEMA standards.
- .3 All transformers for each project shall be from the same manufacturer.
- .4 ATC Frost Magnetic Inc., 1640, or approved equivalent.

.7 Request to Exit Sensors

- .1 Wall mount high impact ABS plastic enclosure, alarm output: form “C” contact, single or double door use, adjustable to 60 s, UL Listed.
- .2 Honeywell Model IS310

.8 Push Buttons

a. Exit Push Button

- .1 Wall mount brushed stainless steel plate enclosure, momentary switch output, SPDT 10A @ 125/250 VAC, UL Listed.
- .2 Tyco Security Products - Kantech PB-EXIT, or approved equivalent.

b. Arming Push Button

- .1 RCI R991RBPTD9 Wall mount brushed stainless steel plate enclosure, push button with pneumatic time delay (adjustable 0-45 seconds), blank red button.

.9 Glass Break Detectors

- .1 Shall detect breakage of plate, tempered, layered, laminated and wired glass types, complete with automatic environment test circuitry, detection range of 9 metres, alarm contact 50mA @ 24VDC, UL Listed.
- .2 Honeywell FlexGuard FG-1625F, or approved equivalent.

.10 Motion Detectors

- .1 Wall mount motion monitor with temperature compensation, high impact ABS plastic enclosure, alarm output: form “C” contact, 125 mA @ 28 VDC, tamper and trouble output contacts, UL Listed.
- .2 Detection Systems DS940Q.
- .3 Optex DX40.
- .4 Approved equivalent.

.11 Audio Annunciator

- .1 Wall mount, 24 VDC, 100 dB @ 10', UL Listed.
- .2 Toxalert Inc. HORN/REM RH-24 VDC, or approved equivalent.

.12 Uninterruptible Power Supply

- .1 APC Back-UPS Pro to power all security, access control and wireless network solution. Model to be used is Antigen-presenting cell ("APC") Pro BR1500G or approved equivalent.
- .2 The UPS must reside on a dedicated AC circuit fed from an emergency power panel wherever possible.

4.16 Appendix P – Digital Video Management System

.1 Digital Video Management System (DVMS)

- .1 Lenel Milestone XProtect® Expert Digital Video Management System. The Digital Video Management System (DVMS) shall be designed and developed in conformity with the following standards:

- ISO 9001 (2015) Quality management systems
- ISO/IEC 15504 Measurement Framework for Process Capability and CMMI Level 3 or higher (Capability Maturity Model Integration) (SPICE 2.0 Software Process Improvement and Capability dEtermination)
- SEI CMM Level 3 or higher (American Software Engineering Institute - Capability Maturity Model)

The Digital Video Management System shall include:

- Database Server(s)
- Application Server(s)
- Local recording Networked Camera Server(s) with appropriate software and databases as required
- Operator Workstations (dedicated to the DVMS)
- Network connected cameras and/or network connected video encoders
- Continuous Recording capability for a minimum of thirty (30) days at 30 frames per second (note: see more on the attached camera configuration parameters)

- .2 The Digital Video Management System (“DVMS”) shall be capable of supporting unlimited number of cameras.

As a minimum, the system must support all the latest Axis network cameras, encoders and camera streamers.

- .3 The following DVMS equipment must be used:

- Camera Streamers / Video Encoders:
 - AXIS Communications
- PTZ Network Cameras:
 - AXIS Communications Q6078-E
- Fixed Indoor Dome Cameras:
 - AXIS Communications P3247-LV
- Fixed Outdoor Dome Cameras:
 - AXIS Communications P3247-LVE
- Fixed 360 Indoor/Outdoor Camera:
 - AXIS Communications P3719-PLE
- Use the latest generation of the equipment mentioned in this paragraph. The contractor must ensure that all equipment which is being supplied will be compatible with the existing and previously installed components. If any modifications or upgrades are required, these changes must be included in the project budget and identified in the proposal.

- .4 The DVMS shall support at least the industry-standard Motion JPEG, MPEG-4, H.264, and H.265 as well as Axis's Zipstream technology encoding formats.
- .5 The DVMS system shall be fully integrated with the Lenel OnGuard version currently in use by York Region and be fully compatible with all announced Versions of OnGuard at the time of installation. Lenel OnGuard will be used as the primary user interface.

.2 Network and Video Cabling

- .1 A Local Area Network (LAN) shall be provided for communication between the system elements. All interfaces to the LAN shall be a minimum of 1000BaseTX Ethernet. The LAN may use additional technologies within the backbone for greater speed or distance. Acceptable types are:
 - a. FDDI (Fibre Distributed Data Interface)
 - b. 1000BaseSX or 1000BaseLX Gigabit Ethernet (fibre)
 - c. Asynchronous Transfer Mode (ATM)
 - d. 1000BASE-TX
- .2 The LAN shall use standard network cables. Acceptable cable types are:
 - a. Optical Fibre
 - b. Category 6a or greater Unshielded Twisted Pair (UTP)
- .3 The LAN shall be logically and/or physically separate from any existing LAN infrastructure. Interconnection to other LANs shall **only** be through one of the following:
 - a. A router
 - b. A Layer 3 capable network switch
 - c. As an additional VLAN to the existing LAN equipment. Where required to interconnect VLANs, a router or Layer 3 capable switch shall be provided by the contractor.
- .4 Network video cables shall not be run back to the Camera Server individually. All communications with the Camera Server shall be via the LAN. Each network camera or video streamer shall have a single network interface which is to be used for video and also Pan/Tilt/Zoom communications.
- .5 Supply a complete and working Closed-Circuit Television System (CCTV) System and Digital Video Management System (DVMS).

4.17 Appendix Q – Conduits, Fittings and Accessories

.1 Conduit, Fastenings and Fittings

- .1 Comply with the latest proclaimed version of the OESC.
- .2 Rigid PVC conduit: Conduit, including elbows and fitting, Schedule 40 wall thickness, solvent weld connections, by IPEX Inc., Carlon or approved equivalent.
- .3 Rigid PVC conduit connectors: Adapter type with threaded male portion, by IPEX Inc., Carlon or approved equivalent.
- .4 Conduit straps for rigid steel and PVC conduit: Malleable iron, hot-dip galvanized, single hole type for conduits up to 50 mm, two-hole type for conduits larger than 50 mm.
- .5 Beam clamps: Hot dip galvanized steel designed to clamp onto both sides of the flange. Cat. #S997BC-HG (100-230 mm flange) by Sasco Tube & Roll Forming Inc., Cat. #S999BC-HA (175-430 mm flange) by Sasco Tube & Roll Forming Inc., or type CS91 by Construt Inc. or approved equivalent.
- .6 Expansion couplings: With ground straps or clamps. Type XJ by Cooper Crouse-Hinds Canada or approved equivalent.
- .7 Swivel couplings: Threaded, one piece, by Elliot Electrical Manufacturing Co. Running threads are not acceptable or approved equivalent.
- .8 Conduit spacers: Malleable iron, sized to suite conduit size, by O-Z/Gedney Co., or 1300 Series by Thomas & Betts Ltd or approved equivalent.
- .9 Conduit seals and fittings for hazardous locations: Suitable for applications in designated area, by Crouse-hinds, Pyle-National of Canada Inc., Killark Electrical Manufacturing Co., Appleton Electric Ltd., O-Z/Gedney Co., or approved equivalent
- .10 Hazardous area seal filling compound: As recommended by seal manufacturer.
- .11 Pull cords: 6 mm polypropylene or nylon material. Pro-pull rope by Ideal Industries Inc. or approved equivalent
- .12 Bituminous backpaint: In accordance with CAN/CGSB-1.108.
- .13 Conduits and all junction boxes shall be colour coded to identify the nature of the cabling which is contained within. Where it is not practical to paint the entire conduit, pull box or junction box, e.g., PVC devices, suitable coloured markings shall be applied and visible from a distance, e.g., boxes on the ceiling shall be visible from the ground.

.2 York Region Convention for Conduit Colours:

Sequence No.	Voltage	Colour
1	High Voltage (In Excess Of 750 V):	Brown
2	347/600 V:	Sand
3	120/208 V:	Grey
4	Emergency Power:	Associated Voltage Colour
5	Fire Alarm & Fire phone:	Red
6	Security/Intrusion/Surveillance:	Green
7	Low Voltage Switching:	Black
8	Annunciator Cabinets:	Black
9	Data/Telephone Cabinets:	Blue
10	Telephone Backboards:	Grey
11	Television:	White
12	Public Address/Intercom:	Purple

Cable Colours are not specified unless they are defined for a particular project

4.18 Appendix R – Cabling, Conductors and Miscellaneous Accessories

.1 Wiring and Miscellaneous Accessories

- .1 Provide all RS-232, RS-485, Optical Fibre and Ethernet cabling, and Fibre and Ethernet jacks as required for a complete network, as applicable.
- .2 Direct burial cable for all outdoor applications.

.2 Cabling

- .1 RS-485 Cables
 - .1 Belden EIA Industrial RS-485.
 - .2 Conductors: Twisted pair, each conductor No. 22 AWG stranded copper.
 - i. Pairs: 2.
 - ii. Shield: Aluminum-polyester and 90% copper tinned braid.
 - iii. Jacket: Black UV resistant PVC.
 - iv. Electrical Characteristics at 20°C
 - o Capacitance: 36.1 pF/m
 - o Impedance: 120 ohms
 - o Propagation Velocity: 78%
 - v. Belden Datalene Insulated 3107A.

.2 Lenel hardware wiring shall follow the wiring guide below:

Purpose	Cable type	Gauge	Cond.	Description	Belden number
RS-485, 4-wire	Non-plenum	24	2P	Overall shield	9842
RS-485, 4-wire	Plenum	24	2P	Overall shield	88102
RS-232	Non-plenum	24	5	Overall shield	9610
	Plenum	24	6	Overall shield	83506
Reader drops	Non-plenum	22	6/8	Overall shield	5504FE/ 5506FE
	Non-plenum	22	6	Overall shield	5504FE, 9536
	Plenum	22	6/8	Overall shield	6504FE/6506FE
12 VDC power	Non-plenum	18	2	Overall shield	5300FE, 8760
	Plenum	18	2	Overall shield	6300FE, 88760

.3 CAT6a Cables

.1 Conform with the following plenum rated Ethernet 1000BASE-TX TIA/EIA 568-B.2-1 Category 6a cable:

- i. CSA Certified for trays and risers.
- ii. Conductors: Unshielded twisted pair, #23 AWG solid copper.
- iii. Pairs: 4
- iv. Jacket: Purple Flamearrest, CSA FT4/FT6 rating.
- v. Certification/Testing to at least Category 6a in accordance with the current TIA/ISO Channel Standards.
- vi. Belden Inc. #2400 or approved equivalent.

.4 Instrumentation Cables (4-20mA)

.1 Belden Inc. #8760 or approved equivalent.

- i. #18 AWG.
- ii. 16-stranded copper.
- iii. Beldfoil aluminium polyester shield.
- iv. Twisted shielded pair.
- v. Bare #20AWG copper drain wire.

.3 Wiring Accessories

- .1 Wire and cable markers: Printable, self-laminating, self-adhesive markers, white background, black lettering on white background, vinyl plastic or polyester film suitable to environment. Wire marker to be sleeved with clear heat shrink tubing.
- .2 Terminal blocks: 600 V, 25 A minimum rating, modular, 35 mm DIN rail mounted, provision for circuit number labelling, individually removable, sized to accommodate conductor size and circuit current.
 - a. SAK Series by Weidmuller Ltd.,
 - b. UK Series by Phoenix Terminal Blocks Ltd.,
 - c. WK Series by Wieland Electric Inc.,
 - d. ABB Entrelec or
 - e. Approved equivalent.
- .3 Field wiring terminations: Where screw-type terminal blocks are provided, supply insulated fork tongue terminals.
 - a. Sta-Kon by Thomas & Betts Ltd.,
 - b. Scotchlok by 3M Canada Inc or
 - c. Approved equivalent.
- .4 Moisture and waterproofing: In wet locations, with Liquid Tape by Ideal Industries Canada Corp. or approved equivalent.
- .5 Cables ties: Nylon, one-piece, self-locking type, by
 - a. Thomas & Betts Ltd.,
 - b. Burndy Inc.,
 - c. Wieland Electric Inc or
 - d. Approved equivalent.
- .6 Electrical insulating tape: Scotch 33 by 3M Canada Inc or approved equivalent.
- .7 Cable grips: To accommodate type and geometry of cable supported, single weave, variable mesh design, by:
 - a. Thomas and Betts Ltd.,
 - b. Crouse Hinds,
 - c. Woodhead Canada Ltd or
 - d. Approved equivalent.
- .8 Cable pulling lubricant shall be compatible with cable covering and not to cause damage or corrosion to conduits or ducts. Yellow77 or Clear-Glide by Ideal Industries Canada Corp. or approved equivalent.
- .9 Input 120 VAC power to all security related and access control panels must be provided at each location identified in the design drawings and must be dedicated and separated from any other loads.
- .10 Where conduits may be accessible to “rodents”, or if gas seepage is a risk, steps should be taken to block such rodents from entering and damaging cable insulation.

The contractor shall ensure that the proposed products do not prejudice the cables which are installed in the conduits (or ducts). Possible products include:

- a. Polywater Conduit/Duct Seal,
 - b. 3M Scotchcast Duct Sealing Kit,
 - c. Filoseal + HD Duct Sealing Kit or
 - d. Approved equivalent.
- .11 Wherever conduits or cables are installed through fire rated elements the contractor is responsible to repair any damage to the impregnability of the wall in conformity with the Code requirements.

.4 Communications Line Extenders

1. When communications lines are subject to interference from electrical noise, as for example, when using travelling lines intended for power transmission to elevator cars or lines passing through elevator mechanical rooms, precautions are needed to avoid the introduction of erroneous data.
2. Products provided by Cypress Integration Solutions have been proven to allow Wiegand signals to maintain their integrity under onerous conditions and are to be used for the Region under such circumstances.
3. The recommended device is the Suprex RS-485, Single Reader Extender SPX-1300. 2 modules are required, one at the computer end and one in the elevator and both will require power.

4.19 Appendix S – Parking Barriers

.1 General Observations

.1 There are currently no specified manufacturers or models for the following items:

- a. Detector Loops
- b. Detector loop sealants
- c. Loop Amplifiers
- d. Barrier Arms

Full details of the proposed equipment must therefore be provided for each project.

4.20 Appendix T – Locks

1. Keys and Cylinders

- .1 All doors are to be equipped as outlined in the Security Device Summary document which is associated with the current project. The final configuration will require that the construction (temporary) lock cylinder cores will be replaced with Medeco M³ IC cores. Where specific locks are not defined, doors should initially be equipped with:
 - a. Sargent,
 - b. Assa Abloy or
 - c. Corbin locksets.
- .2 All interior pedestrian exit doors (not overhead doors) shall be equipped with either a “push paddle” or a “panic crash bar” exit device. Such devices shall be installed at a standard height.
- .3 For ALL Environmental Water and Wastewater facilities Medeco M³ Logic Cylinders shall be used for all exterior doors, and doors that need to be secured. All door hardware must be compatible with Medeco M³ Logic Cylinders.

2. Electromagnetic Locks

- .1 As is stated elsewhere electromagnets may be used on York Region projects where specified. Such installations require permits and integration with the Fire Alarm system.
- .2 The Hold Force Sensor should be wired to the door controller if the controlled allows for an auxiliary connection to this sensor or may be wired in series with the door contact so that in either case the Intrusion Detection System will report that the door is improperly closed.
- .3 Note that in the event that the power to the magnet fails and the door remains closed, the HFS will report the door as being “forced”.
- .4 It is recommended that the electromagnet should be installed with the factory installed door position indicators and LED status indicator.
- .5 The Contractor shall reinforce the door and, as required the door frame, to ensure that neither will distort sufficiently to allow the door to open because of a mechanical misalignment.
- .6 The Pre-Approved Electromagnetic Lock is:
 - a. RCI (Dormakaba) Model 8310 (single door) and Model 8320 (double door) with auto sensing 24 / 12 V DC and LED Status indicator.
 - b. Brushed Aluminum by default but optional finishes are available.
 - c. Optional Door Status Sensor (DSS), i.e., Door Contact.
 - d. Optional Security Condition Sensor (SCS), i.e., Bond Sensor.

4.21 Appendix U – Universal Washroom

1. Available Washroom Kit

- .1 The approved hardware required to implement the Universal Washroom in compliance with the OBC is

Camden Door Control equipment package CX-WEC10, “Universal Emergency Call System Kit” which includes: Emergency Button, LED Annunciator with sounder, Dome Light (various colours) with sounder and sign.

4.22 Appendix V – Labelling

1. Introduction

- .1 This section describes the requirement for the Contractor to suitably identify and label all pieces of equipment.
- .2 ANSI/TIA-606-C is the current version of the voluntary standard for administering telecommunications cabling infrastructure, released by the Telecommunications Industry Association (TIA) in July 2017. TIA-606-C builds on the guidelines already established in TIA-606-B, released in 2012, as well as includes some new additions and updates. This standard provides extensive guidelines to the proper use of labelling for environments such as that used at York Region.
- .3 The primary objecting of the labelling is to ensure that all those charged with the responsibility of performing maintenance or repairs on the system at any time can uniquely and safely refer to each component of the system.
- .4 The labelling shall always correspond with the terminology and format of the labels defined on the drawings. Labels shall always be applied to every serviceable or adjustable component of the system.
- .5 Details related to the labelling should always be presented to York Region before being applied.
- .6 Depending on the installation, there will be equipment cabinets, junction boxes, pull boxes, man holes, cameras, network components and other components which are installed to support the security system. Each of these “devices” must be labelled clearly and permanently, using the same nomenclature than has been documented in the system schematics.
- .7 Typically, the preferred form of permanent labelling is engraved Lamacoid. The colours and the format of the label shall be approved by York Region and shall follow the guidance of this section. The selection of colours should be designed so that the engraved or printed labels exhibit good contrast and will not fade or deteriorate due to exposure to the environment in which they are installed, e.g., sunlight or de-icing chemicals.
- .8 The labels, Lamacoid or flexible cable labels shall not, inherently or through their means of installation, induce damage or corrosion to the surface to which they are being attached.
- .9 There will be situations where other means of labelling devices may be more suitable and such options should be reviewed with York Region.
- .10 The labels shall be screwed to the cabinets or, at the discretion of York Region, may be attached to the cabinet using a suitable double-sided weatherproof tape. The surfaces to which the tape is to be applied shall be properly prepared if this approach is selected. All labels to be attached in this manner shall be in “landscape mode” and centred from left to right.

- .11 In some situations, labels will need to be “hung” directly from a component, and this may be accomplished by means of a hole drilled into the label and the use of suitable stainless-steel aircraft cable made for this purpose.
- .12 Further a suitable colour code which may be implemented on conduits with a colour band or in the labelling is recommended. (See Appendix Q: Conduits, Fittings and Accessories)
- .13 All labels shall be machine-generated. Handwritten labels are not acceptable.
- .14 All cables and conductors shall be labelled at each end and at each pull box or hand-hole.
- .15 All labelling shall be consistent on site, in the as-built documentation and in the software.
- .16 Special care should be exercised and labels should be applied to provide warnings related to special procedures when opening some “devices”. For example, if there are multiple sources of power, potentially dangerous supervision of, or monitoring of, automated responses to “tampering” etc. notifications should be present to advise the service staff of such situations.
- .17 The contractor shall post warranty/contact information on the inside of the main control enclosure for each facility as well as the commissioning date.

2. Labelling Details

- .1 Details with respect to the information to be included within the labels are provided below.
- .2 Main alarm outputs and relays shall be labelled accordingly. All alarm points, card readers and other system components shall be labelled in accordance with the door numbering and description syntax.

3. Enclosures

- .1 **Electrical cabinets shall be identified with at least:**
 - Voltage, type of power, power source (including as appropriate Circuit No);
 - Purpose of the cabinet; and
 - Name of the cabinet as shown on the drawings.
- .2 **Communications / Security cabinets shall be identified with at least:**
 - Type of Application, Signal source (including as appropriate Circuit / Port No);
 - Purpose of the cabinet; and
 - Name of the cabinet as shown on the drawings.
- .3 **Junction boxes shall be identified with at least:**
 - Nature of enclosure content, e.g., Data, CCTV, Power, etc
 - If appropriate, Voltage, type of power, power source (including as appropriate Circuit No);
 - Purpose of the cabinet; and
 - Name of the cabinet as shown on the drawings.

- .4 The Contractor shall label all enclosures containing security equipment indicating the nodes installed within.
- .5 All Networked equipment is to be labelled with corresponding IP information.

4. Conduits

- .1 The following information is repeated here for the sake of convenience and also appears in Appendix Q: Conduits, Fittings and Accessories.
- .2 York Region uses the following Conduit colours:

Category No.	Voltage	Colour
.1	High Voltage (in excess of 750 V):	Brown
.2	347/600 V:	Sand
.3	120/208 V:	Grey
.4	Emergency Power:	Associated Voltage Colour
.5	Fire Alarm & Fire phone:	Red
.6	Security/Intrusion/Surveillance:	Green
.7	Low Voltage Switching:	Black
.8	Annunciator Cabinets:	Black
.9	Data/Telephone Cabinets:	Blue
.10	Telephone Backboards:	Grey
.11	Television:	White
.12	Public Address/Intercom:	Purple

- .3 Cable Colours are not specified unless they are defined for a particular project.

5. Cables

- .1 Each end of every cable including the grounding system shall be labelled. Every cable shall also be identified at every pull box or other accessible location along the length of the run.
- .2 These labels shall be of the “wraparound” variety, and as for all other labels shall be machine-generated.
- .3 The labels shall be of suitable size to fit the cables to which they are applied i.e., there will generally be a requirement for multiple label sizes. The labels shall be PANDUIT PLL-33-Y3-5 labels or approved equivalent.
- .4 The specific cable label types are designated based on diameters anticipated for a project. It is recognised that some of the cable diameters may be changed during project execution and for this, or other reasons, the Contractor shall ensure that the overall requirement to ensure that the clear part of the cable label protects the printed part of the cable label is always satisfied. This specification may demand alternative cable labels which shall be from the PANDUIT PLL product line or approved equivalent.
- .5 The label shall be applied within 15 cm (6 ins) of the end of the cable and shall be located so that the cable may readily be identified.
- .6 The printing shall be at least 12-point Arial font or approved equivalent.

- .7 All labelling must be mechanically printed using a laser printer and follow the ANSI/EIA/TIA-606C guideline for colour codes. Hand written labels are not permitted. The following identifies the labelling convention.

6. Cable Labelling Conventions

- .1 The labelling of cables shall clearly identify the application of the cables. This convention requires that cables be identified as follows:
- C for communications;
 - F for fire related applications;
 - H for “high”-voltage power (greater than 48V);
 - L for “low”-voltage power (less than 48V);
 - N for networking;
 - S for signalling;
 - T for transducer; and
 - V for video cables.
- .2 A typical cable label might, for example, be labelled as: “L0003-GAR001-064-ADMIN009-922”. Which would signify,
- Low Voltage Cable
 - Number 0003 cable
 - Cable is from location “GAR001”, “connection 064” to location “ADMIN009”, “connection 922”, i.e., source and destination must be uniquely specified.
- .3 Such cable identifications shall be incorporated in the documentation.
- .4 The Contractor shall obtain the York Region’s approval of any modification or extension to this convention.
- .5 Main alarm outputs and relays shall be labelled accordingly. All alarm points, card readers and other system components shall be labelled in accordance with the door numbering and description syntax.

7. Considerations Regarding ANSI / TIA-606-C:

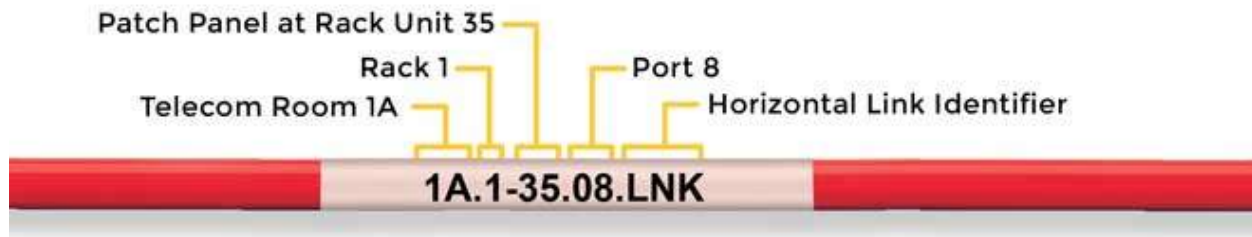
- .1 TIA-606-C is the latest update to the voluntary standard for administering telecommunications cabling infrastructure, released by the Telecommunications Industry Association (TIA) in July 2017. TIA-606-C builds on the guidelines already established in TIA-606-B, released in 2012, as well as includes some new additions and updates.

8. How to Properly Identify Cables According to TIA-606-C

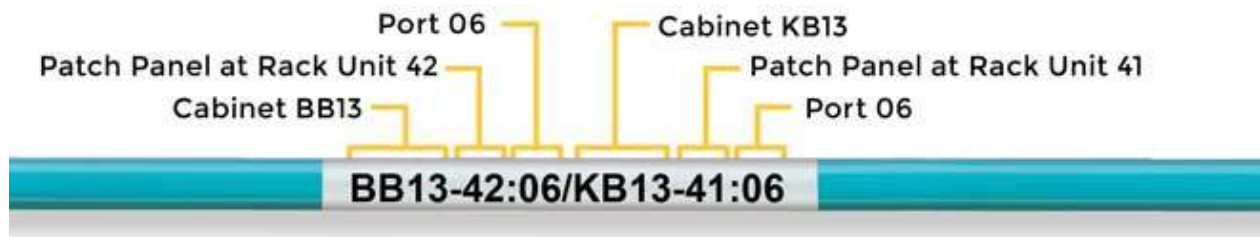
- .1 Each of the following components must be clearly labelled with the appropriate identifiers:
- Pathways
 - Work area outlets
 - Patch panels
 - Racks and cabinets
 - Ports
 - Grounding busbars
 - Cabling
 - Firestop locations
 - Telecommunications space
 - Data center room grid

9. Examples of TIA 606C Compliant Labelling (Brady Labels)

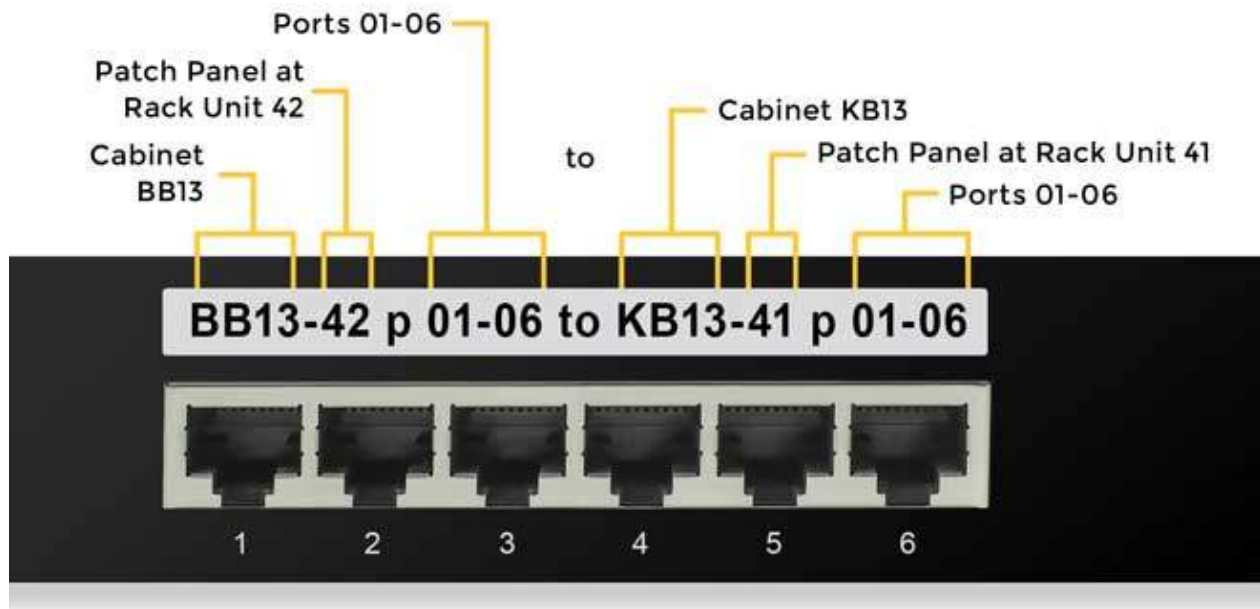
a. LINK Identifier Not Terminated in the Same Space Label Example



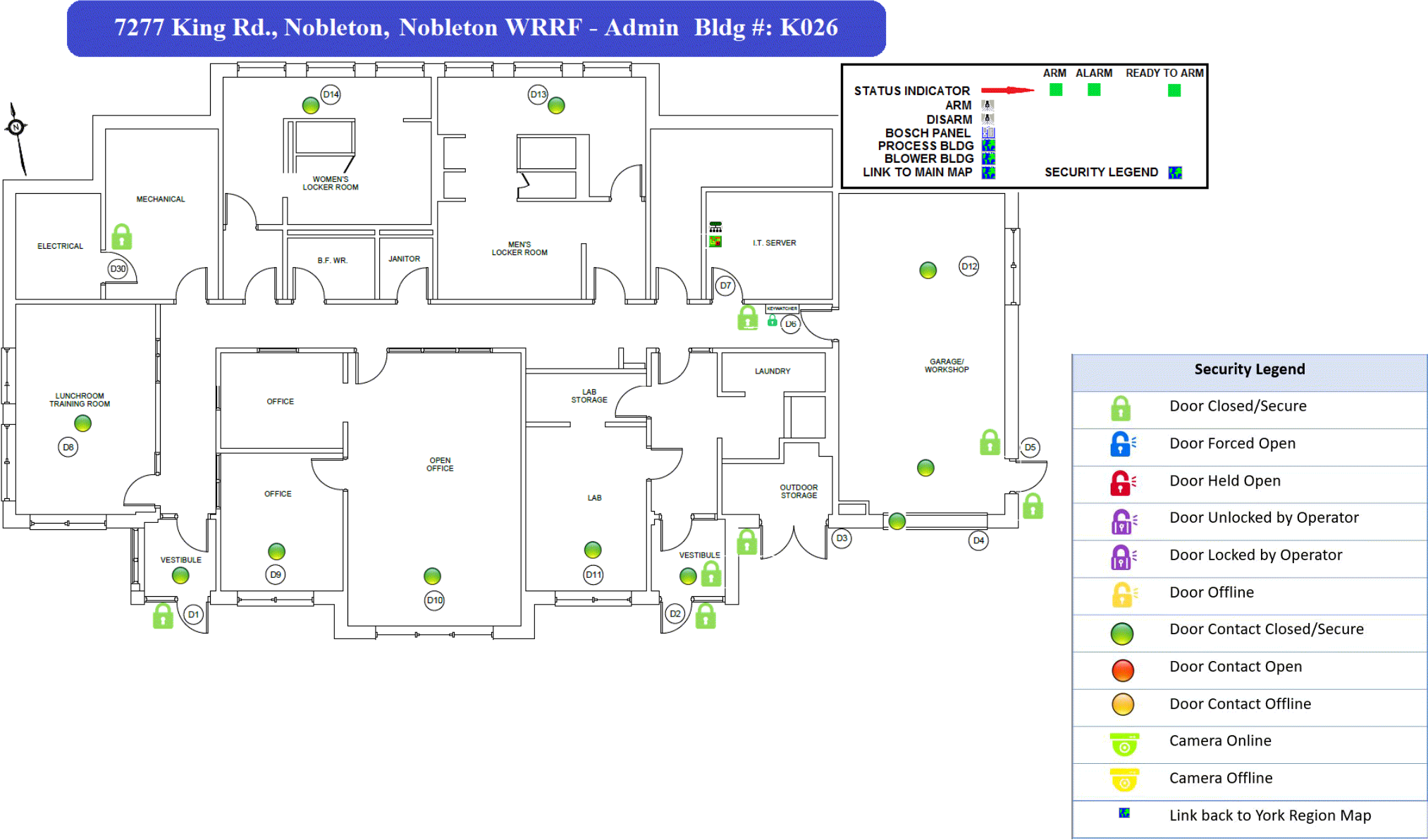
b. LINK Identifier Terminated in Same Space Label Example

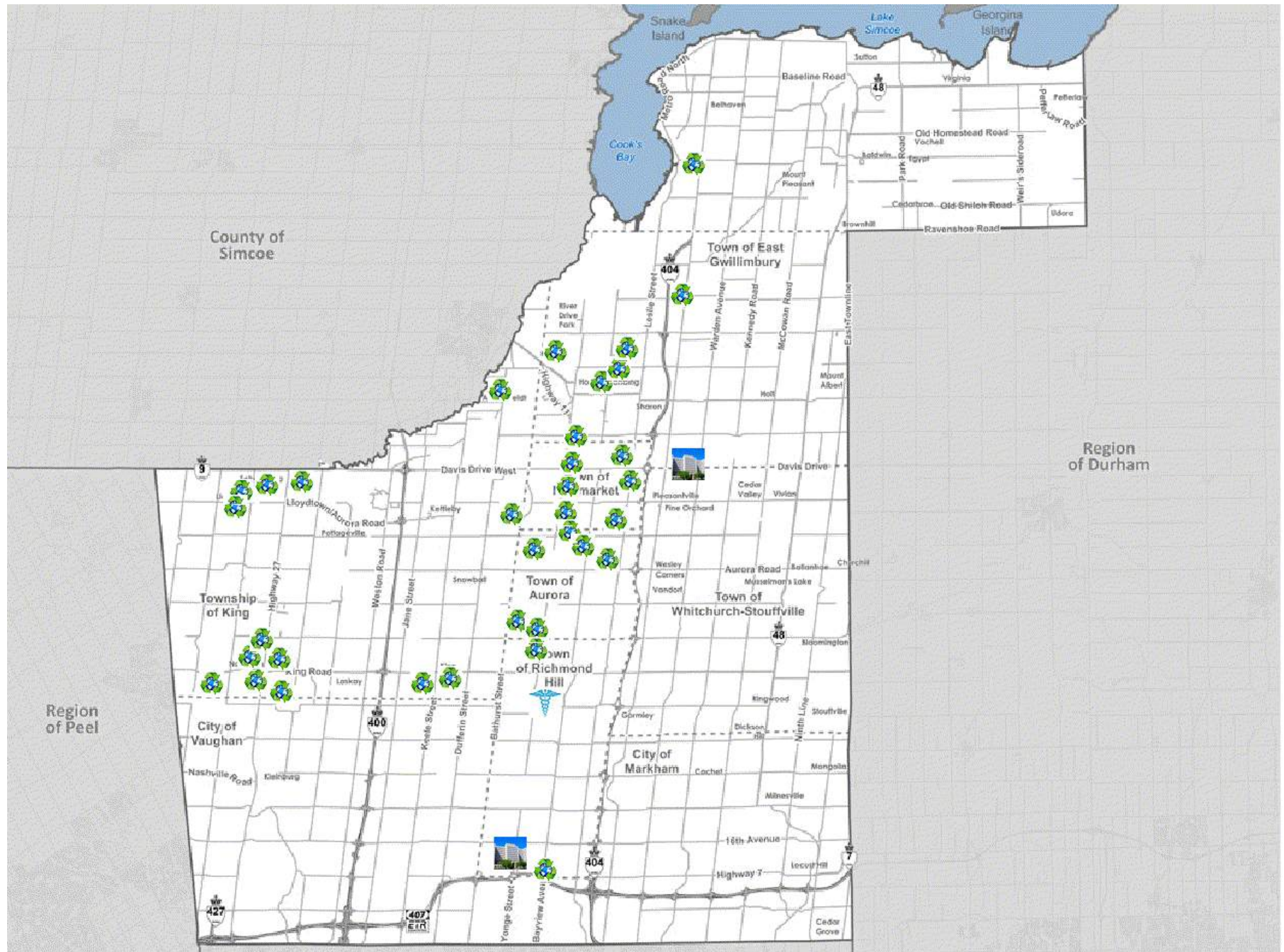


c. Patch Panel Identification Label Example



4.23 Appendix W – Sample Graphic Alarm Map, Regional Layout and Icons





1 General

1.01 RELATED REQUIREMENTS

- .1 Section 03 30 00 – Cast-in-Place Concrete

1.02 ABBREVIATIONS

- .1 GW: Well-graded gravel
- .2 GP: Poorly graded gravel
- .3 GC: Clayey gravel
- .4 SW: Well-graded sand
- .5 SP: Poorly graded sand
- .6 SC: Clayey sand
- .7 CL: Lean clay
- .8 ML: Silt
- .9 CH: Fat clay
- .10 MH: Elastic silt

1.03 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
 - .1 ASTM C136/C136M-19, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - .2 ASTM D1140-17, Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No.200) Sieve in Soils by Washing
 - .3 ASTM D2487-17e1, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
 - .4 ASTM D4318–17e1, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 - .5 ASTM D4791-19, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

1.04 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Submit manufacturer's instructions, product literature, and data sheets for aggregate materials. Include product characteristics, performance criteria, practical size, finishes, and limitations.
- .3 Samples:
 - .1 Submit 1-kg samples of each type of aggregate, as specified.
 - .2 Allow continual sampling by consultant during production.

- .3 Supply new or clean sample bags or containers appropriate for the type of aggregate materials.
- .4 Install sampling facilities at discharge end of production conveyor to allow Consultant to obtain representative samples of items being produced. Stop conveyor belt when requested by Consultant to permit full cross-section sampling.
- .5 Provide front-end loader or other suitable equipment and a trained operator for stockpile sampling as necessary. Move samples to storage location reviewed by Consultant.

1.05 DELIVERY, STORAGE, AND HANDLING

- .1 Segregation, contamination, and degradation of aggregates during handling and transportation is not permissible.
- .2 Store washed materials or materials excavated from underwater for a minimum of 24 hours to allow for free drainage of water and for materials to reach uniform water content.

2 Products

2.01 MATERIALS

- .1 Aggregate Quality: Sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, and adherent coatings or other deleterious substances.
- .2 Aggregate Classification:
 - .1 Cohesionless materials: To ASTM D2487.
 - .2 Cohesive materials: To ASTM D2487.
 - .3 Perform testing in accordance with ASTM D4318, ASTM C136/C136M, and ASTM D1140.
- .3 Flat and Elongated Particles of Coarse Aggregate: To ASTM D4791.
 - .1 Length to thickness ratio equal to or greater than 5:1.
- .4 Fine aggregates satisfying requirements of applicable sections, such as Section 03 30 00 – Cast-in-Place Concrete to be one of or a blend of the following:
 - .1 Screenings produced from crushing quarried rock, boulders, gravel or slag.
 - .2 Reclaimed asphalt pavement.
 - .3 Reclaimed concrete material.
- .5 Coarse aggregates satisfying requirements of applicable sections, such as Section 03 30 00 – Cast-in-Place Concrete to be one of or a blend of the following:
 - .1 Crushed rock.
 - .2 Gravel composed of naturally formed particles of stone.
 - .3 Lightweight aggregate, including slag and expanded shale.

- .4 Reclaimed asphalt pavement.
- .5 Reclaimed concrete material.

2.02 SOURCE QUALITY CONTROL

- .1 Inform Consultant of proposed source of aggregates and provide access for sampling a minimum 1 weeks before starting production.
- .2 If materials from proposed source do not meet or cannot reasonably be processed to meet specified requirements then locate alternative source.
- .3 Advise Consultant a minimum 2 weeks in advance of proposed change of material source.
- .4 Provide Consultant with access to source and processed material for sampling.
- .5 Acceptance of material at source does not exclude it from potential future rejection if it fails to conform to specified requirements, lacks uniformity, or if its site performance is found to be unsatisfactory.
- .6 Pay cost of sampling and testing of aggregates which fail to meet specified requirements.

3 Execution

3.01 EXAMINATION

- .1 Verification of Conditions:
 - .1 Topsoil:
 - .1 Examine topsoil for clods, rocks, snow, large roots, litter, and toxic substances before proceeding with stripping.
 - .2 Proceed with topsoil stripping, after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Consultant.

3.02 TOPSOIL STRIPPING

- .1 Do not handle topsoil when wet or frozen or in any manner in which soil structure is adversely affected.
- .2 Begin topsoil stripping of areas as reviewed by Consultant after clearing and removal of brushes, weeds and grasses from site.
- .3 Strip topsoil to depths as reviewed by Consultant. Avoid mixing topsoil with subsoil.
- .4 Stockpile in locations as indicated by Departmental Representative. Stockpile height not to exceed 2 m.
- .5 Dispose of topsoil to location as indicated Departmental Representative.

3.03 AGGREGATE SOURCE PREPARATION

- .1 Clear, grub, and strip unsuitable surface materials before excavating for aggregate production. Dispose of unsuitable materials using method reviewed Consultant.
- .2 Where clearing is required, leave screen of trees between cleared area and roadways as indicated on Contract Documents.
- .3 Clear, grub and strip area ahead of quarrying or excavate sufficiently to prevent contamination of aggregate by deleterious materials.
- .4 When excavation is completed, dress sides of excavation to nominal 1.5:1 slope. Provide drains or ditches as required to permit for proper drainage.
- .5 Trim off and dress slopes of waste material piles. Leave site in neat condition.
- .6 Provide silt fence or other means to prevent contamination of existing watercourse or natural wetland features in accordance with Section 01 57 00 – Temporary Controls.

3.04 PROCESSING

- .1 Process aggregate uniformly using methods that prevent contamination, segregation, and degradation.
- .2 Blend aggregates as required, including reclaimed materials that meet specified requirements in order to satisfy gradation requirements or specified particle shapes.
 - .1 Use methods and equipment reviewed in writing by Consultant.
- .3 When operating in stratified deposits use excavation equipment and methods that produce uniform and homogeneous aggregate gradation.
- .4 Screen, crush, wash, classify and process aggregates with suitable equipment to meet requirements.
 - .1 Use only equipment reviewed in writing by Consultant.

3.05 STOCKPILING

- .1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Departmental Representative. Do not stockpile on completed pavement surfaces.
- .2 Stockpile aggregates in sufficient quantities to meet project schedules.
- .3 Use stockpile sites that are level, well-drained and have adequate bearing capacity to support the weight of stockpiled materials and handling equipment.
- .4 Except where stockpiled on acceptably stabilized areas:
 - .1 Provide compacted sand base minimum of 300 mm in depth to prevent contamination of aggregate; or,
 - .2 Stockpile aggregates on ground but do not incorporate bottom 300 mm of stockpile into Work.
- .5 Divide different aggregates by strong, full depth bulkheads, or separate each stockpile by a sufficient distance to prevent intermixing.

- .6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials [in accordance with Section 01 74 19 – Waste Management and Disposal within 48 hours of rejection.
- .7 Stockpile materials in uniform layers a maximum 1.5 m in depth. Complete and level each layer before placing the subsequent layer.
- .8 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
- .9 Do not cone piles or spill material over edges of piles. Keep the completed stockpiles neat, regular in form and occupying the smallest possible area.
- .10 Do not use stacking conveyors.
- .11 During winter operations, prevent penetration of ice and snow into stockpile or in material being removed from stockpile.

3.06 CLEANING

- .1 Cleaning: Perform in accordance with Section 01 74 00 – Cleaning.
- .2 Leave aggregate stockpile site in tidy, well-drained condition, free of standing surface water.
- .3 Leave any unused aggregates in neat compact stockpiles in locations directed by Departmental Representative.
- .4 Waste Management: Perform in accordance with Section 01 74 19 – Waste Management and Disposal.
- .5 For temporary or permanent abandonment of aggregate source, restore source to condition meeting requirements of AHJ.

Restrict public access to temporary or permanently abandoned stockpiles by means acceptable to Departmental Representative or Consultant in accordance with Section 01 56 00 Temporary Barriers and Enclosures.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Stabilizing Base Gravel.
 - .2 Filter Fabric.
 - .3 Backfill Material.
 - .4 Fillcrete.
 - .5 Trenching.
 - .6 Shoring.
 - .7 Trench Drainage.
 - .8 Backfilling.
 - .9 Backfill Compaction.
 - .10 Testing Backfill Compaction.

1.2 PRICE AND PAYMENT PROCEDURES

- .1 Measurement and Payment:
 - .1 Payment for the work of this Section shall be on a lump sum basis as tendered which shall be full compensation for labour, materials and equipment necessary to complete the work, including all subsidiary and incidental items thereto for which separate payment is not elsewhere provided.

1.3 REFERENCES

- .1 Definitions:
 - .1 Common Excavation:
 - .1 The excavation of all materials including hardpan, quicksand, and frozen earth; also rock, concrete or masonry less than 1.0 m³ in volume shall be classified as common excavation.
 - .2 Rock Excavation:
 - .1 The excavation of rock, concrete or masonry exceeding 1.0 m³ in volume; and solid ledge rock, concrete or masonry which requires for its removal drilling, blasting, wedging, sledging, barring or breaking with a power operated hand tool shall be classified as rock excavation. Soft or disintegrated rock, concrete or masonry which can be removed with a hand pick, power operated excavator or shovel; and loose, shaken or previously blasted rock will not be classified as rock excavation.
 - .3 Class One Backfill:
 - .1 Class One backfilling shall consist of backfilling the trench with sand or gravel compacted in even layers not exceeding 300 mm in depth so that there is no subsequent subsidence in the trench. Backfill shall be compacted to a minimum of 100% Standard Proctor Density. Fillcrete may be used in lieu of Class One backfill.

- .4 Class Two Backfill:
 - .1 Class Two backfilling shall consist of replacing the excavated material in even layers not exceeding 300 mm in depth, and compacting each layer by mechanical means to 95% Standard Proctor Density.
- .5 Class Three Backfill:
 - .1 Class Three backfilling shall consist of replacing excavated material in the trench by approved methods. Every attempt shall be made to consolidate the backfill to avoid bridging and subsidence. The Contractor shall ensure that settlement of the surface shall not exceed 100 mm over a period of one year. Contractor shall be responsible for all costs associated with the repairs of subsistence during the warranty period.
- .6 Topsoil:
 - .1 The top layer of soil containing organic material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
- .2 Reference Standards:
 - .1 Ontario Government:
 - .1 Occupational Health and Safety Act.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM C136/C136M-19, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .2 ASTM D698-12(2021), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft.-lbf/ft³ (600 kN-m/m³)).
 - .3 ASTM D1883-21, Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils.
 - .4 ASTM D3786/3786M-18, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
 - .5 ASTM D4533/D4533M-15, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - .6 ASTM D4632/D4632M-15a, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - .7 ASTM D4833/D4833M-07(2020), Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS:

- .1 Samples:
 - .1 At least two weeks prior to commencing work, inform Engineer of proposed source of granular materials.
 - .2 The Contractor shall provide a sieve analysis of the material for the Engineer's approval.
 - .3 Sand and gravel shall be approved by the Engineer before being used.

.2 Test and Evaluation Reports:

- .1 Submit compaction and density test results to the Consultant.
- .2 The cost of all initial testing will be borne by the Owner and the Contractor is responsible for the costs of any re-testing for areas where initial testing failed.

1.5 QUALITY ASSURANCE

.1 Safety Requirements:

- .1 The Contractor shall be required to observe all applicable Sections of the Province of Ontario's Occupational Health and Safety Act and Code covering worker safety in trenches and excavations.
- .2 Open cut trenches shall be sheeted and braced as required by the Accident Prevention Regulations of the Occupational Health and Safety Division of the Department of Labour and Municipal Ordinances, and as may be necessary to protect life, property and the work.
- .3 Prefabricated cages or shields, provided they conform with all applicable safety requirements, may be used to supplement or replace conventional shoring.

Part 2 Products

2.1 STABILIZING BASE GRAVEL

- .1 Stabilizing base gravel shall be well graded gravel consisting of hard durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
- .2 The material shall meet one of the following gradations depending on the native foundation material encountered:

Screened Rock-Washed (Not Crushed)		Crushed Gravel	
Sieve Size (mm)	Percent Passing (by weight)	Sieve Size (mm)	Percent Passing (by weight)
25	100	25	100
10	30 – 55	20	35 - 60
2	5 – 25	5	15 - 40
0.4	0 – 5	0.4	5 - 15
		0.063	0 - 5

- .3 The liquid limit shall not exceed 25 and the plasticity index shall not exceed six.

2.2 FILTER FABRIC

- .1 The synthetic filter fabric shall consist of a durable, permeable, non-woven, polyester fabric composed of continuous synthetic filaments in a random arrangement with typical properties as follows:

Tensile Grab Strength – ASTM D4632/D4632M	700 N
Trapezoid Tear Strength – ASTM D4533/D4533M	285 N

Mullen Burst Strength – ASTM D3786/D3786M 2,100 kPa
Puncture – ASTM D4833/D4833M 400 N
Filter fabric shall be Amoco 4551, Layfield 601 or approved equal.

2.3 CLASS 1 BACKFILL MATERIAL

- .1 Material for Class One backfill shall consist of sound, hard, durable, uniformly graded crushed gravel and shall not contain organic or soft materials, materials that break up when alternately frozen and thawed or wetted and dried, or other deleterious materials. When compacted near the optimum moisture content to not less than 95% of the maximum dry density corrected for the stone content as determined by ASTM D698, the material shall have a minimum bearing ratio as defined ASTM D1883, of fifteen percent (15%).
- .2 Class One backfill shall meet the following gradation when tested to ASTM C136/C136M:

Sieve Size (mm)	Percent Passing (by weight)
60	100
16	32 - 85
5	20 - 65
0.315	6 - 30
0.08	2 - 10

2.4 FILLCRETE

- .1 Non-shrinking fill made up of a mixture of Portland cement, sand, water and admixtures conforming to the following:
 - .1 Minimum 28 day compressive strength 1.00 to 2.00 MPa
 - .2 Slump 100 mm \pm 25 mm
 - .3 Portland Cement Type Ten
 - .4 Air entrainment 5% \pm 1%

Part 3 Execution

3.1 PREPARATION

- .1 Protection of in-place conditions:
 - .1 Existing buried utilities and structures:
 - .1 Prior to commencing any excavation work, notify applicable owner or authorities, establish location and state of use of buried utilities and structures. Clearly mark such locations to prevent disturbance during work.
 - .2 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. All damage incurred shall be repaired by the Contractor at his expense.
 - .2 Existing buildings and surface features:

- .1 Maintain and protect from damage existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, paving, survey bench marks and monuments which may be affected by work. All damage incurred shall be repaired by the Contractor at his expense.
- .2 Site Preparation:
 - .1 Strip organic material, clear and grub, remove weeds and grasses as specified or as required by the Engineer prior to excavation. Avoid intermixing of subsoil fill materials with organic material and from other forms of contamination.

3.2 TRENCHING

- .1 Trench width:
 - .1 The minimum trench width below the crown of the pipe shall be not less than the nominal diameter of the pipe plus 400 mm. The maximum width of the trench below the crown of the pipe including shoring shall be not more than the nominal diameter of the pipe plus 600 mm or not more than a total width of 900 mm, whichever is the larger. Where the maximum trench width is exceeded, the Contractor shall, at his own expense, provide special bedding or take other precautions as directed by the Engineer. Where more than one pipe is laid in the same trench, the minimum and maximum widths shall be as directed by the Engineer.
 - .2 The Contractor shall confine his activities to the immediate area of the trench. All activities outside trench boundaries shall be performed so as not to damage other existing features. The Contractor shall generally have the option of using either vertical shored trenches or Vee trenches. Every effort shall be made to restrict the trench widths to minimize the area disturbed.
- .2 All excavated material shall be piled at least 1.0 m clear of the trench top to prevent material from falling back into the excavation. The material shall be piled in such a manner that it will not endanger the work, or obstruct other work or rights-of-way. Sufficient clear space must be left on one side of the trench to accommodate the Engineer's stakes.
- .3 The trench shall be excavated so that the pipe can be laid to the alignment, grade and depth required.
- .4 Trench Rock Excavation:
 - .1 Where excavation is made in rock or where excavation is made in a material which cannot provide an even, uniform and smooth surface; or where large stones are encountered in the trench, such material shall be removed to provide a clear distance between any part or projection of such material and the surface of all pipe and fittings of not less than 150 mm for 600 mm outside diameter pipe or less, and 200 mm for pipe having an outside diameter greater than 600 mm. The subgrade shall then be made by backfilling with an approved sand compacted in 75 mm layers at the Contractors expense. Excavated rock shall not be used for

- backfill. The finished subgrade surface shall be shaped by hand tools to provide a uniform and continuous support for the pipe.
- .2 Blasting for excavation will be permitted only with the approval of the Engineer and only when proper precautions are taken for the protection of persons or property. The Contractor's method of procedure in blasting shall conform to provincial statutes and municipal ordinances.
- .5 The subgrade shall provide an uniform and continuous support for the pipe and fittings on solid undisturbed ground. Any over excavation by the Contractor below the required grade shall be backfilled at his expense with an approved compacted sand.

3.3 UNSTABLE SUBGRADE

- .1 Where the subgrade of the trench is unstable or will not properly support the pipe, or where it contains materials harmful to the pipe such as ashes, cinders, refuse, vegetable or organic material, the Contractor shall excavate such material to the width, depth and length ordered by the Engineer and dispose of the material as directed. The subgrade shall then be made by backfilling with an approved stabilizing gravel compacted in 75 mm layers. The finished subgrade surface shall be shaped by hand tools to provide an uniform and continuous support for the pipe.
- .2 The stabilization gravel may be completely wrapped in the filter fabric as specified. The fabric shall be overlapped a minimum of 500 mm at all joints to provide a full, continuous wrap and shall be smooth and free of tension, stress, folds, wrinkles or creases.
- .3 Where the subgrade cannot be made to properly support the pipe by replacing unsound material with stabilizing gravel, the Contractor shall construct a foundation for the pipe in accordance with a drawing prepared at the time by the Engineer. Payment for this work shall be made in accordance with the provisions for extra work unless specified otherwise.

3.4 SHORING

- .1 When close sheeting is required, it shall be so driven as to prevent adjacent soil from entering the trench either below or through such sheeting. The Engineer reserves the right to order the sheeting driven to the full depth of the trench or to such additional depths as may be required for the protection of the work.
- .2 Trench bracing may be removed when the backfilling has reached the respective level of such bracing. Sheeting shall be removed as the backfilling proceeds. Backfilling of holes left by sheeting below the trench bottom shall be carefully compacted, and thereafter backfilling and withdrawal of sheeting shall proceed together. No voids shall be left in the backfill by the withdrawal of the sheeting.
- .3 When a cage or shield is used in the trench instead of shoring, special care shall be taken to ensure that there is no lateral or longitudinal movement of the pipe when the cage is moved. The cage shall be raised vertically so that the bottom member is clear of the crown of the pipe before the cage is pulled forward in the trench.

3.5 TRENCH DRAINAGE

- .1 Gutters and natural drainage channels shall not be obstructed. Satisfactory provisions shall be made for alternate drainage where this is impractical.
- .2 The trench shall be so drained that the workmen may work safely and effectively. All water encountered in trenches shall be pumped or bailed out, and in no case shall the pipe be used as a drain for such water. It is essential that the discharge of the trench dewatering pumps be conducted away from the site of the work and into natural drainage channels, drains or storm sewers.

3.6 BACKFILLING

- .1 Bedding and initial backfilling shall be as specified for the particular pipe installed.
- .2 General backfilling:
 - .1 Class Two backfill as defined in Section 1.1 - Definitions shall be used.
 - .2 No boulders, rock, ice, snow, organic material or debris shall be permitted in the trench. These unsuitable materials shall be hauled away.
 - .3 All surplus excavated material shall also be hauled away, or disposed of as directed by the Engineer. In the event of deficiency of backfill material, suitable material shall be supplied by the Contractor at his expense.
 - .4 All trenches shall be backfilled as the work proceeds and no more than 30 m shall be left open at the end of a days work.

3.7 BACKFILL COMPACTION

- .1 The Contractor shall be responsible for adequate compaction of the trenches and for the correction of settlement during the maintenance period of the Contract. Mechanical compaction equipment shall not be used until there is sufficient cover to prevent damage to the pipe.
- .2 The type of compaction equipment shall be chosen with regard to minimizing the vibration effect on nearby buildings and utilities. The Contractor shall inspect the condition of buildings prior to construction. The Engineer shall have the right to request the Contractor to replace any equipment causing unacceptable vibrations. The Contractor is responsible for any damage caused to buildings due to construction.

3.8 TESTING BACKFILL COMPACTION

- .1 Compaction results shall be based on a minimum of two density tests per 100 metres of trench for each 0.6 metres of compacted vertical backfill. Additional tests may be called for by the Engineer as deemed necessary.
- .2 If a density test indicates insufficient compaction at any depth, then two more densities, where are proportionally representative of trench length, shall be taken at that depth. If the average of these tests is below the required density, the trench shall be re-excavated and re-compacted to meet the specified density.
- .3 This testing in no way relieves the Contractor of his maintenance responsibilities with respect to settlements as specified. The Contractor shall repair any

settlement and damaged surface improvements due to the settlement which occurs during the maintenance period.

- .4 The cost of all initial testing will be borne by the Owner and the Contractor is responsible for the costs of any re-testing for areas where initial testing failed. Non-conformity with the specified density or moisture content shall constitute sufficient grounds for rejection of the work.

3.9 AUGERED/BORED CROSSINGS

- .1 The augering/boring machine shall be aligned and set to the required grade. If the hole deflects from desired course, another hole shall be bored in the location specified by the Engineer. Minimum allowable grades and maximum allowable bends shall be as specified by water mains laid in an open trench.
- .2 The bored hole shall be of sufficient size to allow the carrier pipe or casing pipe, as specified, to pass through unrestricted. After installation of the pipe, the bored hole void shall be backfilled with pneumatically blown free running sand or sealed with 5 MPa pressure grouting.
- .3 Highway crossings shall be cased as shown on the drawings. Casing pipe joints shall be welded. Each joint shall be coated and wrapped with primer and tape.
- .4 Anodes and warning signs shall be installed as specified.

3.10 FENCES AND GATES

- .1 Maintain gates and fences along and crossing the right-of-way and on access roads.
- .2 Do not open fences crossing the construction right-of-way unless installing the pipe underneath the fence is not feasible.
- .3 Notify landowners and tenants if a fence must be opened. Install temporary gates in accordance with the wishes of the landowners and tenants.
- .4 Return fences to original condition, at no cost to the Owner, as soon as fence openings or alterations are no longer required for construction.

END OF SECTION

1 GENERAL

1.01 RELATED REQUIREMENTS

- .1 Section 02 41 13 – Selective Site Demolition
- .2 Section 31 05 16 – Aggregate Materials
- .3 Section 33 31 11 – Public Sanitary Sewerage Gravity Piping
- .4 Section 33 41 00 – Storm Utility Drainage Piping

1.02 DEFINITIONS

- .1 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .2 Topsoil:
 - .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
 - .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters 1 inch in any dimension.
- .3 Waste material: Excavated material unsuitable for use in Work or surplus to requirements.
- .4 Borrow material: Material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
- .5 Recycled fill material: Material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .6 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Frost susceptible materials:
 - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136/C136M : Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2 .
 - .2 Table:

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45-100
0.02 mm	10-80
0.005 mm	0-45

- .3 Coarse grained soils containing more than 20 % by mass passing 0.075 mm sieve.
- .7 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.03 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
 - .1 ASTM C117- 17 , Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing
 - .2 ASTM C136/C136M- 19 , Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - .3 ASTM D422-63 2002 , Standard Test Method for Particle-Size Analysis of Soils
 - .4 ASTM D698- 12 , Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³)
 - .5 ASTM D1557- 12 , Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m³)
 - .6 ASTM D4318- 17el , Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric
- .3 CSA Group (CSA):
 - .1 CAN/CSA-A3000- 18 , Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005)
 - .1 CSA-A3001- 18 , Cementitious Materials for Use in Concrete
 - .2 CSA-A23.1/A23.2- 14 , Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete

1.04 MEASUREMENT PROCEDURES

- .1 Excavated materials will be measured in cubic metres in their original location.
 - .1 Common Unclassified excavation quantities measured will be actual volume removed within the following limits:
 - .1 Width for trench excavation as indicated.
 - .2 Width for excavation for structures as indicated.
 - .3 Depth from ground elevation and surface of pavement surface of sidewalk immediately prior to excavation, to elevation as indicated as directed by Consultant .
 - .2 Rock quantities measured will be actual volume removed within the following limits:
 - .1 Width for trench excavation as indicated.
 - .2 Width for excavation for structures to be bounded by vertical planes up to 500 mm outside of and parallel to neat lines of footings as indicated.
 - .3 Depth from rock surface elevations immediately prior to excavation, to elevation as indicated.
 - .4 Where design elevation is less than 300 mm below original rock surface, depth will be considered to be 300 mm below original rock surface.
 - .5 Volume of individual boulders and rock fragments will be determined by measuring three maximum mutually perpendicular dimensions.
- .2 Sheeting and bracing left in place on direction of Consultant will be measured in square metres of surface area of plane surface of sheeting.
- .3 Shoring, bracing, cofferdams, underpinning and de-watering of excavation will not be measured separately for payment.
- .4 Backfilling to authorized excavation limits will be measured in cubic metres compacted in place tonnes for each type of material specified.
- .5 Placing and spreading of topsoil will be measured for payment in cubic metres calculated from cross sections taken in area of excavation from original location.
 - .1 If double handling of topsoil is directed by Consultant (stockpiling and later placing), then quantities will be measured twice; on excavation from original location and on excavation from stockpile.

1.05 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures .
- .2 Quality Control: in accordance with Section 01 45 00 – Quality Control :
 - .1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
 - .2 Submit for review by Consultant proposed dewatering and heave prevention methods as described in PART 3 of this Section.

- .3 Submit to Consultant written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
- .4 Submit to Consultant written notice when bottom of excavation is reached.
- .5 Submit to Consultant testing results and report as described in PART 3 of this Section.
- .3 Preconstruction Submittals:
 - .1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
 - .2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field and clearance record from utility authority and location plan of relocated and abandoned services, as required .
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 – Submittal Procedures .
 - .2 Inform Consultant at least 4 weeks prior to beginning Work, of proposed source of fill unshrinkable fill materials and provide access for sampling.
 - .3 Submit 70 kg samples of type of fill specified including representative samples of excavated material .
 - .4 Ship samples prepaid to Consultant , in tightly closed containers to prevent contamination and exposure to elements.
 - .5 At least 4 weeks prior to beginning Work, inform Consultant source of fly ash and submit samples to Consultant .
 - .1 Do not change source of Fly Ash without written approval of Consultant .

1.06 QUALITY ASSURANCE

- .1 Where Consultant is employee of Contractor, submit proof that Work by Consultant is included in Contractor's insurance coverage.
- .2 Submit design and supporting data at least 2 weeks prior to beginning Work.
- .3 Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in Ontario , Canada.
- .4 Keep design and supporting data on site.
- .5 Engage services of qualified professional Engineer who is registered or licensed in Ontario , Canada in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.
- .6 Do not use soil material until written report of soil test results are reviewed and approved by Consultant .

1.07 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Waste Management and Disposal .

- .2 Divert excess aggregate materials from landfill to local quarry recycling facility for reuse as directed by Consultant .

1.08 EXISTING CONDITIONS

- .1 Examine soil report
- .2 Buried services:
 - .1 Before commencing work verify location of buried services on and adjacent to site.
 - .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
 - .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
 - .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
 - .5 Before beginning excavation Work, notify applicable Consultant authorities having jurisdiction establish location and state of use of buried utilities and structures. Consultant authorities having jurisdiction to clearly mark such locations to prevent disturbance during Work.
 - .6 Confirm locations of buried utilities by careful test excavations and/or soil hydrovac methods .
 - .7 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered as indicated .
 - .8 Where utility lines or structures exist in area of excavation, obtain direction of Consultant before removing or re-routing . Costs for such Work to be paid by Owner .
 - .9 Record location of maintained, re-routed and abandoned underground lines.
 - .10 Confirm locations of recent excavations adjacent to area of excavation.
- .3 Existing buildings and surface features:
 - .1 Conduct, with Consultant , condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.
 - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Consultant .

2 PRODUCTS

2.01 MATERIALS

- .1 Type 1 and Type 2 fill: properties to Section 31 05 16 – Aggregate Materials and the following requirements:
 - .1 Crushed, pit run or screened stone, gravel, or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136/C136M and ASTM C117 . Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2 .

.3 Table:

Sieve Designation	% Passing	
	Type 1	Type 2
75 mm	-	100
50 mm	-	-
37.5 mm	-	-
25 mm	100	-
19 mm	75-100	-
12.5 mm	-	-
9.5 mm	50-100	-
4.75 mm	30-70	22-85
2.00 mm	20-45	-
0.425 mm	10-25	5-30
0.180 mm	-	-
0.075 mm	3-8	0-10

- .2 Type 3 fill: selected material from excavation or other sources, approved by Consultant for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials.
- .3 Unshrinkable fill: proportioned and mixed to provide:
 - .1 Maximum compressive strength of 0.4 MPa at 28 days.
 - .2 Maximum cement content of 25 kg/m³ with 40 % by volume fly ash replacement : to CSA-A3001, Type GU .
 - .3 Minimum strength of 0.07 MPa at 24 h.
 - .4 Concrete aggregates: To CSA-A23.1/A23.2
 - .5 Cement: Type GU .
 - .6 Slump: 160 to 200 mm
- .4 Shearmat: Honeycomb type bio-degradable cardboard 100 mm thick, treated to provide sufficient structural support for poured concrete until concrete cured.

3 EXECUTION

3.01 SITE PREPARATION

- .1 Remove obstructions, ice, and snow from surfaces to be excavated within limits indicated.
- .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly in accordance with Section 02 41 13 – Selective Site Demolition .

3.02 PREPARATION/PROTECTION

- .1 Protect existing features in accordance with Section 01 56 00 – Temporary Barriers and Enclosures and applicable local regulations.
- .2 Keep excavations clean, free of standing water and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Consultant approval.
- .4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
- .5 Protect buried services that are required to remain undisturbed.

3.03 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping of areas as indicated as directed by Consultant after area has been cleared of brush weeds and grasses and removed from site.
- .2 Strip topsoil to depths as indicated as directed by Consultant .
 - .1 Do not mix topsoil with subsoil.
- .3 Stockpile in locations as indicated as directed by Consultant .
 - .1 Stockpile height not to exceed 2 m and should be protected from erosion.
- .4 Dispose of unused topsoil to location as indicated as directed by Consultant off site .

3.04 STOCKPILING

- .1 Stockpile fill materials in areas designated by Consultant .
 - .1 Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.
- .3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.05 COFFERDAMS, SHORING, BRACING AND UNDERPINNING

- .1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Health and Safety Act for the Province of Ontario .
 - .1 Where conditions are unstable, Consultant to verify and advise methods .

- .2 Obtain permit from authority having jurisdiction for temporary diversion of water course.
- .3 Construct temporary Works to depths, heights and locations as indicated or directed by Consultant .
- .4 During backfill operation:
 - .1 Unless otherwise indicated or directed by Consultant , remove sheeting and shoring from excavations.
 - .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
 - .3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500 mm above toe of sheeting.
- .5 When sheeting is required to remain in place, cut off tops at elevations as indicated.
- .6 Upon completion of substructure construction:
 - .1 Remove cofferdams, shoring and bracing.
 - .2 Remove excess materials from site and restore watercourses as directed by Consultant .

3.06 DEWATERING AND HEAVE PREVENTION

- .1 Keep excavations free of water while Work is in progress.
- .2 Provide for Consultant's review and approval details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.
- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
 - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in accordance with Section 01 35 43 – Environmental Procedures to approved runoff areas and in manner not detrimental to public and private property, or portion of Work completed or under construction.
 - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.

3.07 EXCAVATION

- .1 Advise Consultant at least 7 days in advance of excavation operations for initial cross sections to be taken.
- .2 Excavate to lines, grades, elevations and dimensions as indicated by Consultant .
- .3 Remove concrete masonry paving walks demolished foundations and rubble and other obstructions encountered during excavation in accordance with Section 02 41 13 – Selective Site Demolition .
- .4 Excavation must not interfere with bearing capacity of adjacent foundations.

- .5 Do not disturb soil within branch spread of trees or shrubs that are to remain.
 - .1 If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
- .6 For trench excavation, unless otherwise authorized by Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.
- .7 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Consultant .
- .8 Restrict vehicle operations directly adjacent to open trenches.
- .9 Dispose of surplus and unsuitable excavated material off site .
- .10 Do not obstruct flow of surface drainage or natural watercourses.
- .11 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .12 Notify Consultant when bottom of excavation is reached.
- .13 Obtain Consultant approval of completed excavation.
- .14 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Consultant .
- .15 Correct unauthorized over-excavation as follows:
 - .1 Fill under bearing surfaces and footings with concrete specified for footings fill concrete Type 2 fill compacted to not less than 100 % of corrected Standard Proctor maximum dry density in accordance with Section 31 05 10 – Corrected Maximum Dry Density for Fill
 - .2 Fill under other areas with Type 2 fill compacted to not less than 95 % of corrected Standard Proctor maximum dry density in accordance with Section 31 05 10 – Corrected Maximum Dry density fir Fill
- .16 Hand trim, make firm and remove loose material and debris from excavations.
 - .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
 - .2 Clean out rock seams and fill with concrete mortar or grout to approval of Consultant .

3.08 FILL TYPES AND COMPACTION

- .1 Use types of fill as indicated or specified below. Compaction densities are percentages of maximum densities obtained from ASTM D698 ASTM D1557 in accordance with Section 31 05 10 – Corrected Maximum Dry Density for Fill .
 - .1 Exterior side of perimeter walls: use Type 3 fill to subgrade level. Compact to 95 % of corrected maximum dry density.
 - .2 Within building area: use Type 2 to underside of base course for floor slabs. Compact to 100 % of corrected maximum dry density.

- .3 Under concrete slabs: provide 150 mm compacted thickness base course of Type 1 fill topped with shearmat filler as indicated to underside of slab. Compact base course to 100 %.
- .4 Retaining walls: use Type 2 fill to subgrade level on high side for minimum 500 mm from wall and compact to 95 %. For remaining portion, use Type 3 fill compacted to 95 %.
- .5 Place unshrinkable fill in areas as indicated.

3.09 BEDDING AND SURROUND OF UNDERGROUND SERVICES

- .1 Place and compact granular material for bedding and surround of underground services as indicated and as specified in Section 33 14 16 – Site Water Utility Distribution Piping Section 33 31 11 – Public Sanitary Sewerage Gravity Piping Section 33 41 00 – Storm Utility Drainage Piping .
- .2 Place bedding and surround material in unfrozen condition.

3.10 BACKFILLING

- .1 Vibratory compaction equipment: _____ .
- .2 Do not proceed with backfilling operations until completion of the following:
 - .1 Consultant has inspected and approved installations.
 - .2 Consultant has inspected and approved of construction below finish grade.
 - .3 Inspection, testing, approval, and recording location of underground utilities.
 - .4 Removal of concrete formwork.
 - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.
- .3 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .4 Do not use backfill material which is frozen or contains ice, snow or debris.
- .5 Backfilling around installations:
 - .1 Place bedding and surround material as specified elsewhere.
 - .2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
 - .3 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed _____ m.
 - .4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
 - .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Consultant or :
 - .2 If approved by Consultant , erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Consultant .
- .6 Place unshrinkable recycled fill in areas as indicated.

- .7 Consolidate and level unshrinkable fill with internal vibrators.
- .8 Install drainage system in backfill as indicated .

3.11 RESTORATION

- .1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 74 19 – Waste Management and Disposal , trim slopes, and correct defects as directed by Consultant .
- .2 Replace topsoil as indicated .
- .3 Reinstall lawns to elevation which existed before excavation.
- .4 Reinstall pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .5 Clean and reinstall areas affected by Work as directed by Consultant .
- .6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.
- .7 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 19 - Waste Management and Disposal.

1.2 MEASUREMENT FOR PAYMENT

- .1 No measurement for payment will be made under this Section.
- .2 Measure cleaning pavement surfaces in square metres of pavement surface cleaned.
- .3 Measure removal of pavement markings metres of solid lines or painted length of broken lines removed.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management And Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal: paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Fold up metal banding, flatten and place in designated area for recycling.
- .6 Do not dispose of unused solvent materials into landfill. Divert materials to municipal hazardous materials depot as approved by Contract Administrator.

Part 2 Products

2.1 MATERIALS

- .1 Abrasives and solvents used for removal of paint, oil, grease, rubber deposits: proprietary products specially designed for pavement cleaning, subject to approval by Contract Administrator.

Part 3 Execution

3.1 REMOVING PAVEMENT MARKINGS

- .1 Remove rubber tire deposits and paint markings, in areas designated by Contract Administrator, by sand blasting, rotary grinding, heater planing or other method approved by Contract Administrator.

- .2 Exercise care to avoid dislodging of coarse aggregate particles, excessive removal of fines, damage to bituminous binder or damage to joint and crack sealers.
- .3 Do not heat pavement surfaces above 120°C, when using heater planning equipment.

3.2 PAVEMENT SURFACE CLEANING

- .1 Remove sealing compound which has protruded excessively, where directed by Contract Administrator. Dispose of removed material as directed by Contract Administrator.
- .2 Remove dust, contaminants, loose and foreign materials, oil and grease, in areas designated and by method approved by Contract Administrator.
- .3 Use rotary power brooms and vacuum sweepers as needed supplemented by hand brooming.

END OF SECTION

1 General

1.01 RELATED REQUIREMENTS

- .1 Section 32.12.16 Asphalt paving

1.02 REFERENCE STANDARDS

- .1 American Association of State Highway and Transportation Officials (AASHTO)
 - .1 AASHTO T245-97-UL-2004, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
- .2 Ministry of Transportation Ontario (MTO)
 - .1 MTO Laboratory Testing Manual-09: LS-283, Resistance to Stripping of Asphalt Cement in Bituminous Mixtures by Immersion Marshall.

1.03 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Samples:
 - .1 Submit 2 samples of each proposed asphalt paving mixture.

2 Products

2.01 MATERIALS

- .1 Representative samples of each asphalt paving mixture proposed for use on Project.

2.02 EQUIPMENT

- .1 One or more water baths with automatic controls for immersing specimens. Baths normally used for Marshall Immersion Test are suitable for test.
- .2 Scale and water bath with suitable accessory equipment for weighing test specimens in air and in water to determine their densities.
- .3 Flat transfer plates of glass or metal. Keep 1 plate under each specimen during immersion period and during subsequent handling, except when weighing and testing, to prevent breakage or distortion of specimens.
- .4 Apparatus required to conduct Marshall Immersion Test.

3 Execution

3.01 PREPARATION

- .1 Prepare at least 8 specimens for each test [with hand-operated hammer], in accordance with LS-283, except where specified otherwise.

3.02 TEST PROCEDURE

- .1 Do Marshall testing to LS-283.

- .2 Weigh each specimen in air and in water. Weigh in water as rapidly as possible to minimize absorption.
- .3 Calculate specific gravity of each specimen as follows:
 - .1 Specific Gravity = $A / A - B$
 - .2 Where A = weight of specimen in air in grams
 - .3 B = weight of specimen in water in grams
- .4 Sort each set of 8 specimens into 2 groups of 4 specimens each so that average specific gravity of specimens in group 1 is essentially same as that of group 2.
- .5 Test group 1 specimens for Marshall stability. Calculate S1 = Marshall stability of group 1 (average).
- .6 Immerse group 2 specimens in water for 24 hours at 60 degrees C, then test immediately for Marshall stability. Calculate S2 = Marshall stability of group 2 (average).

3.03 CLOSEOUT ACTIVITIES

- .1 Report test results to consultant.
- .2 Report numerical index of retained stability as resistance of asphaltic paving mixtures to detrimental effect of water, expressed as percentage of original stability retained after immersion period.
- .3 Calculate index as follows:
 - .1 Index of Retained Stability = $S2 / S1 \times 100$.

END OF SECTION

Part 1 General

1.1 MEASUREMENT PROCEDURES

- .1 Asphalt tack coat will be measured in square metres at 15 degrees C of undiluted emulsified asphalt actually applied.
 - .1 Volume to be corrected to the volume at 15 degrees C to ASTM D1250 for cutback asphalt, and ASTM D633 for tar, and Table IV-3 of the Asphalt Institute's Manual MS-6 for emulsified asphalt.
 - .2 Water added to emulsified asphalt will not be measured for payment.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for asphalt tack coat and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit two - 4 L samples of asphalt tack coat material proposed for use in new, clean, airtight, sealed, wide plastic lined cans to Contract Administrator, at least 2 weeks prior to beginning Work.
 - .2 Sample asphalt tack coat material to: ASTM D140.
 - .3 Provide access on tank truck for contract Administrator to sample asphalt material to be incorporated into Work to ASTM D140.

1.3 QUALITY ASSURANCE

- .1 Upon request Contract Administrator, submit manufacturer's test data and certification that asphalt prime material meets requirements of this Section.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect asphalt tack coats from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Deliver, store and handle materials in accordance with ASTM D140.
- .5 Provide, maintain and restore asphalt storage area.

Part 2 Products

2.1 MATERIALS

- .1 Anionic emulsified asphalt: to CAN/CGSB-16.2, grade: SS-1, SS-1h.
- .2 Cut-back asphalt; to AASHTO M081-92-UL, grade RC-70 or RC-250.
- .3 Water: clean, potable, free from foreign matter.

2.2 EQUIPMENT

- .1 Equipment required for Work of this Section to be in satisfactory working condition and maintained for duration of Work.
- .2 Pressure distributor:
 - .1 Designed, equipped, maintained and operated so that asphalt material can be:
 - .1 Maintained at even temperature.
 - .2 Applied uniformly on variable widths of surface up to 5 m.
 - .3 Applied at readily determined and controlled rates from 0.2 to 5.4 L/m² with uniform pressure, and with allowable variation from any specified rate not exceeding 0.1 L/m.
 - .4 Distribute in uniform spray without atomization at temperature required.
 - .2 Equipped with meter, registering travel in metres per minute, visibly located to enable truck driver to maintain constant speed required for application at specified rate.
 - .3 Equipped with pump having flow metre graduated in units of 5 L or less per minute passing through nozzles and readily visible to operator. Pump power unit to be independent of truck power unit.
 - .4 Equipped with easily read, accurate and sensitive device which registers temperature of liquid in reservoir.
 - .1 Measure temperature to closest whole number.
 - .5 Equipped with accurate volume measuring device or calibrated tank.
 - .6 Equipped with nozzles of same make and dimensions, adjustable for fan width and orientation.
 - .7 Equipped with nozzle spray bar, with operational height adjustment in increments of 0.6 metres and capable of being raised or lowered.
 - .8 Cleaned if previously used with incompatible asphalt material.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt tack coat installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Contract Administrator.
- .2 Inform Contract Administrator of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 APPLICATION

- .1 Apply asphalt tack coat only on clean and dry surface.
- .2 Dilute asphalt emulsion with water at 1:1 ratio for application.
 - .1 Mix thoroughly by pumping or other method approved by Contract Administrator.
- .3 Apply asphalt tack coat evenly to pavement surface at rate as recommended by supplier but not to exceed 0.7 L/m²
- .4 Paint contact surfaces of curbs, gutters, headers, manholes and like structures with thin, uniform coat of asphalt tack coat material.
- .5 Apply asphalt tack coat only when air temperature greater than 10 degrees C and when rain is not forecast within 2 hours minimum of application.
- .6 Apply asphalt tack coat only on unfrozen surface.
- .7 Evenly distribute localized excessive deposits of tack coat by brooming as directed by Contractor Administrator.
- .8 Where traffic is to be maintained, treat no more than one half of width of surface in one application.
 - .1 Control traffic in accordance with Section 01 55 26 - TRAFFIC CONTROL.
- .9 Keep traffic off tacked areas until asphalt tack coat has set.
- .10 Re-tack contaminated or disturbed areas as directed by Contractor Administrator.
- .11 Permit asphalt tack coat to set before placing asphalt pavement.
- .12 Submit summary report within 7 days minimum of date of application and include information as follows:
 - .1 Total area tack coated.
 - .2 Quantity of tack coat used.
 - .3 Mean application rate.
 - .4 Actual product quantity used when using equipment on pressure distributors.
 - .5 Dipstick measurements or electronic printouts are acceptable.
- .13 Carry out measurements in presence of Contractor Administrator upon request.
- .14 Inspect tack coat application to ensure uniformity.
 - .1 Re-spray areas of insufficient or non-uniform tack coat coverage as directed by Contractor Administrator.

- .2 Ensure tack coating performed using hand held devices is consistent in appearance with adjacent areas of machine applied material.

END OF SECTION

Part 1 General

1.1 MEASUREMENT AND PAYMENT

- .1 Measure asphalt concrete paving in tonnes of asphalt concrete actually incorporated into Work.
- .2 Measure supply of asphalt cement in tonnes litres at 15 degrees C.
- .3 Measure supply of hydrated lime in tonnes.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for asphalt mixes and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit viscosity-temperature chart for asphalt cement to be supplied showing either Saybolt Furol viscosity in seconds or Kinematic Viscosity in centistokes, temperature range 105 to 175 degrees C 4 weeks prior to beginning Work.
- .3 Samples:
 - .1 Inform Contract Administrator of proposed source of aggregates and provide access for sampling 4 weeks prior to beginning Work.
 - .2 Submit samples of following materials proposed for use 4 weeks prior to beginning Work.
 - .1 One 5 L container of asphalt cement.
 - .2 1 kg of hydrated lime.
- .4 Test and Evaluation Reports:
- .5 Certificates:
 - .1 Certification to be marked on pipe.
- .6 Test and Evaluation Reports:
 - .1 Submit manufacturer's test data and certification that asphalt cement meets specification requirements.
 - .2 Submit manufacturer's test data and certification that hydrated lime meets specified requirements.
 - .3 Submit asphalt concrete mix design and trial mix test results to Contract Administrator for review at least 4 weeks prior to beginning Work.
 - .4 Submit printed record of mix temperatures at end of each week.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

- .2 Deliver and stockpile aggregates in accordance with Section 31 05 16 - Aggregate Materials and erosion and sedimentation control plan. Stockpile minimum 50 % of total amount of aggregate required before beginning asphalt mixing operation.
- .3 When necessary to blend aggregates from one or more sources to produce required gradation, do not blend in stockpiles.
- .4 Stockpile fine aggregate separately from coarse aggregate, although separate stockpiles for more than two mix components are permitted.
- .5 Provide approved storage, heating tanks and pumping facilities for asphalt cement.
- .6 Submit to Contract Administrator copies of freight and waybills for asphalt cement as shipments are received.
 - .1 Contract Administrator reserves right to check weights as material is received.
- .7 Stockpile crushed RAP separately in accordance with Section 31 05 16 - Aggregate Materials where directed by Contract Administrator.
- .8 Protect and cover stockpiles of crushed RAP from rain to approval of Contract Administrator in accordance with erosion and sedimentation control plan.

Part 2 Products

2.1 MATERIALS

- .1 Performance graded asphalt cement: to AASHTO M320, grade PG58-28 when tested to AASHTO R29.
- .2 RAP:
 - .1 Crushed and screened to ensure 100% of RAP material passes 50 mm screen before mixing.
- .3 Aggregates: in accordance with Section 31 05 16 - Aggregate Materials General and requirements as follows:
 - .1 Crushed stone or gravel.
 - .2 Gradations: within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.
 - .3 Table:

Sieve Designation	% Passing		
	Lower Course	Surface Course	Sheet Asphalt
200 mm	-	-	-
75 mm	-	-	-
50 mm	-	-	-
38.1 mm	-	-	-
25 mm	100	-	-
19 mm	-	-	-
12.5 mm	70-85	100	-

9.5 mm	-	-	100
4.75 mm	40-65	55-75	85-100
2.00 mm	30-50	35-55	80-95
0.425 mm	15-30	15-30	40-70
0.180 mm	5-20	5-20	10-35
0.075 mm	3-8	3-8	4-14

- .4 Coarse aggregate: aggregate retained on 4.75 mm sieve and fine aggregate is aggregate passing 4.75 mm sieve when tested to ASTM C136.
- .5 When dryer drum plant or plant without hot screening is used, process fine aggregate through 4.75 mm sieve and stockpile separately from coarse aggregate.
- .6 Separate stockpiles for coarse and fine aggregates not required for sheet asphalt.
- .7 Do not use aggregates having known polishing characteristics in mixes for surface courses.
- .8 Sand equivalent: ASTM D2419. Min: 50.
- .9 Magnesium Sulphate soundness: to ASTM C88. Max % loss by mass:
 - .1 Coarse aggregate surface course: 12 %.
 - .2 Coarse aggregate lower course: 12%.
 - .3 Fine aggregate, surface course: 16 %.
 - .4 Fine aggregate, lower course: 16 %.
- .10 Los Angeles degradation: Grading B, to ASTM C131. Max % loss by mass:
 - .1 Coarse aggregate, surface course: 25 %.
 - .2 Coarse aggregate, lower course: 35 %.
- .11 Absorption: to ASTM C127. Max % by mass:
 - .1 Coarse aggregate, surface course: 1.75 %.
 - .2 Coarse aggregate, lower course: 2.00 %.
- .12 Loss by washing: to ASTM C117. Max % passing 0.075 mm sieve:
 - .1 Coarse aggregate, surface course: 1.5 %.
 - .2 Coarse aggregate, lower course: 2.0 %.
- .13 Lightweight particles: to ASTM C123. Max % by mass less than 1.95 relative density:
 - .1 Surface course: 1.5 %.
 - .2 Lower course: 3.0 %.
- .14 Flat and elongated particles: to ASTM D4791, (with length to thickness ratio greater than 5): Max % by mass:
 - .1 Coarse aggregate, surface course: 15 %.
 - .2 Coarse aggregate, lower course: 15 %.
- .15 Crushed fragments: at least 60 % of particles by mass within each of following sieve designation ranges, to have 1 minimum freshly fractured face. Material to be divided into ranges, using methods of ASTM C136.

Passing		Retained on
25 mm	to	12.5 mm
12.5 mm	to	_____ mm

- .16 Regardless of compliance with specified physical requirements, fine aggregates may be accepted or rejected on basis of past field performance.
- .4 Mineral filler:
 - .1 Ensure finely ground particles of limestone, hydrated lime, Portland cement or non-plastic mineral matter approved by Contract Administrator are thoroughly dry and free from lumps.
 - .2 Add mineral filler when necessary to meet job mix aggregate gradation or as directed by Contract Administrator to improve mix properties.
 - .3 Ensure mineral filler is dry and free flowing when added to aggregate.
- .5 Anti-stripping agent: hydrated lime to ASTM C207 type N.
 - .1 Add lime at rate of approximately 2-3 % of dry weight of aggregate.
- .6 Water: to approval of Contract Administrator.

2.2 EQUIPMENT

- .1 Pavers: mechanical grade controlled self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown indicated.
- .2 Rollers: sufficient number of type and weight to obtain specified density of compacted mix.
- .3 Vibratory rollers:
 - .1 Drum diameter: 1200mm minimum.
 - .2 Amplitude of vibration (machine setting): 0.5 mm maximum for lifts less than 40 mm thick.
- .4 Haul trucks: sufficient number and of adequate size, speed and condition to ensure orderly and continuous operation and as follows:
 - .1 Boxes with tight metal bottoms.
 - .2 Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.
 - .3 In cool weather or for long hauls, insulate entire contact area of each truck box.
 - .4 Use only trucks which can be weighed in single operation on scales supplied.
- .5 Hand tools:
 - .1 Lutes or rakes with covered teeth for spreading and finishing operations.

- .2 Tamping irons having mass 12 kg minimum and bearing area not exceeding 310 cm² for compacting material along curbs, gutters and other structures inaccessible to roller. Mechanical compaction equipment, when approved by Contract Administrator, may be used instead of tamping irons.
- .3 Straight edges, 4.5 m in length, to test finished surface.
- .6 Plant testing facility: provide laboratory space at plant site for exclusive use of Contract Administrator, for performing tests, keeping records and making reports.

2.3 MIX DESIGN

- .1 Mix design to be provided approved in writing by Contract Administrator.
- .2 Mix design to be developed by testing laboratory approved in writing by Contract Administrator.
- .3 Mix to contain maximum 50% by mass of RAP. Contract Administrator may approve higher proportion of RAP if Contractor demonstrates ability to produce mix meeting requirements of specification.
- .4 Design of mix: by Marshall method to requirements below.
 - .1 Compaction blows on each face of test specimens: 50.
 - .2 Mix physical requirements:

Property	Airfield Pavements	Roads	Sheet Asphalt
Marshall Stability at 60 degrees C kN min	7.0	5.5 surface course/4.5 lower course	3.0
Flow Value mm	2-4	2-4	2-5
Air Voids in Mixture, %	3-5	3-5 surface course/2-6 lower course	3-5
Voids in Mineral Aggregate, % min	15 surface course/13 lower course	15 surface course/13 lower course	16
Index of Retained Stability % minimum	75	75	75

- .3 Measure physical requirements as follows:
 - .1 Marshall load and flow value: to AASHTO T245.
 - .2 Compute void properties on basis of bulk specific gravity of aggregate to ASTM C127 and ASTM C128. Make allowance for volume of asphalt absorbed into pores of aggregate.
 - .3 Air voids: to ASTM D3203.
 - .4 Voids in mineral aggregates: to AI MS2.
 - .5 Index of Retained Stability: measure in accordance with Section 32 12 10 - Marshall Immersion Test for Bitumen.
- .4 Do not change job-mix without prior approval of Contract Administrator. When change in material source proposed, new job-mix formula will be reviewed by Contract Administrator.
- .5 Return plant dust collected during processing to mix in quantities acceptable to Contract Administrator.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt paving in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Contract Administrator.
 - .2 Inform Contract Administrator of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 PLANT AND MIXING REQUIREMENTS

- .1 Batch and continuous mixing plants:
 - .1 To ASTM D995.
 - .2 Feed aggregates from individual stockpiles through separate bins to cold elevator feeders.
 - .1 Do not load frozen materials into bins.
 - .3 Feed cold aggregates to plant in proportions to ensure continuous operations.
 - .4 Calibrate bin gate openings and conveyor speeds to ensure mix proportions are achieved.
 - .5 Before mixing, dry aggregates to moisture content not greater than 1 % by mass or to lesser moisture content if required to meet mix design requirements. Heat to temperature required to meet mixing temperature as directed by Contract Administrator after combining with RAP.
 - .6 Immediately after drying, screen aggregates into hot storage bins in sizes to permit recombining into gradation meeting job-mix requirements.
 - .7 Store hot screened aggregates in manner to minimize segregation and temperature loss.
 - .8 Heat asphalt cement and aggregate to mixing temperature directed by Contract Administrator. Do not heat asphalt cement above 160 degrees C maximum temperature indicated on temperature-viscosity chart.
 - .9 Make available current asphalt cement viscosity data at plant. With information relative to viscosity of asphalt being used, Contract Administrator to approve review temperature of completed mix at plant and at paver after considering hauling and placing conditions.
 - .10 Maintain temperature of materials within 5 degrees C of specified mix temperature during mixing.
 - .11 Mixing time:

- .1 In batch plants, both dry and wet mixing times as directed by Contract Administrator. Continue wet mixing as long as necessary to obtain thoroughly blended mix but not less than 30s or more than 75s.
 - .2 In continuous mixing plants, mixing time as directed by Contract Administrator but not less than 45s.
 - .3 Mixing time as directed by Contract Administrator.
- .12 Where RAP is to be incorporated into mix:
 - .1 Feed from separate cold feed bin specially designed to minimize consolidation of material.
 - .2 Ensure positive and accurate control of RAP cold feed by use of hydraulic motor or electric clutch and equip with anti rollback device to prevent material from sliding backward on feed belt.
 - .3 Combine RAP and new aggregates in proportions as directed by Contract Administrator specified. Dry mix thoroughly, until uniform temperature within plus or minus 5 degrees C of mix temperature, as directed by Contract Administrator, is achieved prior to adding new asphalt cement.
- .2 Dryer drum mixing plant:
 - .1 To ASTM D995.
 - .2 Load aggregates from individual stockpiles to separate cold feed bins. Do not load frozen materials into bins.
 - .3 Feed aggregates to burner end of dryer drum by means of multi-bin cold feed unit and blend to meet job-mix requirements by adjustments of variable speed feed belts and gates on each bin.
 - .4 Where RAP is to be incorporated into mix, dryer drum mixer is to be designed to prevent direct contact of RAP with burner flame or with exhaust gases hotter than 180 degrees C.
 - .5 Feed RAP from separate cold feed bin designed to minimize reconsolidation of material.
 - .6 Meter total flow of aggregate and RAP using electronic weigh belt system with indicator that can be monitored by plant operator and which is interlocked with asphalt pump to ensure proportions of aggregate prepare, RAP and asphalt entering mixer remain constant.
 - .7 Allow for easy calibration of weighing systems for aggregates and RAP without having material enter mixer.
 - .8 Calibrate bin gate openings and conveyor speeds to ensure mix proportions are achieved.
 - .1 Calibrate weigh bridge on charging conveyor by weighing amount of aggregate passing over weigh bridge in set amount of time.
 - .2 Difference between this value and amount shown by plant computer system to differ by not more than plus or minus 2 %.
 - .9 Make provision for conveniently sampling full flow of materials from cold feed.

- .10 Provide screens or other suitable devices to reject oversize particles or lumps of aggregate and RAP from cold feed prior to entering drum.
- .11 Provide system interlock stop on feed components if either asphalt or aggregate from bin stops flowing.
- .12 Accomplish heating and mixing of asphalt mix in approved parallel flow dryer-mixer in which aggregate enters drum at burner end and travels parallel to flame and exhaust gas stream.
 - .1 Control heating to prevent fracture of aggregate or excessive oxidation of asphalt.
 - .2 Equip system with automatic burner controls and provide for continuous temperature sensing of asphalt mixture at discharge, with printing recorder that can be monitored by plant operator.
 - .3 Submit printed record of mix temperatures at end of each week.
- .13 Ensure mixing period and temperature to produce uniform mixture in which particles are thoroughly coated, and moisture content of material as it leaves mixer is 2 % maximum.
- .3 Temporary storage of hot mix:
 - .1 Provide mix storage of sufficient capacity to permit continuous operation and designed to prevent segregation.
 - .2 Do not store asphalt mix in storage bins in excess of 3 hour.
- .4 While producing asphalt mix for this Project, do not produce mix for other users unless separate storage and pumping facilities are provided for materials supplied to this project.
- .5 Mixing tolerances:
 - .1 Permissible variation in aggregate gradation from job mix (percent of total mass).

4.75 mm sieve and larger	
2.00 mm sieve	
0.425 mm sieve	
0.180 mm sieve	
0.075 mm sieve	2.0
 - .2 Permissible variation of asphalt cement from job mix: 0.25%.
 - .3 Permissible variation of mix temperature at discharge from plant: 5 degrees C.
- .6 Addition of anti-stripping agent:
 - .1 Plant to be equipped with pug mill to thoroughly mix aggregates and lime prior to entering the plant.
 - .2 Plant to be equipped with suitable conveyor systems capable of supplying aggregates and lime at constant rate.
 - .3 Plant and equipment used for addition of lime to be equipped with covers to control loss of lime.
 - .4 Plant to be equipped to control rate of lime incorporation to within 1/4%.
 - .5 Add water to aggregate prior to entering pug mill.

- .6 Add water to lime sufficiently in advance to permit time to slake prior to entering pug mill.

3.3 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 Reshape granular roadbed and asphalt pavement in accordance with Section 32 11 17 - Reshaping Granular Roadbed and Section 32 01 16.13 - Reshaping Asphalt Pavement.
- .3 When paving over existing asphalt surface, clean pavement surface in accordance with Section 32 01 11.01 - Pavement Cleaning and Marking Removal.
 - .1 When levelling course is not required, patch and correct depressions and other irregularities to approval of Contract Administrator before beginning paving operations.
- .4 Apply tack coat in accordance with Section 32 12 13.16 - Asphalt Tack Coats prior to paving.
- .5 Prior to laying mix, clean surfaces of loose and foreign material.

3.4 TRANSPORTATION OF MIX

- .1 Transport mix to job site in vehicles cleaned of foreign material.
- .2 Paint or spray truck beds with limewater, soap or detergent solution, or non petroleum based commercial product, at least daily or as required.
 - .1 Raise truck bed and thoroughly drain, and ensure no excess solution remains in truck bed.
- .3 Schedule delivery of material for placing in daylight, unless Contract Administrator approves artificial light for night placing.
- .4 Deposit mix from surge or storage silo to trucks in multiple drops to reduce segregation.
 - .1 Do not dribble mix into trucks.
- .5 Deliver material to paver at uniform rate and in an amount within capacity of paving and compacting equipment.

- .6 Deliver loads continuously in covered vehicles and immediately spread and compact.
 - .1 Deliver and place mixes at temperature within range as directed by Contract Administrator, but not less than 135 degrees C.

3.5 TEST STRIP

- .1 Construct and test test strip to approval of Contract Administrator.
- .2 For airfield pavement, construct test strip in non-critical area to resolve anticipated problems with equipment, mix behaviour or compaction, prior to starting paving operation.
- .3 Construct test strip with at least 500 tonnes of mix, and involving more than one lane, so that joint finishing techniques can be established.
- .4 During construction of test strip, Contract Administrator will establish optimum rolling pattern by taking nuclear densimeter readings and observations to:
 - .1 Determine sequence and number of passes.
 - .2 Determine correct operating characteristics of vibratory rollers.
 - .3 Determine maximum density of asphalt mix.
 - .4 Ensure smooth surface finish.
 - .5 Establish actual density achieved by coring in order to determine if additional or other rolling equipment is required to achieve density of not less than 98 % of density obtained with Marshall specimens prepared from samples of mix being used.

3.6 PLACING

- .1 Obtain Contract Administrator approval of base and existing surface and tack coat prior to placing asphalt.
- .2 Place asphalt concrete to thicknesses, grades and lines as indicated.
- .3 Placing conditions:
 - .1 Place asphalt mixtures only when air temperature is 5 degrees C minimum.
 - .2 When temperature of surface on which material is to be placed falls below 10 degrees C, provide extra rollers as necessary to obtain required compaction before cooling.
 - .3 Do not place hot-mix asphalt when pools of standing water exist on surface to be paved, during rain, or when surface is damp.
- .4 Place Hot Max Asphalt in compacted lifts of thickness as indicated.
 - .1 Levelling courses to thicknesses required but not exceeding 50 mm.
 - .2 Lower course in 1 layer of 50 mm SP19.0 CAT-D PG 58-28.
 - .3 Surface course in 1 layer of maximum 50 mm SP12.5 CAT-D PG 64-28XJ.
- .5 Where possible do tapering and levelling where required in lower lifts. Overlap joints by not less than 300 mm.

- .6 Place individual strips no longer than 500 m.
- .7 Spread and strike off mixture with self propelled mechanical finisher.
 - .1 Construct longitudinal joints and edges true to line markings.
 - .1 Contract Administrator to establish lines for paver to follow parallel to centerline of proposed pavement. Position and operate paver to follow established line closely.
 - .2 When using pavers in echelon, have first paver follow marks or lines, and second paver follow edge of material placed by first paver.
 - .1 Work pavers as close together as possible and in no case permit them to be more than 30 m apart.
 - .3 Maintain constant head of mix in auger chamber of paver during placing.
 - .4 If segregation occurs, immediately suspend spreading operation until cause is determined and corrected.
 - .5 Correct irregularities in alignment left by paver by trimming directly behind machine.
 - .6 Correct irregularities in surface of pavement course directly behind paver.
 - .1 Remove excess material forming high spots using shovel or lute.
 - .7 Do not throw surplus material on freshly screeded surfaces.
- .8 When hand spreading is used:
 - .1 Use approved wood or steel forms, rigidly supported to assure correct grade and cross section.
 - .1 Use measuring blocks and intermediate strips to aid in obtaining required cross-section.
 - .2 Distribute material uniformly without broad casting material.
 - .3 During spreading operation, thoroughly loosen and uniformly distribute material by lutes or covered rakes.
 - .1 Reject material that has formed into lumps and does not break down readily.
 - .4 After placing and before rolling, check surface with templates and straightedges and correct irregularities.
 - .5 Provide heating equipment to keep hand tools free from asphalt.
 - .1 Control temperature to avoid burning material.
 - .2 Do not use tools at higher temperature than temperature of mix being placed.

3.7 COMPACTING

- .1 Roll asphalt continuously using established rolling pattern for test strip and to density of not less than 100% of maximum density determined for test strip.
- .2 Do not change rolling pattern unless mix changes or lift thickness changes.
 - .1 Change rolling pattern only as directed by Contract Administrator.
- .3 Roll asphalt continuously to density not less than 98 % blow Marshall density to AASHTO T245.

.4 General:

- .1 Provide at least 2 rollers and as many additional rollers as necessary to achieve specified pavement density. When more than 2 rollers are required, 1 roller must be pneumatic tired type.
- .2 Start rolling operations as soon as placed mix can bear weight of roller without excess displacement of material or cracking of surface.
- .3 Operate roller slowly initially to avoid displacement of material. Do not exceed 5 km/h for breakdown and intermediate rolling for static steel-wheeled and pneumatic tired rollers. Do not exceed 9 km/h for finish rolling.
- .4 Use static compaction for levelling coarse less than 25 mm thick.
- .5 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of 25 impacts per metre of travel. For lifts less than 50 mm thick, impact spacing not to exceed compacted lift thickness.
- .6 Overlap successive passes of roller by minimum of 200 mm and vary pass lengths.
- .7 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.
- .8 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.
- .9 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.
- .10 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side.
 - .1 Ensure that all points across width of pavement receive essentially equal numbers of passes of compactors.
- .11 When paving in echelon, leave unrolled 50 to 75 mm of edge which second paver is following and roll when joint between lanes is rolled.
- .12 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.

.5 Breakdown rolling:

- .1 Begin breakdown rolling with static steel wheeled roller and vibratory roller immediately following rolling of transverse and longitudinal joint and edges.
- .2 Operate rollers as close to paver as necessary to obtain adequate density without causing undue displacement.
- .3 Operate breakdown roller with drive roll or wheel nearest finishing machine. When working on steep slopes or super-elevated sections use operation approved by Contract Administrator.
- .4 Use only experienced roller operators.

.6 Intermediate rolling:

- .1 Use pneumatic-tired, steel wheel or vibratory rollers and follow breakdown rolling as closely as possible and while paving mix temperature allows maximum density from this operation.
- .2 Rolling to be continuous after initial rolling until mix placed has been thoroughly compacted.
- .7 Finish rolling:
 - .1 Accomplish finish rolling with two-axle or three-axle tandem steel wheeled rollers while material is still warm enough for removal of roller marks.
 - .1 If necessary to obtain desired surface finish, use pneumatic-tired rollers as directed by Contract Administrator.
 - .2 Conduct rolling operations in close sequence.
- .8 Dust entire area of sheet asphalt pavements with hydrated lime immediately after rolling to eliminate tendency to pick-up under traffic.

3.8 JOINTS

- .1 General:
 - .1 Remove surplus material from surface of previously laid strip.
 - .1 Do not deposit on surface of freshly laid strip.
 - .2 Construct joints between asphalt concrete pavement and Portland cement concrete pavement as indicated.
 - .3 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.
- .2 Transverse joints:
 - .1 Offset transverse joint in succeeding lifts by at least 600 mm.
 - .2 Cut back to full depth vertical face and tack face with thin coat of hot asphalt prior to continuing paving.
 - .3 Compact transverse joints to provide smooth riding surface. Use methods to prevent rounding of compacted surface at joints.
- .3 Longitudinal joints:
 - .1 Offset longitudinal joints in succeeding lifts by at least 150 mm.
 - .2 Cold joint is defined as joint where asphalt mix is placed, compacted and left to cool below 100 degrees C prior to paving of adjacent lane.
 - .1 For airfield runway paving, avoid cold joint construction in mid 30 m of runway.
 - .2 If cold joint can not be avoided, cut back by saw cutting previously laid lane, by at least 150 mm, to full depth vertical face, and tack face with thin coat of hot asphalt of adjacent lane.
 - .3 Overlap previously laid strip with spreader by 25 to 50 mm.
 - .4 Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with lute or rake.
 - .5 Roll longitudinal joints directly behind paving operation.

- .6 When rolling with static or vibratory rollers, have most of drum width ride on newly placed lane with remaining 150 mm extending onto previously placed and compacted lane.
- .4 Construct feather joints so that thinner portion of joint contains fine graded material obtained by changed mix design or by raking out coarse aggregate in mix.
 - .1 Place and compact joint to ensure joint is smooth and without visible breaks in grade.
 - .2 Locate feather joints as indicated.
- .5 Construct butt joints as indicated.

3.9 FINISH TOLERANCES

- .1 Finished asphalt surface to be within 5 mm of design elevation but not uniformly high or low.
- .2 Finished asphalt surface not to have irregularities exceeding 5 mm when checked with 4.5 m straight edge placed in any direction.

3.10 DEFECTIVE WORK

- .1 Correct irregularities which develop before completion of rolling by loosening surface mix and removing or adding material as required.
 - .1 If irregularities or defects remain after final compaction, remove surface course promptly and lay new material to form true and even surface and compact immediately to specified density.
- .2 Repair areas showing checking, rippling, or segregation.
- .3 Adjust roller operation and screed settings on paver to prevent further defects such as rippling and checking of pavement.

SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes concrete paving, sidewalks, curbs and gutters including:
 - .1 Forming.
 - .2 Steel reinforcement.
 - .3 Subgrade preparation and compaction.
 - .4 Sand and granular cushion.
 - .5 Concrete placement.
 - .6 Concrete finishing.
 - .7 Pavement markings.
 - .8 Accessories including joint filler and curing compound.
- .2 Related Requirements:
 - .1 Section 03 20 00 – Concrete Reinforcing
 - .2 Section 03 30 00 – Cast-In-Place Concrete
 - .3 Section 31 23 00 – Excavation and Fill

1.2 REFERENCES

- .1 Reference Standards:
 - .1 American Association of State and Highway Transportation Officials (AASHTO):
 - .1 AASHTO M336M/M336-20, 2020, Standard Specification for Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement.
 - .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A496/A496M-07, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement. (Withdrawn 2013).
 - .2 ASTM A497/A497M-07, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete. (Withdrawn 2013).
 - .3 ASTM C42/C42M-20, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - .4 ASTM C295/C295M-19, Standard Guide for Petrographic Examination of Aggregates for Concrete.
 - .5 ASTM C309-19, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .6 ASTM D1751-23, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .7 ASTM D4797-17(2022), Standard Test Methods for Gravimetric Analysis of White and Yellow Thermoplastic Pavement Marking
 - .8 ASTM E1360-05(2019), Standard Practice for Specifying Color by Using the Optical Society of America Uniform Color Scales System.

- .3 Canada Green Building Council (CaGBC):
 - .1 LEED Canada V4 – Building Design and Construction (BD+C).
- .4 Canadian Standards Association (CSA Group):
 - .1 CSA-A23.1-19/A23.2-19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA-A3000-23, Cementitious Materials Compendium.
 - .3 CSA G30.18:21, Carbon Steel Bars for Concrete Reinforcement.
 - .4 CAN3-A266.1-M78, Air Entraining Admixtures for Concrete (Withdrawn).
- .5 The Master Painters Institute (MPI):
 - .1 MPI Architectural Painting Specification Manual (ASM).

1.3 ADMINSTRATIVE REQUIREMENTS

- .1 Pre-Installation Meeting: Convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with Contractor, Consultant, installer, manufacturer's representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Coordination: Coordinate with York Region requirements for standard sidewalks, curbs, and gutters.

1.4 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit design mixes for each concrete pavement mixture including alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances require adjustments.
 - .2 Provide electronic copy of WHMIS SDS - Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .2 Certificates: Submit to Consultant, manufacturer's test data and certification that the following material meets requirements of this section prior to starting concrete work:
 - .1 Cementitious materials.
 - .2 Supplementary Cementing Material.
 - .3 Steel reinforcement and reinforcement accessories.
 - .4 Admixtures.
 - .5 Joint Sealants.
 - .6 Curing Materials.

.7 Joint Filler.

- .3 LEED Submittals: provide LEED submittals in accordance with Section 01 61 01 – LEED Product Requirements.

1.5 QUALITY ASSURANCE

- .1 Use ready mixed concrete producers in accordance with CSA A23.1, CSA A23.2 and CSA A3000 requirements for production facilities and equipment, and which is a member of the Ready Mixed Concrete Association of Ontario.
- .2 Installer Qualifications: Company or person specializing in Portland cement concrete paving with five years documented experience who has completed systems similar in materials, design and extent to that indicated for Project and with a record of successful performance.
- .3 Testing:
- .1 Compaction testing of base, and testing of concrete, will be performed in accordance with Sections 03 30 00 and 31 23 10 respectively.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packaging Waste Management
- .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management.

1.7 SITE CONDITIONS

- .1 Ambient Conditions:
- .1 Use winter concreting methods in accordance with CSA A23.1 section 7.4.2.5 when the mean daily temperature falls below 5°C. Concrete shall not be considered a seasonal deficiency and shall be installed with heating and hoarding as part of the Contract.

Part 2 Products

2.1 FORMS

- .1 Form Materials: Plywood, metal, metal framed plywood, or other acceptable panel type materials to provide full depth, continuous, straight, smooth exposed surfaces.
- .2 Use flexible or curved forms for curves with a radius of 30 m or less.
- .3 Form Release Agent: Commercially formulated form release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- .1 Deformed Steel Welded Wire Reinforcement: Meeting the requirements of ASTM A497/A497M, flat sheet.
- .2 Welded Wire Fabric: to AASHTO M 336M/336.
- .3 Tie Bar for Construction Joints: plain steel bars to CSA G30.18.

- .4 Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place, fabricated from steel wire, plastic, or precast concrete of greater compressive strength than concrete; equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 CONCRETE MATERIALS

- .1 Cement Type: Normal Portland Cement in accordance with CSA A3000, Type GU.
- .2 Water: Meeting requirements of CSA A23.1/A23.2.
- .3 Aggregates For Concrete: to CSA A23.1 and as follows:
 - .1 Normal Density Fine Aggregate: Nominal maximum aggregate size in accordance with CSA A23.2-1A, uniformly graded to maintain Workability and control water bleed out, as indicated on Drawings.
 - .2 Normal Density Coarse Aggregate: Aggregate selected from Group I or Group II Grading Classifications, to suit design mix, in accordance with CSA A23.2-13A, nominal maximum aggregate sizes and applications as indicated on Drawings.
 - .3 Ironstone content of aggregates in exposed interior or exterior concrete subject to intermittent or continuous wetting shall not exceed the following, when tested Meeting requirements of ASTM C295/C295M:
 - .1 Coarse Aggregate: maximum 1%.
 - .2 Fine Aggregate, Retained on 2.5 mm Sieve: maximum 1.5%.
- .4 Air Entraining Admixtures for Concrete: to CAN3-A266.1.

2.4 CONCRETE MIXES

- .1 Design ready-mix concrete conforming to CSA A23.1/A23.2, and as indicated in Structural Specifications.
 - .1 Compressive Strength: Minimum 32 MPa after 28 days.
 - .2 Class of Exposure: C-2.
 - .3 Slump: 30 mm maximum.
 - .4 Air Content Category: 1.
 - .5 Maximum Water to Cement Ratio: 0.45.
 - .6 Aggregate Size: 20 mm Maximum.
 - .7 Concrete Admixtures:
 - .1 Air Entrained.
 - .2 Fly Ash or Pozzolan, limited to 25% maximum.
- .2 Temperature of concrete mix at placing shall be no less than 10°C and no greater than 27°C. Provide mix toward lower end of temperature range during hot weather and toward higher end of temperature range during cold weather, in accordance with CSA A23.1.
- .3 Use of admixtures, other than air-entraining admixtures, are not permitted without prior written approval of Consultant.

- .4 Site mix concrete is permitted for placements not exceeding 1 m³ and for core filling of non-load bearing masonry and bond beams.
- .5 Add an air entraining admixture to all concrete exposed to the weather or in contact with the ground, producing entrained air in accordance with CSA A23.1, Table Ten; air entraining admixture is not required for interior slabs on grade.

2.5 PAVEMENT MARKINGS

- .1 Paint: Latex traffic paint meeting requirements of ASTM D4797, colour to ASTM E1360 yellow, white and blue in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing MPI #97, Latex Traffic Marking Paint. Refer to Section 09 91 00, Exterior System EXT 2.1A.

2.6 ACCESSORIES

- .1 Poured Joint Filler: Asphalt elastic compound.
- .2 Preformed Joint Filler: asphalt impregnated type to ASTM D1751.
- .3 Curing Compound: to ASTM C309, Type Two white pigmented, Class B resin-based, liquid membrane-forming type.

Part 3 Execution

3.1 PROTECTION

- .1 Protection of In-Place Conditions:
 - .1 Prevent damage to buildings and adjacent property.

3.2 SUBGRADE PREPARATION

- .1 Construct subgrade to elevation and grade indicated.
- .2 Compact subgrade to 95% Standard Proctor Maximum Dry Density.
- .3 Excavate soft spots and fill with 50 mm crushed gravel compacted to 95% Standard Proctor Maximum Dry Density.

3.3 SAND AND GRANULAR CUSHION

- .1 Place 50 mm thick sand layer and crushed gravel layer on prepared subgrade, and compact to 95% Standard Proctor Dry Density.
- .2 Place 50 mm thick sand cushion layer for precast sidewalk blocks and compact to 95% Standard Proctor Dry Density.

3.4 REINFORCEMENT

- .1 Install steel reinforcement in accordance with CSA A23.1 for fabricating, placing, and supporting reinforcement.
- .2 Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- .3 Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement; maintain minimum cover to reinforcement.

- .4 Install welded wire reinforcement in longest practical lengths; lap adjoining pieces at least one full mesh and lace splices with wire; offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 CONCRETE PLACEMENT

- .1 Inspect and complete formwork installation, steel reinforcement, and items being embedded or cast in concrete before placing concrete; notify other trades to permit installation of their work.
- .2 Remove snow, ice, or frost from sub-base surface and reinforcement before placing concrete; do not place concrete on frozen surfaces.
- .3 Moisten sub-base to provide a uniform dampened condition at time concrete is placed; do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- .4 Place concrete in accordance with recommendations in CSA A23.1 for measuring, mixing, transporting, and placing concrete.
- .5 Do not add water to concrete during delivery, at project site, or during placement.
- .6 Consolidate concrete with mechanical vibrating equipment.
- .7 Do not add water to fresh concrete after testing.
- .8 Deposit and spread concrete in a continuous operation between transverse joints; do not push or drag concrete into place or use vibrators to move concrete into place.
- .9 Place concrete in two operations as follows, hooking and raising reinforcing mats will not be considered as an acceptable method for setting reinforcing:
 - .1 Strike off initial pour for entire width of placement and to the required depth below finish surface.
 - .2 Lay welded wire fabric or fabricated bar mats immediately in final position.
 - .3 Place top layer of concrete, strike off, and screed.
 - .4 Remove and replace concrete that has been placed for a maximum of 15 minutes without being covered by top layer, or use bonding agent if acceptable by Consultant.
- .10 Screed pavement surfaces with a straightedge and strike off.
- .11 Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface; do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- .12 Submit revised mix design and laboratory test results that meet or exceed requirements when automatic machine placement is used for curb and gutter placement; produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete; remove and replace with formed concrete where results are not acceptable to the Consultant.
- .13 Submit revised mix design and laboratory test results that meet or exceed requirements when automatic machine placement is used for pavement; produce pavement to required thickness, lines, grades, finish, and jointing as required for

formed pavement; compact sub-base and prepare sub-grade of sufficient width to prevent displacement of paver machine during operations.

3.6 JOINTS

- .1 Construct joints true to line with faces perpendicular to surface of paving. Construct transverse joints at right angles to paving centreline and longitudinal joints, unless otherwise indicated.
- .2 Expansion Joints at Building Face or Other Vertical Abutments: place 15 mm wide preformed joint filler 5 mm below finished surface for full width and depth of concrete.
- .3 Contraction Joints for Concrete Paving, Curbs and Gutters: construct 35 mm deep by 5 mm wide joints 3 m on centre and where shown on drawings by means of marking tool or other approved method.
- .4 Align curb, gutter, and sidewalk joints.

3.7 FINISHING

- .1 Do not add water to concrete surfaces during finishing operations.
- .2 Begin second floating operation when bleed water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations, and as follows:
 - .1 Float surface with power driven floats, or by hand floating if area is small or inaccessible to power units
 - .2 Finish surfaces to true planes.
 - .3 Cut down high spots and fill low spots.
 - .4 Re-float surface immediately to uniform granular texture.
- .3 Apply following finishes as indicated on Drawings:
 - .1 Medium-to-Fine Textured Broom Finish: Draw a soft bristle broom across float finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CURING AND PROTECTION

- .1 Cure freshly deposited concrete in accordance with CSA A23.1.
- .2 Apply curing compound immediately after finishing, in accordance with manufacturer's instructions. Promptly re-coat areas subjected to heavy rainfall within three hours after initial application.
- .3 When ambient air temperature is at or below 5°C, or when there is a probability of it falling to 5°C within 24 hours of placing, provide cold weather protection until a period of seven days of concrete temperature at or above 10°C has been attained. Protection shall meet requirements of CSA A23.1.
- .4 Estimate rate of surface moisture evaporation in accordance with CSA A23.1 and provide protection from drying as required.
- .5 Keep vehicular traffic off paved areas until paving has cured sufficiently to support such loads.

3.9 TOLERANCES

- .1 Place concrete in accordance with tolerances listed in CSA A23.1 and as follows:
 - .1 Elevation: 6 mm.
 - .2 Thickness: +10 mm, -6 mm.
 - .3 Surface: Gap below 3 m long, unlevelled straightedge not to exceed 6 mm.
 - .4 Lateral Alignment and Spacing of Tie Bars and Dowels: 25 mm.
 - .5 Vertical Alignment of Tie Bars and Dowels: 6 mm.
 - .6 Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 13 mm.
 - .7 Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 6 mm per 300 mm.
 - .8 Joint Spacing: 75 mm.
 - .9 Contraction Joint Depth: +6 mm, no minus.
 - .10 Joint Width: +3 mm, no minus.

3.10 PAVEMENT MARKINGS

- .1 Do not apply pavement marking paint until layout, colours, and placement have been verified with Consultant.
- .2 Allow concrete pavement to cure for a minimum of 28 days and be dry before starting pavement marking; delay application of pavement markings where slow curing conditions exist.
- .3 Sweep and clean surface to remove loose material and dust.
- .4 Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges to paint manufacturer's recommended wet film thickness.

3.11 FIELD QUALITY CONTROL

- .1 Testing Agency: Engage qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article in accordance with CSA A23.2.
 - .1 Testing Frequency:
 - .1 Obtain at least one composite sample for each 75 m³ or 450 m², or fraction thereof of each concrete mix placed each day.
 - .2 Conduct testing from at least five randomly selected batches or from each batch if fewer than five are used when frequency of testing will provide fewer than five compressive strength tests for each concrete mixture.
 - .2 Slump: Perform one test at point of placement for each composite sample, but a minimum of one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.

- .3 Air Content: Perform one test for each composite sample using pressure method, with a minimum of one test for each day's pour of each concrete mix.
- .4 Concrete Temperature: Perform one test hourly when air temperature is 4°C and below and when 27°C and above, and one test for each composite sample.
- .5 Compression Test Specimens: Cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
- .6 Compressive Strength Tests: Test One specimen at seven days and two specimens at 28 days, and one specimen at 56 days.
- .2 Non-Destructive Testing: Impact hammer, sonoscope, or other non-destructive device may be permitted by Consultant, but will not be used as sole basis for acceptance or rejection of concrete.
- .3 Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Consultant with costs being paid for by the Contractor.
- .4 Remove and replace concrete pavement where test results indicate that it does not meet specified requirements.
- .5 Additional testing and inspecting, at Contractor's expense, will be performed to determine acceptance of replaced or additional work with specified requirements.

3.12 REPAIRS

- .1 Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

3.13 PROTECTION

- .1 Protect surfaces of fresh concrete against damage by rain, dirt and dust, debris and traffic until sufficient strength attained to resist damage.
- .2 Protect concrete from damage:
 - .1 Exclude traffic from pavement for at least 14 days after placement.
 - .2 Maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur when construction traffic is permitted.
- .3 Maintain concrete pavement free of stains, discolouration, dirt, and other foreign material.
- .4 Sweep concrete pavement a maximum of two days before date scheduled for Substantial Performance.

END OF SECTION

1 General

1.01 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C 136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .2 ASTM C 117-04, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

1.02 MEASUREMENT AND PAYMENT

- .1 Measure granular base in cubic metres of material incorporated into Work and accepted by Consultant.
- .2 Measure granular topping in cubic metres of material incorporated into Work and accepted by Consultant.

1.03 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.04 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Store crushed stone as and where directed by Consultant.

2 Products

2.01 MATERIALS

- .1 Granular base in accordance with the following requirements:
 - .1 Crushed stone or gravel: hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
 - .2 Gradations: within limits specified when tested to ASTM C 136 and ASTM C 117]. Sieve sizes to CAN/CGSB-8.1 and CAN/CGSB-8.2.
 - .3 Table:

<u>Sieve Designation</u>	<u>% Passing</u>
19 mm	100
12.5 mm	70-100
4.75 mm	40-70
2.00 mm	23-50
0.425 mm	7-25
0.075 mm	3-8

- .4 Liquid limit: ASTM D 4318 maximum 25
- .5 Plasticity index: ASTM D 4318 maximum 6
- .2 Granular topping:
 - .1 Screenings: hard, durable, crushed stone particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
 - .2 Gradations: within limits specified when tested to ASTM C 136 and ASTM C 117.

<u>Sieve Designation</u>	<u>% Passing</u>
9.5 mm	100
4.75 mm	50-100
2.00 mm	30-65
0.425 mm	10-30
0.075 mm	5-10

3 Execution

3.01 SUBGRADE

- .1 Ensure subgrade preparation conforms to levels and compaction required, to allow for installation of granular base.

3.02 GRANULAR BASE

- .1 Granular sub-base material minimum thickness: 150 mm.
- .2 Place material in uniform layers not to exceed 150 mm compacted thickness.
 - .1 Compact layer to 98 % Standard Proctor Density.

3.03 GRANULAR TOPPING

- .1 Place granular topping to compacted thickness of 150 mm minimum.
- .2 Place material in uniform layers not to exceed 50 mm compacted thickness.
 - .1 Compact layer to 98 % Standard Proctor Density.

3.04 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 02 41 13 - Site Selective Demolition.
- .2 Final Cleaning: Upon completion, remove surplus materials, rubbish, tools and equipment in accordance with Section 01 77 00 - Closeout Procedures.

3.05 PROTECTION

- .1 Prevent damage to buildings, landscaping, curbs, sidewalks, trees, fences, roads and adjacent property.
- .1 Repair damages incurred.

END OF SECTION

Part 1 GENERAL

1.1 GENERAL

- .1 Comply with General Conditions, Supplementary General Conditions, General Requirements, Addenda thereto, specifications and drawings.

1.2 RELATED SECTIONS

- .1 Comply with following sections:
 - .1 Section 32 12 16 – Asphalt Pavement

1.3 REFERNECES

- .1 Comply with following, which are invoked and form part of this specification section, as modified by this section:
 - .1 OPSS 710 Construction Specification for Pavement Marking
 - .2 OPSS 1712 Material Specification for Organic Solvent Based Traffic Paint.
 - .3 MTO Manual of Uniform Traffic Control Devices.
 - .4 Metrolinx GO Design Requirements Manual

1.4 DEFINITIONS

- .1 Definitions of the referenced OPSS sections are invoked and apply to this section.

1.5 QUALITY ASSURANCE

- .1 Use only products from the MTO Designated Sources for Materials (DSM).
- .2 Paint applicator equipment to be an approved pressure-type distributor capable of applying paint in single, double and dashed lines.
- .3 Quality Assurance requirements of the referenced OPSS are invoked and apply to the Work of this section, except as noted in 1., (e)., (i). and (ii). herein.
- .4 OPSS 1712.09 Authority Purchase of Material by Purchase Order is not used.

1.6 SUBMITTALS

- .1 Submit paint manufacturer's material data sheets.
- .2 OPSS 710.04.01, and 710.05.03 through 710.06, and 710.06.02.02 and 710.06.02.03 are not used.

1.7 DELIVERY, STORAGE & HANDLING

- .1 Protect products from contamination and freezing.
- .2 Store securely in original containers with all proper labelling.

Part 2 PRODUCTS

2.1 MATERIALS

- .1 Paint: to OPSS 1712 and listed with MTO DSM.
- .2 Reflectorized glass beads are not required for parking lot pavement markings.
- .3 Pre-marking paint to be compatible with final marking paint listed above.
- .4 Purchase and supply traffic paint for this Contract. OPSS 1712.09 Authority Purchase of Material by Purchase Order is not used.

Part 3 EXECUTION

3.1 SURFACES PREPARATION

- .1 Examine surfaces prior to performing work.
- .2 Comply with OPSS 710.07.02, and pavement surface to be free from ponded water, frost, ice, dust, oil, grease and other foreign materials.
- .3 Commencement of work signifies the Contractor's acceptance of conditions.

3.2 APPLICATION

- .1 Methods and equipment used in surface preparation shall not result in dust or debris that could mar or cause damage to existing structures and vehicles parked within and adjacent to the Place of the Work.
- .2 Notwithstanding 3., (b)., (vi) below, do not carry out premarking or permanent paint application during environmental conditions where wind speed will result in paint particle drift that could mar or cause damage to existing structures and vehicles parked within and adjacent to site of the work.
- .3 At no change in the Contract Price, make good to the satisfaction of the direction of Consultant, damage to or claims against the Owner or third party property resulting from surface preparation and application of painted traffic lines and markings. At no change in the Contract Price, pay any claims for damage to the Owner or third party property resulting from surface preparation and application of painted traffic lines and markings.
- .4 Lay out pavement markings as shown on drawings.
- .5 Apply pavement markings in accordance with OPSS 710.07.09.01 and 710.07.09.02 for Organic Solvent Based Traffic Paint without reflectorizing glass beads.
- .6 Comply with 710.07.09.02. In addition to 710.07.02.02, unless otherwise approved by Consultant, apply paint only when air temperature is above 5°C, wind speed is less than 40 km/h and no rain is forecast within next 4 hours.
- .7 Apply one coat of traffic paint evenly at a rate that results in a dry film thickness of not less than 200 microns.
- .8 Symbols and letters to conform to dimensions indicated.
- .9 Paint lines to be of uniform colour and density with sharp edges.
- .10 Thoroughly clean distributor tank before refilling with paint of different colour.

3.3 TOLERANCE

- .1 Paint markings to be within plus or minus 12 mm of dimensions indicated.

3.4 PROTECTION OF COMPLETED WORK

- .1 Protect pavement markings until dry.

3.5 COLOURS AND DIMENSIONS

- .1 Pavement Marking Colour

Line Marking (Parking Structures Only)	
Location	Colour
Parking stalls, parking restricted areas and islands	Yellow
Directional dividing lines	White with reflectorizing glass beads
Lane lines, stop lines and arrows	White with reflectorizing glass beads
Stop Block	White with reflectorizing glass beads
Pedestrian crosswalk lines	White with reflectorizing glass beads

- .2 Vehicular Parking Diagram – Detail
.3 Line Marking – Row Parking Stalls
.4 Hatched Parking Area Configuration
.5 Line Marking for Islands

END OF SECTION

Part 1 GENERAL

1.1 GENERAL

- .1 Comply with General Conditions, Supplementary General Conditions, General Requirements, Addenda thereto, specifications and drawings.

1.2 RELATED SECTIONS

- .1 Comply with following sections:
 - .1 Section 32 12 16 – Asphalt Pavement

1.3 REFERNECES

- .1 Comply with following, which are invoked and form part of this specification section, as modified by this section:
 - .1 ASTM D-4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Tester.
 - .2 ASTM D-4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
 - .3 ASTM D-2697 Standard Test Method for Volume of Nonvolatile Matter in Clear or Pigmented Coatings.
 - .4 ASTM D522-93A Standard Test Method for Mandrel Bend Test of Attached Organic Coatings.
 - .5 ASTM D1653 Standard test method for water vapor transmission through organic film coatings.
 - .6 ASTM G-154 QUV Accelerated Weathering Environment. Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
 - .7 ASTM D 2369 Weight Solids Standard test method for Volatile Content of Coatings.
 - .8 ASTM D 1475 Standard Test method for Density of Paint, Varnish, Lacquer, Other related products.
 - .9 ASTM D-2240 (2000) Standard Test Method for Rubber property – Durometer hardness
 - .10 ASTM D-5895 Standard Test Method of drying or curing during film formation of organic coatings using mechanical recorders.
 - .11 ASTM D-570 Standard Test Method for water absorption of plastics.

1.4 QUALITY ASSURANCE

- .1 Applicator must be approved by the manufacturer, and have minimum five years experience on projects of similar size.

1.5 SUBMITTALS

- .1 Submit manufacturer's material data sheets.
- .2 Submit copy of the Accreditation Certificate, available from the Applicator.

- .3 Provide independent test results upon request

1.6 DELIVERY, STORAGE & HANDLING

- .1 Protect products from contamination and freezing.
- .2 Store securely in original containers with all proper labelling.

Part 2 PRODUCTS

2.1 MATERIALS

- .1 Coating: epoxy modified acrylic waterborne coating.
- .2 Density: 1.58 kg/l to ASTM D1475
- .3 Abrasion Resistance: 0.76 g/1000 cycles to ASTM D4060 dry, 1.67 g/1000 cycles to ASTM D4060 wet.
- .4 Shore Hardness: 38.3 to ASTM D2240
- .5 Permeance: 3.45 g/m²/24hu/mm Hg to ASTM D1653
- .6 Colourant: UV stable pigment.
- .7 Colour: provide in dark grey colour with minimum SR value of 0.33.
- .8 Basis of Design Materials:
 - .1 StreetbondSR, HUBSS
 - .2 Acceptable Alternate Materials:
 - .1 Reflective Coating, Neyra Superior Pavement Products and Surfacing Solutions.

Part 3 EXECUTION

3.1 SURFACES PREPARATION

- .1 Examine surfaces prior to performing work.
- .2 Prepare surfaces in accordance with manufacturer's recommendations.
- .3 Commencement of work signifies the Contractor's acceptance of conditions.

3.2 APPLICATION

- .1 Apply pavement coating in accordance with manufacturer's instructions through sprayers onto completely clean and dry asphalt. Allow to dry between coats as required by manufacturer's instructions.
- .2 Apply in coating thickness to suit application for up to 500 cars per day on surface.

3.3 PROTECTION OF COMPLETED WORK

- .1 Protect pavement coating until dry.

END OF SECTION

1 GENERAL

1.01 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Provide manufacturer's instructions, printed product literature and data sheets for furniture and playground structures and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings indicating dimensions, sizes, assembly, anchorage and installation details for each furnishing specified.

1.02 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for care and cleaning of site furnishings for incorporation into manual specified in Section 01 77 00 - Closeout Procedures.

1.03 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect furnishings and playground structures from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2 PRODUCTS

2.01 BENCH

- .1 Manufacturer: Subject to compliance with requirements, provide the following products:
 - .1 MAGLIN SITE FURNISHINGS INC. Canada, Woodstock, ON
 - .1 Ogden Series
 - .1 Model: Straight backless
 - .2 Mount: Wall mount
 - .1 Rust resistant and tamper proof hardware
 - .3 Material
 - .1 Wood Grain Texture High Density Polyethylene
 - .2 Colour: Cedar
 - .4 Finish: Powder Coated Matte Black
 - .5 Warranty: Standard manufacturer warranty

2.02 CLUSTER SEATING

- .1 Manufacturer: Subject to compliance with requirements, provide the following products:
 - .1 MAGLIN SITE FURNISHINGS INC. Canada, Woodstock, ON
 - .1 210 Series
 - .1 Model: MTB-210-00027
 - .2 Mount: Surface mount
 - .1 Rust resistant and tamper proof hardware
 - .3 Material
 - .1 Wood Grain Texture High Density Polyethylene
 - .2 Colour: Cedar
 - .4 Finish: Powder Coated Matte Black
 - .5 Warranty: Standard manufacturer warranty

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for exterior site furnishing installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.02 PREPARATION

- .1 Locate and protect utility lines.
- .2 Notify and acquire written acknowledgement from utility authorities before beginning installation Work

3.03 INSTALLATION

- .1 Assemble furnishings in accordance with manufacturer's written recommendations.
- .2 Install furnishing true, plumb and anchored as indicated contract documents and to manufacturer's recommendations.
- .3 Touch-up damaged finishes to approval of Consultant.

3.04 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 02 41 13 - Selective Site Demolition.

.2 Final Cleaning: Upon completion, remove surplus materials, rubbish, tools and equipment in accordance with Section 01 77 00 - Closeout Procedures.

3.05 PROTECTION

- .1 Protect installed products and components from damage during construction.
 - .2 Repair damage to adjacent materials caused by site furnishing installation.

END OF SECTION

1 General

1.01 RELATED REQUIREMENTS

- .1 Not Used.

1.02 DEFINITIONS

- .1 Compost:
 - .1 Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil amendment.
 - .2 Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test.
 - .3 Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth (C:N ratio below 25), and contain no toxic or growth inhibiting contaminants.
 - .4 Composed bio-solids to: CCME Guidelines for Compost Quality, Category (A)(B).

1.03 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Quality control submittals:
 - .1 Soil testing: submit certified test reports showing compliance with specified performance characteristics and physical properties as described in PART 2 - SOURCE QUALITY CONTROL.
 - .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.04 QUALITY ASSURANCE

- .1 Testing Agency Qualifications: An independent, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
 - .1 Laboratories: Subject to compliance with requirements, provide testing by one of the following:
 - .2 A & L Canada Laboratories Inc., 2136 Jetstream Rd, London, Ontario N5V 3P5.
 - .3 Euorofins Environment Testing Canada Inc., 8-146 Colonade Road, Ottawa, Ontario K2E 7Y1
 - .4 SGS Agrifood Laboratories, 503 Imperial Road, Unit #1, Guelph, Ontario N1H 6T9
 - .5 University of Guelph, Laboratory Services, P.O. Box 3650 95 Stone Road, West Guelph, Ontario N1H 8J7
 - .6 Stratford Agri-Analysis, 1131 Erie Street, Box 760, Stratford, Ontario N5A 6W1
 - .7 Activation Laboratories Ltd., 41 Bittern Street, Ancaster, Ontario L9G 4V5
 - .8 Honeyland Ag Services, 3918 West Corner Drive, Ailsa Craig, Ontario N0M 1A0

- .2 Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.
- .3 Qualifications: Submit proof of qualifications when requested by Consultant.
- .4 Contractor Qualifications:
 - .1 Landscape Contractor: To be a Member in Good Standing of International Society of Arboriculture, Canadian Nursery Landscape Association, or Landscape Ontario Green for Life (LO).
 - .2 Landscape Supervisor: Landscape Horticulturist Journeyperson or Landscape Industry Certified Technician with Softscape Installation designation or equivalent.

2 Products

2.01 TOPSOIL

- .1 Topsoil for planting beds and sod: mixture of particulates, micro-organisms and organic matter which provides suitable medium for supporting intended plant growth. For horticultural beds of shrubs and perennials, a mixture of topsoil, coarse sand and compost mixed to the following proportions, by volume: Topsoil 40% (+/- 10%); Coarse Sand 50% (+/- 10%); High-lignin Organic Matter 10% (+/- 2%)
 - .1 Soil parameters:
 - .1 pH: 5.5-7.5
 - .2 Phosphorous (ppm): 10-60
 - .3 Potassium (ppm): 80-250
 - .4 Calcium (ppm): < 5000
 - .5 Magnesium (ppm): 100-300
 - .6 Soluble salt: < 1.5 mmhos/cm
 - .7 Organic matter: 4-15%
 - .8 Sodium (ppm): <200
 - .2 Contain no toxic elements or growth inhibiting materials.
 - .3 Finished surface free from:
 - .1 Debris and stones over 50 mm diameter.
 - .2 Coarse vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.
 - .4 Consistency: Friable when moist.
- .2 Topsoil for sodded and seeded areas: mixture of particulates, micro organisms and organic matter which provides suitable medium for supporting intended plant growth.
 - .1 Soil parameters:
 - .1 Total Sand (0.05-2 mm): 50-60%
 - .2 Silt: 20-40%
 - .3 Clay: 6-10%
 - .4 pH: 6-7.5
 - .5 Phosphorous (ppm): 10-60
 - .6 Potassium (ppm): 80-250

- .7 Calcium (ppm): < 5000
- .8 Magnesium (ppm): 100-300
- .9 Soluble salt: < 1.5 mmhos/cm
- .10 Organic matter: 2-5%
- .2 Contain no toxic elements or growth inhibiting materials.
- .3 Finished surface free from:
 - .1 Debris and stones over 50 mm diameter.
 - .2 Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.
 - .4 Consistence: friable when moist.
- .3 Note any trees or plants that are specified as "pH sensitive" and adjust soil to meet required values.

2.02 SOIL AMENDMENTS

.1 INORGANIC SOIL AMENDMENTS

- .1 Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - .1 Class: T, with a minimum of 99 percent passing through a 2.36-mm sieve and a minimum of 75 percent passing through a 0.25-mm sieve.
 - .2 Form: Provide lime in form of ground dolomitic limestone.
- .2 Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a 3.35-mm sieve and a maximum of 10 percent passing through a 0.425-mm sieve.
- .3 Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- .4 Perlite: Horticultural perlite, soil amendment grade.
- .5 Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a 0.30-mm sieve.
- .6 Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

.2 ORGANIC SOIL AMENDMENTS

- .1 Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing CCC's "Compost Quality Alliance seal," and as follows:
 - .1 Feedstock: Limited to leaves May include sewage sludge May include animal waste.
 - .2 Reaction: pH of 5.5 to 8.
 - .3 Soluble-Salt Concentration: Less than 4 dS/m.
 - .4 Moisture Content: 35 to 55 percent by weight.
 - .5 Organic-Matter Content: 50 to 60 percent of dry weight.
 - .6 Particle Size: Minimum of 98 percent passing through a 25-mm sieve.
- .2 Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 13-mm sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by

- electrical conductivity of maximum 5 dS/m.
- .3 Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 13-mm sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- .4 Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
 - .1 Partially Decomposed Wood Derivatives: In lieu of shredded and composted wood derivatives, mix shredded and partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 2.4 kg/cu. m of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 4 kg/cu. m of loose sawdust or ground bark.
- .5 Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.03 FERTILIZERS

- .1 Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- .2 Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - .1 Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- .3 Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - .1 Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

2.04 SOURCE QUALITY CONTROL

- .1 Advise Consultant of sources of topsoil and manufactured topsoil to be used with sufficient lead time for testing.
- .2 Contractor is responsible for amendments to imported soil(s) as specified.
- .3 Conduct soil testing by recognized testing facility for pH, Nitrogen (N), Phosphorous (P), and Potassium (K), and organic matter.
- .4 Carry out testing of topsoil by testing laboratory designated by Consultant.
 - .1 Perform soil sampling, testing and analysis in accordance with applicable Provincial standards.

3 Execution

3.01 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping of areas as directed by Consultant after area has been cleared of stumps, rocks 100 mm and over, invasive and noxious plants and their reproductive parts, brush, weeds and grasses and removed from site.
- .2 Strip topsoil to depths as directed Consultant.
 - .1 Avoid mixing topsoil with subsoil where textural quality will be moved outside acceptable range of intended application.
- .3 Stockpile in locations as directed by Consultant.
 - .1 Stockpile height not to exceed 2 m.
 - .2 Protect stockpile from adverse weather conditions, contamination from invasive plant material, and compaction.
 - .3 Avoid placing stockpile in low areas where natural drainage or storm water could pond, or erode these materials during inclement weather.
- .4 Dispose of unused topsoil in an environmentally responsible manner but do not use as landfill as directed by Consultant.

3.02 PREPARATION OF EXISTING GRADE

- .1 Verify that grades are correct.
 - .1 If discrepancies occur, notify Consultant and do not start work until instructed by Consultant.
- .2 Grade soil, eliminate uneven areas and low spots, ensure positive drainage.
- .3 Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious materials.
 - .1 Remove soil contaminated with calcium chloride, toxic materials and petroleum products.
 - .2 Remove debris which protrudes more than 75 mm above surface.
 - .3 Dispose of removed material off site.
- .4 Cultivate entire area which is to receive topsoil to minimum depth of 100 mm.
 - .1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

3.03 PLACING AND SPREADING OF TOPSOIL/PLANTING SOIL

- .1 Place topsoil after Consultant has accepted subgrade.
- .2 Spread topsoil in uniform layers of 150 mm to 300mm.
- .3 Keep topsoil 15 mm below finished grade for sodded areas.
- .4 Spread topsoil as indicated to the following minimum depths after settlement.
 - .1 150 mm for sodded and seeded areas.
 - .2 450 mm for flower beds and for shrub beds.

- .3 1200 mm for tree beds.
- .5 Manually spread topsoil/planting soil around trees, shrubs and obstacles.
- .6 Avoid spreading or grading in wet, frozen, or saturated state.

3.04 FINISH GRADING

- .1 Grade to eliminate rough spots and low areas and ensure positive drainage.
 - .1 Prepare loose friable bed by means of cultivation and subsequent raking.
- .2 Consolidate topsoil to required bulk density using equipment approved by Consultant.
 - .1 Leave surfaces smooth, uniform and firm against deep footprinting.

3.05 PROTECTION

- .1 Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- .2 Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - .1 Scarify or remove and replace soil material to depth as directed by Prime Consultant; reshape and recompact.
- .3 Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - .1 Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.06 ACCEPTANCE

- .1 Consultant will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

3.07 SURPLUS MATERIAL

- .1 Dispose of materials except topsoil not required off site with the approval of the Consultant. Materials to be used for fill to remain on site.

3.08 CLEANING

- .1 Leave Work area organized and tidy at end of each day.
- .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- .3 Upon completion remove surplus materials, rubbish, tools and equipment.

- .1 Clean and reinstate areas affected by Work.
- .4 Divert unused fertilizer from landfill to official hazardous material collections site.

END OF SECTION

1 GENERAL

1.01 RELATED REQUIREMENTS

- .1 Section 02 41 13 "Site Preparation"
- .2 Section 32 91 19.13 "Topsoil Placement and Grading"

1.02 MEASUREMENT AND PAYMENT

- .1 Measure hydraulic seeding square metres of actual surface area for:
 - .1 Low maintenance "eco-lawn" mixture
- .2 Measure maintenance during warranty period of areas seeded in square metres.

1.03 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Schedule hydraulic seeding to coincide with preparation of soil surface.
 - .2 Schedule hydraulic seeding using grass mixtures and mixtures between dates recommended by Provincial Agricultural Department.

1.04 SUBMITTALS PRIOR TO ANY PROGRESS DRAW

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for seed, mulch, tackifier, fertilizer, liquid soil amendments and micronutrients.
- .2 Submit in writing:
 - .1 Volume capacity of hydraulic seeder in litres.
 - .2 Amount of material to be used per tank based on volume.
 - .3 Number of tank loads required per hectare to apply specified slurry mixture per hectare.
- .3 Samples:
 - .1 Submit [0.5] kg container of each type of fertilizer used.
- .4 Certificates:
 - .1 Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .5 Test Reports:
 - .1 Submit certified test reports showing compliance with specified performance characteristics and physical properties.

1.05 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Landscape Contractor: to be a Landscape Ontario Member in Good Standing

- .2 Landscape Planting Supervisor: Landscape Industry Certified Technician with Softscape Installation designation.
- .3 Landscape Maintenance Supervisor: Landscape Industry Certified Technician with Turf Maintenance designation.

1.06 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Labelled bags of fertilizer identifying mass in kg, mix components and percentages, date of bagging, supplier's name and lot number.
 - .2 Inoculant containers to be tagged with expiry date.
- .3 Storage and Handling Requirements:
 - .1 Store fertilizer in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

1.07 WARRANTY

- .1 For seeding, 24 months warranty period is extended to 2 full growing seasons.
- .2 End-of-warranty inspection will be conducted by Consultant.
- .3 Refer to Fixed price Construction Contract (between Hallman Construction Ltd. and the "Contractor").

2 PRODUCTS

1.1 MATERIALS

- .1 Seed: "Canada pedigreed grade" in accordance with Government of Canada Seeds Act and Regulations.
 - .1 Low Maintenance "Eco-Lawn" Mixture: OSC Seeds
 - 1. Mixture composition:
 - .1 35% Audubon Creeping Red Fescue
 - .2 35% J-5 Chewings Fescue
 - .3 20% Ecostar Hard Fescue
 - .4 10% Evolution Perennial Ryegrass
- .2 Mulch: specially manufactured for use in hydraulic seeding equipment, non-toxic, water activated, green colouring, free of germination and growth inhibiting factors with following properties:
 - .1 Type I Mulch:
 - .1 Made from wood cellulose fibre.

- .2 Organic mater content: 95% plus or minus 0.5%
 - .3 Value of pH: 6.0
 - .4 Potential water absorption: 900%
- .2 Type II Mulch:
 - .1 Made from newsprint, raw cotton fibre and straw, processed to produce fibre lengths of 15 mm minimum and 25 mm maximum. Greater proportions of ingredients to be straw.
- .3 Tackifier: water soluble vegetable carbohydrate powder.
- .4 Water: Free of impurities that would inhibit germination and growth.
- .5 Fertilizer:
 - .1 To Canada "Fertilizers Act" and Regulations.
 - .2 Complete synthetic, slow release with 35% of nitrogen content in water-insoluble form.
- .6 Inoculants: inoculant containers to be tagged with expiry date.
- .7 Erosion Mat (Required on slopes of 3 to 1 or greater – Refer to drawings by Civil Engineer):
 - .1 Supplier: Terrafix Geosynthetics Inc. or approved equal.
 - .2 Model: Terrafix Geosynthetics erosion control blanket, C200, 100% coconut fibre, double net, with biodegradable straw fibre fill.

3 EXECUTION

1.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for hydraulic seeding in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

1.2 INSTALLERS

- .1 Use installers-members in Good Standing.

1.3 PROTECTION OF EXISTING CONDITIONS

- .1 Protect structures, signs, guide rails, fences, plant material, utilities and other surfaces not intended for spray.
- .2 Immediately remove any material sprayed where not intended as directed by Consultant.

1.4 PREPARATION OF SURFACES

- .1 Do not perform work under adverse field conditions such as wind speeds over 10km/h, frozen ground or ground covered with snow, ice or standing water.
- .2 Fine grade areas to be seeded free of humps and hollows.
 - .1 Ensure areas are free of deleterious and refuse materials.
- .3 Cultivated areas identified as requiring cultivation to depth of 25 mm.
- .4 Ensure areas to be seeded are moist to depth of 150 mm before seeding.
- .5 Obtain Consultant's approval of grade and topsoil depth before starting to seed.

1.5 FERTILIZING PROGRAM

- .1 Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - .1 Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- .2 Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - .1 Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

1.6 PREPARATION OF SLURRY

- .1 Measure quantities of materials by weight or weight-calibrated volume measurement satisfactory to Consultant. Supply equipment required for this work.
- .2 Charge required water into seeder. Add material into hydraulic seeder under agitation. Pulverize mulch and charge slowly into seeder.
- .3 After materials are in seeder and well mixed, charge tackifier into seeder and mix thoroughly to complete slurry.

1.7 SLURRY APPLICATION

- .1 Ensure seed is placed under supervision of certified Landscape Planting Supervisor.
- .2 Hydraulic seeding equipment:
 - .1 Slurry tank.
 - .2 Agitation system for slurry to be capable of operating during charging of tank and during seeding, consisting of recirculation of slurry and/or mechanical agitation method.
 - .3 Capable of seeding by 50 m hand operated hoses and appropriate nozzles.
 - .4 Tank volume to be certified by certifying authority and identified by authorities "Volume Certification Plate".

- .3 Slurry mixture applied per hectare.
 - .1 Apply mixture per manufacturer's recommendation.
- .4 Apply slurry uniformly, at optimum angle of application for adherence to surfaces and germination of seed.
 - .1 Using correct nozzle for application.
 - .2 Using hoses for surfaces difficult to reach and to control application.
- .5 Blend application 300mm into adjacent grass areas or sodded areas to form uniform surfaces.
- .6 Re-apply where application is not uniform.
- .7 Remove slurry from items and areas not designated to be sprayed.

1.8 CLEANING

- .1 Leave work area clean at end of each day.
- .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- .3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment. Clean and reinstate areas affected by work.

1.9 PROTECTION

- .1 Protect seeded areas from trespass until plants are established.
- .2 Remove protection devices as directed by Consultant.

1.10 MAINTENANCE DURING ESTABLISHMENT PERIOD

- .1 Ensure maintenance is carried out under supervision of certified Landscape Maintenance Supervisor.
- .2 Perform the following operations from time of seed application until acceptance by Consultant:
 - .1 Repair and reseed dead or bare spots to allow establishment of seed prior to acceptance.
 - .2 Fertilize seeded areas after 10 weeks after germination provided plants have mature true leaves.
 - .3 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.
 - .4 Water seeded area to maintain optimum soil moisture level for germination and continued growth of grass. Control watering to prevent washouts.

1.11 ACCEPTANCE

- .1 Seeded areas will be accepted by Consultant provided that:
 - .1 Plants are uniformly established.

- .2 Areas have been fertilized.
- .2 Areas seeded in fall will achieve final acceptance in following spring, one month after start of growing season provided acceptance conditions are fulfilled.

1.12 MAINTENANCE DURING WARRANTY PERIOD

- .1 Perform the following operations from time of acceptance until end of warranty period:
 - .1 Repair and reseed dead or bare spots to satisfaction of Consultant.
 - .2 Fertilize seeded areas in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles.

END OF SECTION

1 General

1.01 RELATED REQUIREMENTS

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- .1 Section 32 91 19.13 - Topsoil Placement and Grading

1.02 REFERENCE STANDARDS

- .1 Canadian Nursery Landscape Association (CNLA)
 - .1 Canadian Standards for Nursery Stock, Latest Edition.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.03 COORDINATION

- .1 Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - .1 When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.04 ACTION AND INFORMATION SUBMITTALS

- .1 Scheduling: obtain approval from Consultant of schedule 7 days in advance of shipment of plant material.
 - .1 Schedule to include:
 - .1 Quantity and type of plant material.
 - .2 Shipping dates.
 - .3 Arrival dates on the Place of the Work.
 - .4 Planting Dates.
- .2 Product Data: For each type of product.
 - .1 Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
- .3 Samples for Verification: For each of the following:

- .1 Organic Compost Mulch: 0.5-L volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
- .2 Mineral Mulch: 1.0 kg of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on-site; provide an accurate indication of color, texture, and makeup of the material.
- .4 Edging Materials and Accessories: Manufacturer's standard size, to verify selected.
- .5 Weed Control Barrier: 300 by 300 mm.
- .6 Stakes: Provide mock up of staking on tree prior to completing all trees. Approved mock up can remain.
- .7 Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- .8 Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - .1 Manufacturer's certified analysis of standard products.
 - .2 Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- .9 Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- .10 Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

- .1 Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.06 QUALITY ASSURANCE

- .2 Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
 - .1 Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the Canadian Nursery Landscape Association.
 - .2 Experience: Five years' experience in landscape installation.

- .3 Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Place of the Work when work is in progress.
- .4 Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - .1 Landscape Industry Certified Technician - Exterior.
 - .2 Landscape Industry Certified Interior.
 - .3 Landscape Industry Certified Horticultural Technician.
 - .4 Pesticide Applicator: Province licensed, commercial.
- .3 Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANLA Z60.1-2014 - Nursery Stock.
 - .1 Selection of plants purchased under allowances is made by Consultant, who tags plants at their place of growth before they are prepared for transplanting.
- .4 Measurements: Measure according to ANLA Z60.1-2014 - Nursery Stock. Do not prune to obtain required sizes.
 - .1 Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 150 mm above the root flare for trees up to 100-mm caliper size, and 300 mm above the root flare for larger sizes.
 - .2 Other Plants: Measure with stems, petioles, and foliage in their normal position.
- .5 Plant Material Observation: Consultant may observe plant material either at place of growth or at the Place of the Work before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Consultant may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from the Place of the Work.
 - .1 Notify Consultant of sources of planting materials seven days in advance of delivery to the Place of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

- .6 Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- .7 Bulk Materials:
 - .1 Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

- .2 Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
- .3 Accompany each delivery of bulk materials with appropriate certificates.
- .8 Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- .9 Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- .10 Handle planting stock by root ball.
- .11 Store bulbs, corms, and tubers in a dry place at 16 to 18 deg C until planting.
- .12 Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - .1 If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- .13 Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- .14 Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - .1 Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
 - .2 Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - .3 Do not remove container-grown stock from containers before time of planting.
 - .4 Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.
- .15 Plants specified B/B (Ball and Burlap) or W/B (Wire Basket) on the plant list shall be moved with root systems as solid units, with balls of earth firmly wrapped with burlap. The diameter and depth must be sufficient to encompass a fibrous and feeding root

system necessary for the healthy development of the plant. No plant shall be accepted when the ball of earth surrounding its roots has been cracked or broken preparatory to, or during planting, or after the burlap, staves, ropes, or platform required in connection with its transplanting has been removed. All balled plants that cannot be planted at once shall be kept watered and shaded from the hot sun. The least possible time shall elapse between the digging of the tree and its final planting. The entire root system of all plant material shall be kept moist and at no time shall the root system be exposed to drying winds or air.

1.08 FIELD CONDITIONS

- .1 Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- .2 Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- .3 Installation shall be done under weather conditions and in suitable growth season for each specified material, and as approved by the Consultant.

1.09 WARRANTY

- .4 Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - .1 Failures include, but are not limited to, the following:
 - .1 Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - .2 Structural failures including plantings falling or blowing over.
 - .3 Faulty performance of tree stabilization.
 - .4 Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- .5 Warranty Periods: From date of Substantial Completion.
 - .1 Trees, Shrubs, Vines, and Ornamental Grasses: 24 months.
 - .2 Ground Covers, Biennials, Perennials, and Other Plants: 24 months.
 - .3 Annuals: Three months.

- .4 Trees and shrubs planted in the fall that are found to be dead, defective, or not in a healthy, growing condition in the spring are to be replanted at that time, not at the end of the warranty period. Trees planted in the spring that are found to be dead, defective, or not in a healthy growing condition in the fall, are to be replanted. All plants that are replaced are to be re-guaranteed for an additional one year dated from the date of replacement.
- .6 Include the following remedial actions as a minimum:
 - .1 Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - .2 Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - .3 A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
 - .4 Replace, during next planting season, trees and shrubs which failed to survive. Replacements are subject to same approval and guarantee conditions specified for initial planting. Continue this replacement until all specified trees and shrubs are well established.

2 Products

1.2 PLANT MATERIAL

- .1 General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANLA Z60.1-2014 - Nursery Stock; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 - .1 Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 19 mm in diameter; or with stem girdling roots are unacceptable.
 - .2 Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- .2 Provide plants of sizes, grades, and ball or container sizes complying with ANLA Z60.1-2014 - Nursery Stock for types and form of plants required. Plants of a larger size may be used if acceptable to Consultant, with a proportionate increase in size of roots or balls.
- .3 Bare root plant material that has come out of dormant stage and is too far advanced will not be accepted unless due to special circumstances and if Consultant's approval has been obtained.

- .4 Use of plant material which has been held in "Cold Storage" requires approval of the Consultant.
- .5 Container grown stock is acceptable if containers are large enough for root development. Trees and shrubs must have grown in container for minimum of one growing season but not longer than two. Root system must be able to "hold" soil when removed from container. Plants that have become root bound are not acceptable. Container stock must have been fertilized with slow releasing fertilizer. Soil mixture in container must consist of: 6 parts loam soil, 3 parts peatmoss and 1 part sand.
- .6 Balled and Burlapped: Conifer, Broad-leaf evergreens and trees in excess of 10'0" (3 m) height must have been dug with large firm ball. Measure calliper at 12" (300 mm) above ground level. A tree with 3" (75 mm) calliper requires root ball of 40" (1 m) diameter. Increase diameter of root ball by 10" (250 mm) with each increase of 1" (25 mm) in calliper. Root balls of proper size must include 75% of fibrous and feeder root system. This excludes use of native trees grown in light sandy or rocky soil. Secure root balls with burlap, heavy twine and rope. Use hessian burlap. Frozen root balls will be permitted provided root balls are sufficiently protected to prevent breakage. Protect root balls from sudden changes in temperature and exposure to heavy rainfall.
- .7 The sizes of root balls for trees shall be as specified below. Ball sizes are minimum and shall be adjusted according to growth habits of plants.

DECIDUOUS TREES

<u>Calliper</u>	<u>Root Ball Diameter</u>
1" (25 mm)	24" (.6 m)
2" (50 mm)	32" (.8 m)
3" (75 mm)	40" (1.0 m)
4" (100 mm)	50" (1.25 m)
5" (125 mm)	60" (1.5 m)
6" (150 mm)	70" (1.75 m)
7" (175 mm)	80" (2.0 m)
8" (200 mm)	90" (2.25 m)

CONIFEROUS TREES

<u>Height</u>	<u>Root Ball Diameter</u>
6'-8' (1820 mm to 2430 mm)	32" (800 mm)
8'-10' (2430 mm to 3040 mm)	36" (900 mm)

10'-12' (3040 mm to 3650 mm)	44" (1100 mm)
12'-15' (3650 mm to 4570 mm)	48" (1200 mm)
15'-18' (4570 mm to 5480 mm)	56" (1400 mm)

- .8 Imported plant material must be accompanied by the necessary permits and import licences. Conform to Federal and Provincial Regulations.
- .9 Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANLA Z60.1-2014 - Nursery Stock. Root flare shall be visible before planting.
- .10 Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- .11 If formal arrangements or consecutive order of plants is indicated on Contract Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- .12 Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

1.3 WATER

- .1 Free of impurities that would inhibit plant growth.

1.4 PLANT ACCESSORIES

- .1 Refer to Contract Documents and Standard Details for the local municipal body.
- .2 Anchors: For support of large shrubs and trees up to (90 mm) in calliper use wooden stakes.
 - .1 Size: 50mm x 50mm x 2400mm
- .3 Ties: Ties shall form a loose loop around the stake and loop in a figure '8' around the trunk of the tree. Interlink both figure '8's and secure Arbortie to the stake using nails.
 - .1 Arbortie or approved equivalent
 - .1 Colour: Green
 - .2 Nails: 1" galvanized roofing nails

- .4 Hose: New black rubber hose (12.7 mm) in diameter, with 2 ply wire tie or as required by the municipality.
- .5 Tree guard: Arborgard + AG9-4 or approved equivalent

1.5 MULCH

- .1 Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:
 - .1 Type: Shredded hardwood.
 - .2 Size Range: 76 mm maximum, 13 mm minimum.
 - .3 Color: Natural.
 - .4 Depth: 150mm over planting soil.
 - .5 Do not place mulch directly in contact with the trunk. Do not under any circumstances mound mulch up against trunk.
- .2 Compost is a widely used bulk organic mulch and a recycled product. Because it is applied at much greater rates than fertilizer, compost has a significant cumulative effect on nutrient availability and may reduce or eliminate top-dressed fertilizing. Consider each plant's pH and soluble-salt requirements and how those relate to the compost being used.
- .3 Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 25-mm sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - .1 Organic Matter Content: 50 to 60 percent of dry weight.
 - .2 Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- .4 Stone Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:
 - .1 Type: Rounded riverbed stone or smooth-faced stone.
 - .2 Size Range: 150mm maximum, 75mm minimum.
 - .3 Color: Readily available natural grey gravel color range.

1.6 FERTILIZER

- .1 Shall be complete commercial fertilizer 50% of the elements of which shall be derived from organic sources, and shall contain no less than 60% urea formaldehyde with the following percentages by weight of nitrogen, phosphoric acid, and potash in that order for:
 - .1 Trees 10-6-4

.2 Shrubs 12-6-6

- .2 Peatmoss: Decomposed plant material, fairly elastic and homogenous, free of decomposed colloidal residue, wood, sulphur and iron. Brown in colour containing minimum 60% organic matter by weight and moisture content not exceeding 15%. Shredded particles, may not exceed (6 mm) in size. Minimum PH value of peat, 4.5, maximum 6.0.
- .3 Bonemeal: Raw commercial, finely ground, and with a content of minimum 4% Nitrogen and 20% Phosphoric Acid.
- .4 Lime: Lime to be used in all cases where the PH of the soil is less than 6.0 limestone containing not less than 8% of calcium and magnesium carbonates combined, finely ground to pass a 10 mesh sieve with at least one half passing a 100 mesh sieve. Rate of application shall be determined after determining the PH of the topsoil.
- .5 Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 - .1 Size: 21-gram tablets.
 - .2 Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

1.7 WEED CONTROL BARRIERS

- .1 Nonwoven Geotextile Landscape Fabric: Polypropylene or polyester fabric, 101g/sq. m minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

1.8 PESTICIDES

- .1 General: Pesticide registered and approved by Environment Canada, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- .2 Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- .3 Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

1.9 LANDSCAPE EDGING

- .1 Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B 221M, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
 - .1 Edging Size: 4.8 mm thick by 140 mm deep.
 - .2 Stakes: Aluminum, ASTM B 221M, Alloy 6061-T6, approximately 38 mm wide by 300 mm long.

1.10 TREE WATERING BAG

- .1 Reusable watering bag with the following specifications or approved equivalent:
 - .1 Manufacturer: Treegator
 - .2 Model: Original
 - .3 Trunk Diameter: 1 to 2 inch (2.54 to 5.08 cm)
 - .4 Water Capacity: 15 gallons (56.78 liters)

1.11 MISCELLANEOUS PRODUCTS

- .1 Wood Pressure-Preservative Treatment: AWP A U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.
- .2 Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- .3 Burlap: Non-synthetic, biodegradable.
- .4 Clear Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- .5 Filter Fabric: Nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.
- .6 Root Barrier: Black, molded, modular panels 610 mm deep, 2.2 mm thick, and with vertical root deflecting ribs protruding 19 mm out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.
- .7 Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per 0.45 kg of vesicular-arbuscular mycorrhizal fungi and 95 million spores per 0.45 kg of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

3 Execution

1.12 EXAMINATION

- .1 Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
 - .1 Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - .2 Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 - .3 Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - .4 Uniformly moisten excessively dry soil that is not workable or which is dusty.
- .2 If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Consultant and replace with new planting soil.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

1.13 PREPARATION

- .1 Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- .2 Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- .3 Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Consultant's acceptance of layout before excavating or planting. Make minor adjustments as required.

1.14 EXCAVATION AND PREPARATION

- .1 Preparation of planting beds in accordance with Section 32 91 19.13 - "Topsoil Placement and Grading".
- .2 For individual planting holes:
 - .1 Stake out location and obtain approval from Consultant prior to excavating.
 - .2 Excavate to depth and width as indicated in Contract Documents and Standard York Region tree planting detail.

- .3 Remove subsoil, rocks, roots, debris and toxic material from excavated material that will be used as planting soil for trees and individual shrubs. Dispose of excess material.
 - .4 Increase the size of planting holes in compacted soils 150mm for every 300mm of diameter of root ball.
 - .5 Scarify sides of planting hole to 200mm.
 - .6 Remove water which enters excavations prior to planting. Notify Consultant if water source is ground water.
- .3 Planting Pits and Trenches: Excavate circular planting pits.
- .1 Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - .2 Excavate approximately three times as wide as ball diameter for balled and burlapped, balled and potted, container-grown, fabric bag-grown stock.
 - .3 Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 - .4 If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - .5 Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 - .6 Maintain supervision of excavations during working hours.
 - .7 Keep excavations covered or otherwise protected after working hours when unattended by Installer's personnel.
 - .8 If drain tile is indicated on Contract Documents or required under planting areas, excavate to top of porous backfill over tile.
- .4 Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.
- .5 Obstructions: Notify Consultant if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- .1 Hardpan Layer: Drill 150-mm-diameter holes, 600 mm apart, into free-draining strata or to a depth of 3 m, whichever is less, and backfill with free-draining material.
- .6 Drainage: Notify Consultant if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

- .7 Fill excavations with water and allow to percolate away before positioning trees and shrubs.

1.15 TREE, SHRUB AND VINE PLANTING

- .1 Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANLA Z60.1-2014 - Nursery Stock. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- .2 Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- .3 Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 20 mm above adjacent finish grades.
 - .1 Backfill: Planting soil.
 - .2 After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove burlap and rope from the top 1/3 of root ball. Cut top horizontal wire of wire basket in four places and fold down into planting soil unless basket is a low profile.
 - .3 Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - .4 Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - .5 Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 25 mm from root tips; do not place tablets in bottom of the hole.
 - .1 Quantity: As indicated on Drawings.
 - .6 Continue backfilling process. Water again after placing and tamping final layer of soil.
- .4 Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 25 mm above adjacent finish grades.
 - .1 Backfill: Planting soil.
 - .2 Carefully remove root ball from container without damaging root ball or plant.
 - .3 Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

- .4 Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 25 mm from root tips; do not place tablets in bottom of the hole.
 - .1 Quantity: As indicated on Drawings.
- .5 Continue backfilling process. Water again after placing and tamping final layer of soil.
- .5 Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 25 mm above adjacent finish grades.
 - .1 Backfill: Planting soil.
 - .2 Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - .3 Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - .4 Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 25 mm from root tips; do not place tablets in bottom of the hole.
 - .1 Quantity: As indicated on Drawings.
 - .5 Continue backfilling process. Water again after placing and tamping final layer of soil.
- .6 Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

1.16 TREES, SHRUB, AND VINE PRUNING

- .1 Remove only dead, dying, or broken branches. Do not prune for shape.
- .2 Prune, thin, and shape trees, shrubs, and vines as directed by Consultant.
- .3 Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Consultant, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- .4 Do not apply pruning paint to wounds.

1.17 GROUND COVER AND PLANT PLANTING

- .1 Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- .2 Use planting soil for backfill.
- .3 Dig holes large enough to allow spreading of roots.
- .4 For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- .5 Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- .6 Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- .7 Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

1.18 ROOT BARRIER INSTALLATION

- .1 Install root barrier where trees are planted within tree pits in paving.
- .2 Align root barrier vertically and run it around root ball in tree pit to deflect roots below adjacent paving or other hardscape elements.
 - .1 Position top of root barrier according to manufacturer's written recommendations.
 - .2 Overlap root barrier a minimum of 300 mm at joints.
 - .3 Do not distort or bend root barrier during construction activities.

1.19 PLACING SOIL IN PLANTERS

- .1 Place a layer of drainage gravel at least 100 mm thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 150 mm up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.
- .2 Fill planter with planting soil. Place soil in lightly compacted layers to an elevation of 38 mm below top of planter, allowing natural settlement.

1.20 PLANTING AREA MULCHING

- .1 Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 300mm and secure seams with galvanized pins.
- .2 Mulch backfilled surfaces of planting areas and other areas indicated.

- .1 Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 50-mm average thickness, with 900-mm radius around trunks or stems. Do not place mulch within 75 mm of trunks or stems.
- .2 Organic Mulch in Planting Areas: Apply 50-mm average thickness of organic mulch extending 300 mm beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 75 mm of trunks or stems.

1.21 EDGING INSTALLATION

- .1 Aluminum Edging: Install aluminum edging where indicated according to manufacturer's written instructions. Anchor with aluminum stakes spaced approximately 1200 mm apart, driven below top elevation of edging.

1.22 WATERING

- .1 All plant material shall be thoroughly watered within eight (8) hours of planting. The Contractor shall be responsible for supply, delivery and application of the water. The Contractor should note that watering will be the Contractor's responsibility (as per warranty) even during draught conditions.
- .2 Regular and adequate watering shall be provided in order to promote healthy plant growth.
- .3 During extended periods of high temperatures and draught, additional watering may be required to promote plant establishment and healthy plant growth. It is the responsibility of the Contractor to determine watering schedule in order for plant material not to become stressed in dry periods.
- .4 See City Planting Detail for additional planting requirements.

1.23 PLANT MAINTENANCE

- .1 Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- .2 Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- .3 Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

1.24 PESTICIDE APPLICATION

- .1 Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- .2 Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- .3 Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

1.25 REPAIR AND REPLACEMENT

- .1 General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Consultant.
 - .1 Submit details of proposed pruning and repairs.
 - .2 Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - .3 Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Consultant.
- .2 Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Consultant determines are incapable of restoring to normal growth pattern.
 - .1 Provide new trees of same size as those being replaced for each tree of 100 mm or smaller in caliper size.
 - .2 Species of Replacement Trees: Same species being replaced.

1.26 CLEANING AND PROTECTION

- .1 During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving the Place of the Work to avoid tracking soil onto roads, walks, or other paved areas.
- .2 Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- .3 Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

- .4 After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and the Place of the Work.
- .5 At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

1.27 MAINTENANCE SERVICE

- .1 Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - .1 Maintenance Period: 24 months from date of Substantial Completion.
- .2 Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - .1 Maintenance Period: 24 months from date of Substantial Completion.

END OF SECTION

Part 1 General

1.1 MEASUREMENT PROCEDURES

- .1 Measure excavation and backfill in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling.
- .2 Measure maintenance holes and catch basins in units within depth classifications as follows, measured from top of cover or grating to lowest pipe invert top of base slab:
 - .1 2 m or less.
 - .2 Greater than 2 m but not more than 2.5 m.
 - .3 Greater than 2.5 m but not more than 3 m.
 - .4 Greater than 3 m but not more than 3.5 m.
 - .5 Further stages in increments of 0.5 m.
- .3 Measure outfall structures in units.
- .4 Measure adjusting tops of existing maintenance holes or catch basins in units adjusted.
- .5 Measure gratings in units supplied and installed.
- .6 Measure I-beam in metres of each size incorporated into work.
- .7 Measure sealing over existing maintenance holes or catch basins in units sealed.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for [maintenance holes and catch basin structures] and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

1.3 QUALITY ASSURANCE

- .1 Submit in accordance with Section 01 45 00 - Quality Control.
- .2 Certifications:
 - .1 Submit manufacturer's test data and certification at least 4 weeks prior to beginning Work. Include manufacturer's drawings, information and shop drawings where pertinent.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect maintenance holes and catch basin structures] from [nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Precast maintenance hole units: to ASTM C478M, circular or oval.
 - .1 Top sections eccentric cone or flat slab top type with opening offset for vertical ladder installation.
 - .2 Monolithic bases to be approved by Contract Administrator and set on concrete slabs cast in place.
- .2 Precast catch basin sections: to ASTM C139, ASTM C478M.
- .3 Joints: made watertight using rubber rings, bituminous compound, epoxy resin cement or cement mortar.
- .4 Mortar:
 - .1 Aggregate: 19.0mm.
 - .2 Masonry Cement: to CAN/CSA-A3002.
- .5 Ladder rungs: to CSA G30.18, No.25M billet steel deformed bars, hot dipped galvanized to ASTM A123/A123M.
 - .1 Rungs to be safety pattern (drop step type).
- .6 Adjusting rings: to ASTM C478M.
- .7 Concrete Brick: to CAN/CSA-A165 Series.
- .8 Drop maintenance hole pipe: same as sewer pipe.
- .9 Galvanized iron sheet: approximately 2 mm thick.
- .10 Steel gratings, I-beams and fasteners: as indicated.
- .11 Frames, gratings, covers to dimensions as indicated and following requirements:

- .1 Metal gratings and covers to bear evenly on frames.
 - .1 Frame with grating or cover to constitute one unit.
 - .2 Assemble and mark unit components before shipment.
- .2 Gray iron castings: to ASTM A48/A48M, strength class 30B.
- .3 Castings: sand blasted or cleaned and ground to eliminate surface imperfections.
- .4 Maintenance hole frames and covers: cover cast with perforations and complete with two 25 mm square lifting holes to OPSS 407.
- .5 Catch basin frames and covers: to OPSS 407.
- .6 Maintenance hole frames and covers: to CCDG.
- .7 Catch basin frames and covers: to CCDG.
- .8 Maintenance hole frames and covers: heavy duty municipal type for road service.
 - .1 Cover cast without perforations and complete with two 25 mm square lifting holes.
- .9 Catch basin frames and covers: minimum 100 kg per set.
- .10 Size: 762 mm clear diameter.
- .12 Granular bedding and backfill: in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed gravel sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.
 - .3 Table:

Sieve Designation	% Passing	
	Stone/Gravel	Gravel/Sand
200 mm	-	-
75 mm	-	-
50 mm	-	-
38.1 mm	-	-
25 mm	100	-
19 mm	-	-
12.5 mm	65-90	100
9.5 mm	-	-
4.75 mm	35-55	50-100
2.00 mm	-	30-90
0.425 mm	10-25	10-50
0.180 mm	-	-
0.075 mm	0-8	0-10

- .4 Concrete mixes and materials: in accordance with Section 03 30 00 - Cast-in-Place Concrete].
- .13 Unshrinkable fill: in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling].

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for maintenance holes and catch basin structures installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Contract Administrator.
 - .2 Inform Contract Administrator of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 EXCAVATION AND BACKFILL

- .1 Excavate and backfill in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling and as indicated.
- .2 Obtain approval of Contract Administrator before installing outfall structures, maintenance holes or catch basins.

3.3 CONCRETE WORK

- .1 Do concrete work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Place concrete reinforcement in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 Position metal inserts in accordance with dimensions and details as indicated.

3.4 INSTALLATION

- .1 Construct units in accordance with details indicated, plumb and true to alignment and grade.
- .2 Complete units as pipe laying progresses.
 - .1 Maximum of 3 units behind point of pipe laying will be allowed.
- .3 Dewater excavation to approval of Contract Administrator and remove soft and foreign material before placing concrete base.
- .4 Cast bottom slabs directly on undisturbed ground.
- .5 Set precast concrete base on 150 mm minimum of granular bedding compacted to 100% maximum density to ASTM D69.
- .6 Precast units:
 - .1 Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base.

- .2 Make each successive joint watertight with Contract Administrator approved rubber ring gaskets, bituminous compound, cement mortar, epoxy resin cement, or combination of these materials.
- .3 Clean surplus mortar and joint compounds from interior surface of unit as work progresses.
- .4 Plug lifting holes with precast concrete plugs set in cement mortar or mastic compound.
- .7 For sewers:
 - .1 Place stub outlets and bulkheads at elevations and in positions indicated.
 - .2 Bench to provide smooth U-shaped channel.
 - .1 Side height of channel to be 0.75 times full diameter of sewer.
 - .2 Slope adjacent floor at 1 in 20.
 - .3 Curve channels smoothly.
 - .4 Slope invert to establish sewer grade.
- .8 Compact granular backfill to 95% maximum density to ASTM D698.
- .9 Place unshrinkable backfill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .10 Installing units in existing systems:
 - .1 Where new unit is installed in existing run of pipe, ensure full support of existing pipe during installation, [and carefully remove that portion of existing pipe to dimensions required] and install new unit as specified.
 - .2 Make joints watertight between new unit and existing pipe.
 - .3 Where deemed expedient to maintain service around existing pipes and when systems constructed under this project are ready for operation, complete installation with appropriate break-outs, removals, redirection of flows, blocking unused pipes or other necessary work.
- .11 Set frame and cover to required elevation on no more than 4 courses of brick.
 - .1 Make brick joints and join brick to frame with cement mortar.
 - .2 Parge and make smooth and watertight.
- .12 Place frame and cover on top section to elevation as indicated.
 - .1 If adjustment required use concrete ring.
- .13 Clean units of debris and foreign materials.
 - .1 Remove fins and sharp projections.
 - .2 Prevent debris from entering system.
- .14 Install safety platforms in maintenance holes having depth of 5 m or greater, as indicated.

3.5 ADJUSTING TOPS OF EXISTING UNITS

- .1 Remove existing gratings, frames and I beam and store for re-use at locations designated by Contract Administrator.
- .2 Sectional units:
 - .1 Raise or lower straight walled sectional units by adding or removing precast sections as required.
 - .2 Raise or lower tapered units by removing cone section, adding, removing, or substituting riser sections to obtain required elevation, then replace cone section.
 - .1 When amount of raise is less than 600 mm use standard maintenance hole brick, moduloc or grade rings.
- .3 Monolithic units:
 - .1 Raise monolithic units by roughening existing top to ensure proper bond and extend to required elevation with mortared brick course for 150 mm or less alteration.
 - .2 Lower monolithic units with straight wall by removing concrete to elevation indicated for rebuilding.
 - .3 When monolithic units with tapered upper section are lowered more than 150 mm, remove concrete for entire depth of taper plus as much straight wall as necessary, then rebuild upper section to required elevation with cast-in-place concrete.
 - .4 Install additional maintenance hole ladder rungs in adjusted portion of units as required.
 - .5 Re-use existing gratings, frames and I beams.
 - .6 Re-set gratings and frames to required elevation on not more than 4 courses of brick.
 - .1 Make brick joints and join brick to frame with cement mortar, parge and trowel smooth.
 - .2 Re-set gratings and frames to required elevation on full bed of cement mortar, parge and trowel smooth.

3.6 SEALING OVER EXISTING UNITS

- .1 Cut galvanized iron sheet to extend 50 mm beyond opening of existing maintenance hole or catch basin grating.
 - .1 Center iron sheet over existing grating and spot or stitch weld to grating.
- .2 Fill with cast-in-place concrete.

3.7 FIELD QUALITY CONTROL

- .1 Leakage Test:
- .2 Install watertight plugs or seals on inlets and outlets of each new storm sewer maintenance hole and fill maintenance hole with water.
- .3 Leakage not to exceed 0.3% per hour of volume of maintenance hole.

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- .4 If permissible leakage is exceeded, correct defects.
- .5 Repeat until approved by Contract Administrator.
- .6 Contract Administrator will issue Test Certificate for each maintenance hole passing test.

END OF SECTION

Part 1 General

1.1 SCHEDULING

- .1 Schedule Work to minimize interruptions to existing services and to maintain existing flow during construction.
- .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for pipes, and backfill and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Shop drawings to indicate proposed method for installing carrier pipe for undercrossings.
 - .2 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
- .4 Samples:
 - .1 Inform Contract Administrator at least 4 weeks prior to beginning Work, of proposed source of bedding materials and provide access for sampling.
- .5 Certification to be marked on pipe.
- .6 Test and Evaluation Reports: submit manufacturer's test data and certification at least 2 weeks prior to beginning Work.
- .7 Manufacturer's Instructions: submit to Contract Administrator 1 copy of manufacturer's installation instructions.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect pipes from damage.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PLASTIC PIPE

- .1 Type PSM Poly Vinyl Chloride (PVC): to ASTM D3034, CAN/CSA-B1800.
 - .1 Standard Dimensional Ratio (SDR): 28.
 - .2 Locked-in gasket and integral bell system.
 - .3 Nominal lengths: 4m or 6m.
- .2 Large diameter, ribbed PVC sewer pipe and fittings: to ASTM F794, CAN/CSA-B1800.
- .3 Corrugated polyethylene pipe: high density to ASTM F667, ASTM F405, BNQ-3624-115.
- .4 Acrylonitrile - Butadiene - Styrene (ABS): to ASTM D2680, CAN/CSA-B1800.

2.2 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1, CAN/CGSB-8.2.
- .2 Table:

Sieve Designation (mm)	% Passing	
	Stone/Gravel	Gravel/Sand
200	-	-
75	-	-
50	-	-
38.1	-	-
25	100	-
19	-	-
12.5	65-90	100
9.5	-	-
4.75	35-55	50-100
2.00		30-90
0.425	10-25	10-50
0.180	-	-
0.075	0-8	0-10

- .3 Concrete mixes and materials for bedding, cradles, encasement, supports: in accordance with Section 03 30 00 - Cast-in-Place Concrete.

2.3 BACKFILL MATERIAL

- .1 As indicated Granular A.
- .2 Type 2 in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .3 Unshrinkable fill: in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.4 JOINT MORTAR

- .1 Portland cement: to CAN/CSA-A3000, normal type 2.
- .2 Mortar: one part Portland cement to two parts clean sharp sand mixed with minimum amount of water to obtain optimum consistency for use intended. Do not use additives.

Part 3 Execution

3.1 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control drawings.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 Clean pipes and fittings of debris and water before installation, and remove defective materials from site to approval of Contract Administrator.

3.2 TRENCHING

- .1 Do trenching Work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Protect trench from contents of sewer.
- .3 Trench alignment and depth to approval of Contract Administrator prior to placing bedding material and pipe.
- .4 Water jetting of backfill under haunches of corrugated steel pipe may be permitted if recommended by manufacturer and approved by Contract Administrator.

3.3 CONCRETE BEDDING AND ENCASEMENT

- .1 Do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete. Place concrete to details as directed by Contract Administrator.
- .2 Position pipe on concrete blocks to facilitate placing of concrete.
 - .1 When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.
- .3 Backfill over concrete once cured to at least 80% specified compressive strength and as directed by Contract Administrator.

3.4 GRANULAR BEDDING

- .1 Place bedding in unfrozen condition.

- .2 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
 - .1 Do not use blocks when bedding pipes.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% maximum density to ASTM D698.
- .6 Fill excavation below bottom of specified bedding adjacent to manholes or catch basins with compacted bedding material.

3.5 INSTALLATION

- .1 Lay and join pipes to: ASTM C12.
- .2 Lay and join pipe in accordance with manufacturer's recommendations and to approval of Contract Administrator.
- .3 Handle pipe using methods approved by Contract Administrator.
 - .1 Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
- .4 Lay pipes on prepared bed, true to line and grade with pipe inverts smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .5 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .6 Lay corrugated steel pipe:
 - .1 With outside circumferential laps facing upgrade and longitudinal laps or seams at side or quarter points.
 - .2 With longitudinal centre line of paved invert coinciding with flow line.
- .7 Joint deflection permitted within limits recommended by pipe manufacturer.
- .8 Water to flow through pipes during construction only as permitted by Contract Administrator.
- .9 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .10 Install plastic pipe and fittings in accordance with CAN/CSA-B1800.
- .11 Joints:
- .12 When any stoppage of Work occurs, restrain pipes as directed by Contract Administrator, to prevent "creep" during down time.
- .13 Plug lifting holes with Contract Administrator approved prefabricated plugs, set in shrinkage compensating grout.

- .14 Cut pipes as required for special inserts, fittings or closure pieces, as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .15 Make watertight connections to manholes and catch basins.
 - .1 Use shrinkage compensating grout when suitable gaskets are not available.
- .16 Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes.
 - .1 Joint to be structurally sound and watertight.
- .17 Temporarily plug open upstream ends of pipes with removable watertight concrete, steel or plastic bulkheads.

3.6 PIPE SURROUND

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Contract Administrator has inspected pipe joints, surround and cover pipes as indicated.
 - .1 Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
 - .1 Do not dump material within 1m of pipe.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 95 % maximum density to ASTM D698.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 90 % maximum density to ASTM D698.
- .7 When field test results are acceptable to Contract Administrator, place surround material at pipe joints.

3.7 BACKFILL

- .1 Place backfill material in unfrozen condition.
- .2 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .3 Under paving and walks, compact backfill to at least 95 % maximum density to ASTM D698. In other areas, compact backfill to at least 90 % maximum density to ASTM D698.
- .4 Place unshrinkable backfill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.8 FIELD TESTS AND INSPECTIONS

- .1 Repair or replace pipe, pipe joint or bedding found defective.

- .2 Draw tapered wooden plug with diameter of 50 mm less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction directed by Contract Administrator.
- .3 Remove foreign material from sewers and related appurtenances by flushing with water.
- .4 Television and photographic inspections:
 - .1 Carry out inspection of installed sewers by television camera, photographic camera or by other related means.
 - .2 Provide means of access to permit Contract Administrator to do inspections.
 - .3 Payment for inspection services in accordance with Price and Payment Procedures in PART 1.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes requirements for supply and installation of perimeter foundation drainage system with granular filter and/or geotextile filter material.

1.2 RELATED REQUIREMENTS

1.3 REFERENCES

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM C4-04(2018), Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile.
 - .2 ASTM C136/C136M-19, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM C444/C444M-17 Standard Specification for Perforated Concrete Pipe (Metric).
 - .4 ASTM C654M-19, Standard Specification for Porous Concrete Pipe (Metric).
 - .5 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series. (Withdrawn)
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric. (Withdrawn)
- .3 Canadian Standards Association (CSA):
 - .1 CSA A23.1-19/A23.2-19, Concrete materials and methods of concrete construction / Test methods and standard practices for concrete.
 - .2 CSA B1800-18, Thermoplastic Non-pressure Piping Compendium, Includes Update No. 1 (2019)
 - .3 CAN/CSA-G401-14 (R2019), Corrugated Steel Pipe Products.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals Procedures.
 - .1 Submit manufacturer's product literature for each product listed including manufacturer's recommended installation procedures and any modifications required to suit installation conditions.
- .2 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Drainage Pipe: Provide a 300 mm length of perforated pipe and end connection.
 - .2 Filter Fabric: Provide 600 mm x 600 mm filter cloth sample for review and acceptance.
- .3 Certificates:

- .1 Submit manufacturer's test data and certification that drain pipe materials meet requirements of this Section at least two weeks prior to beginning Work.
- .2 Submit proposed source of granular bedding and filter materials a minimum of two weeks before beginning work of this Section, indicate gradation and certification of expected flow rate of granular materials.
- .3 Certification to be marked on pipe.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle, store and protect materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Store materials in accordance with manufacturer's written instructions.
- .3 Packaging Waste Management
 - .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Corrugated Plastic Drainage Tubing: PVC DR 35 to CSA B182.1, perforated, tapered ends, sizes as indicated on drawings. Unperforated matching pipe leads.
- .2 Other pipe as indicated on the drawings or as directed by the Consultant.
- .3 Filter Gravel: Coarse aggregates to CSA A23.1, Table Three, Group 1, 20 mm to 5 mm nominal size of aggregate.
- .4 Filter Cloth and Sock: Tensile strength minimum 400 N, equivalent opening size 120 microns or less.
 - .1 Basis-of-Design Materials:
 - .1 DLCS100, Earthmate, CCG
- .5 Accessories: Drainage pipe couplings (where pipe does not have bell connectors), end caps, clean-outs, and access covers, all as required for complete system.
- .6 Geotextile filter: Geotextile to be non-woven plastic, non-biodegradable type designed for separation of fill materials while permitting movement of ground water.
 - .1 Basis-of-design Material:
 - .1 NudrainPD20, Nillex.

Part 3 Execution

3.1 PREPARATION

- .1 Trenching

- .1 Do excavating, trenching and backfilling in accordance with Section 31 23 10 – Excavating, Trenching, and Backfilling.
- .2 Trim and compact trench bottom to provide firm uniform support throughout length of pipe.
- .3 Allow 100 mm clearance on both sides of pipe for filter aggregate.
- .2 Bedding
 - .1 Place 100 to 150 mm layer of bedding filter material as indicated and compact to minimum 95% of maximum density to ASTM D698.

3.2 INSTALLATION OF PIPE SUB-DRAINS

- .1 Lay pipe drains on prepared bed, true to line and grade with inverts smooth and free of sags or high points.
- .2 Place at trench bottom the geotextile fabric of sufficient width to completely wrap around filter aggregate and pipe with minimum 300 mm overlap. Alternatively a sock of approved geotextile fabric may be slipped over the pipe.
- .3 Ensure barrel of each pipe is in contact with bed throughout full length.
- .4 Begin laying at outlet and proceed in upstream direction.
- .5 Lay perforated pipes on fabric with perforations 2/3 down.
- .6 Lay bell and spigot pipe with bell ends facing upstream.
 - .1 Do not mortar joints.
- .7 Make joints tight in accordance with manufacturer's instructions.
- .8 Make watertight connections to existing drains, new or existing manholes and catch basins where indicated or as directed by Consultant. Seal joints with approved sealant.
- .9 Plug open upstream ends of pipes with watertight concrete, steel or wood bulkheads.
- .10 Surround and cover drain with filter material in uniform 150 mm layers to an elevation of at least 150 mm above top of drain and compact to at least 95% maximum density to ASTM D698. Level aggregate surface and overlap the fabric.
- .11 Cover filter material with geotextile filter.
- .12 Backfill remainder of trench to Section 31 23 00 – Excavation and Fill and as directed by Consultant.
- .13 Do not place bedding surround and backfill materials in frozen condition.
- .14 Protect sub-drains against flotation during installation.
- .15 Install "Y" connections to surface as indicated, for flushing.

END OF SECTION