CITY OF BRAMPTON FIRE STATION #201

27 RUTHERFORD ROAD SOUTH, BRAMPTON, ONTARIO

salter pilon architecture inc.

Project Manual

Volume 1
Divisions 0-33

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Read Jones Christoffersen Limited
Structural Consultants

Quasar Consulting Group
Mechanical Consultants

Quasar Consulting Group
Electrical Consultants

MTE Consultants Inc
Civil Consultants

Hill Design Studio Inc
Landscape Consultants

ARCHITECTURAL SUBCONSULTANT'S SEAL	

CIVIL SUBCONSULTANT'S SEAL	

LANDSCAPE SUBCONSULTANT'S SEAL	

STRUCTURAL SUBCONSULTANT'S SEAL	

MECHANICAL & ELECTRICAL SUBCONSULTANT'S SEAL	

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1 GENERAL

.1 Information on existing conditions made available to bidders under this section, is included in the Bid Documents for information purposes only, and does not form part of the Contract Documents.

.2 The Owner and Consultant assume no responsibility for the scope and accuracy of the information contained in the documents listed herein.

.3 The Contractor shall be responsible for conducting an on-site evaluation of conditions which can be observed and for correlation of these conditions with the information included under this section.

.4 Information contained in documents listed here may be used by the Contractor to assist in an assessment of existing conditions. Evaluation of the information shall remain the responsibility of the Contractor.

2 GEOTECHNICAL REPORT

.1 Refer to specification Section 02 32 00 – Geotechnical Information.

END OF SECTION

1 SUMMARY OF WORK

.1 The project consists of the construction of a new one (1) storey fire station at 27 Rutherfor Road South, Brampton, Ontario.

.2 Work by Owner comprises the following:

.1 Installation of Owner equipment and furnishings.

2 WORK RESTRICTIONS

.1 Contractor's Use Of Site

.1 Use of site to the areas designated on the drawings for execution of the Work. Do not unreasonably encumber site with materials or equipment. Move stored products or equipment which interfere with operations of Owner, or other contractors. Obtain and pay for use of off-site additional storage, or work areas as required by the Work.

.2 Hours of Work

.1 Hours of work for this Contract are generally confined to regular daily business hours of 8am to 5pm, Monday to Friday. Where required by sequencing of the Work, portions of the Work may be required to be performed outside of regular daily business hours, or on weekends, but shall be performed at such times at no additional cost to the Owner.

.3 OFF SITE WORK

.1 All work beyond property lines, adjacent to the site, or beyond Extent of Contract (EOC) line is included in Contract unless noted otherwise.

END OF SECTION

1 GENERAL

.1 Include all allowances listed below in the Bid Price.

.2 Expend Cash Allowances as directed by the Consultant.

.3 Each Cash Allowance will be adjusted to actual cost as defined hereunder and Contract Price will be amended accordingly by written order.

.4 Progress payments for work and material authorized under Cash Allowances will be made in accordance with GC 5.3 of the Contract.

.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 Cash allowances do not include H.S.T.

2 MATERIAL ALLOWANCES (SUPPLY ONLY)

.1 Material cash allowance shall include and provide payment for:
- .1 Net cost of material.
- .2 Applicable duties and taxes.
- .3 Delivery to the Place of the Work.

.2 Include in the Bid Price, in addition to the material cash allowance, costs for the following:
- .1 Handling at the Place of the Work, including unloading, uncrating, storage and hoisting.
- .2 Protection from damage by elements or otherwise.
- .3 Labour for installation and finishing.
- .4 Other expenses required to complete installation.
- .5 Overhead and profit.

3 ASSEMBLY ALLOWANCES (SUPPLY AND INSTALL)

.1 Assembly cash allowance shall include and provide payment for:
- .1 Net cost of material.
- .2 Applicable duties and taxes.
- .3 Delivery to the Place of the Work.
- .4 Assembly contractors'/suppliers' only, expenses relating to the following:
  - .1 Handling at site, including unloading, uncrating, storage and hoisting.
  - .2 Protection from damage by elements or otherwise.
  - .3 Labour installation and finishing.
  - .4 Other expenses required to complete installation.
  - .5 Overhead and profit.

.2 Include in the Bid Price any overhead and profit or related General Contractor costs.

4 TESTING & LABORATORY SERVICES

.1 Testing & Laboratory Services allowances shall include and provide payment for:

.1 Transportation costs to and from the Place of the Work,
.2 Personnel & equipment required to perform tests or inspections,
.3 Costs of shipping & handling samples to laboratory for testing,
.4 Applicable duties and taxes.

5 ALLOWANCE AMOUNTS

.1 The Total Cash Allowance to be included in the Stipulated Price is Three Hundred and Ninety-two Thousand and Five Hundred Dollars ($392,500) in Canadian funds.

.2 The Cash Allowance shall cover the following (in general):

.1 Inspection & Testing - for charges from independent company(s) to provide services related to all areas of the project that require inspection and testing.

.2 Pylon Sign - supply and installation of new exterior building signage. Note: conduit systems and provisions of power are supplied and installed as part of Division 26 - not changed against this Cash Allowance.

.3 Interior Signage - supply and installation of new interior building signage including all required room identification, way finding, department identification, etc.

.4 Finish Hardware – supply of all finish hardware for aluminum, wood, hollow metal doors and frames. Supply of finish hardware for aluminum doors installation by others.

.5 SCBA Compressor – Supply of equipment and installed outside of this Cash Allowance.

.6 Decommissioning of Monitoring wells.

.7 Communications Utility – supply and install of cabling and service. Note: The Electrical contractor shall be responsible for coordinating a serv ice agreement and all associated work with the communications company.

.8 Hydro Service Work – for charges from utility as required to provide new primary and portions of new secondary incoming electrical service.

.9 Natural Gas Utility – General Contractor to apply, obtain permit, complete testing and coordinate install.

.10 TRCA Permit Fees – General Contractor to apply and obtain permit with TRCA.

.11 Regional Service Permit Fees – General Contractor to apply and obtain permit with the Region of Peel.

.12 Water Utility –with the Region of Peel.

.13 Electrical Safety Authority – review of drawings and specifications by the ESA, refer to section 26 01 15 – Electrical Allowances and Fees. Electrical Note: General inspection fees are not to be part of this fee. The Contractors to determine general inspection fees and include in tender price.

END OF SECTION

1 MODIFICATIONS TO CONTRACT

.1 Supplemental Instruction: as issued by the Consultant, consistent with the intent of the Contract Documents, and will not involve an adjustment in Contract Price or Contract Time.

.2 Proposed Change: as issued by the Consultant, will notify the Contractor of an impending or proposed change to the Work, and will require submission of a quotation from the Contractor and all affected Subcontractors for each item noted. Submit quotation within the time period stipulated on the form, and indicate separate line items for labour and materials in each case. Work outlined in a Proposed Change must not proceed without the issuance of a Change Order signed by the Owner.

.3 Change Directive: will be issued by the Consultant where an immediate response is required to an on-site condition. This form will authorize the Contractor to proceed with the change, with the stipulation that accurate accounts of costs be recorded, and may contain an upset cost, as agreed upon by the Owner and the Contractor.

.4 Change Order: will be issued by the Consultant upon review and approval of quotations for a Proposed Change, or a Change Directive, and authorizes the Contractor to proceed with the change(s) proposed. A Change Order will amend the Contract Price, and/or the Contract Time.

2 FEES FOR CHANGES IN THE WORK

.1 The fees (mark-ups) permitted to be applied to the Contract Price for changes to the Work shall be in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2008) as provided.

.2 Fees (mark-ups) for Changes in the Work shall apply to all extras to the Contract Price in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2008) as provided.

.3 Fees (mark-ups) for Changes in the Work shall only apply to credits to the Contract Price in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2008) as provided.

END OF SECTION

1 APPLICATIONS FOR PAYMENT

.1 Applications for payment on account may be made monthly as the Work progresses, and shall be preceded by the submission of a Schedule of Values for review by the Consultant, in accordance with the Contract.

.2 The second and all subsequent applications for payment shall include a statement based on the Schedule of Values, a statutory declaration (CCDC 9A), and a standard Workers Compensation Certificate of Clearance.

2 SCHEDULE OF VALUES

.1 Submit Schedule of Values in spreadsheet form acceptable to the Consultant.

.2 Identify on each Schedule of Values, the following information:

.1 Date of Issue
.2 Project name
.3 Owner's name
.4 Contractor's name
.5 Payment period
.6 Payment certificate number

.3 Items of work listed shall include, but not be limited to, separate line items for the following:

.1 General Accounts
.2 Mobilization
.3 Supervision
.4 Bonds and Insurance
.5 Permits and Licenses
.6 Operations and Maintenance Manuals/As-Built Drawings
.7 All trades or portions of the Work, generally in chronological order
.8 Provision of other Products and/or services
.9 Cash Allowance expenditures
.10 Changes in the Work

.4 The total Contract amount for each trade or portion of the Work shall be listed beside each item.

.5 The Values of the Work shall be listed as to the aggregate percentage and dollar value completed, under the following major headings:

.1 Initial Contract Amounts for each line item,
.2 Progress to Date,
.3 Percent Complete,
.4 Current Invoice,
.5 Previous Billings,
.6 Contract Balance

.6 Work shall be subtotaled under original Contract amounts, Cash Allowance expenditures, and Changes to the Work.

.7 Final totals shall identify:
- .1 Total amount
- .2 Holdback deducted
- .3 Holdback released
- .4 Amount invoiced to date
- .5 Net amount
- .6 HST
- .7 Amount due this Certificate

END OF SECTION

1 PROJECT MANAGEMENT & COORDINATION

.1 Project Coordination

.1 The Contractor is responsible for the overall coordination of the Work. Coordinate the work of all subcontractors, and provide such assistance as is necessary, including but not limited to;

.1 Providing site dimensions and layout,

.2 Providing temporary facilities and controls,

.3 Scheduling subcontractors work to prevent conflicts,

.4 Scheduling and administering regular subtrade scheduling and coordination meetings throughout progress of the Work.

.5 Scheduling and administering regular subtrade safety meetings throughout progress of the Work.

.6 Coordinate construction sequences an schedules including all components of the Work, including all Divisions with interdependent responsibilities.

.2 The Contractor shall facilitate production of interference drawings where necessary for coordination of the Work. Provide such interference drawings to the Consultant for review.

.2 Project Supervision

.1 The Contractor shall provide and maintain full-time supervision on site until Substantial Performance is achieved and the deficiencies have been completed or otherwise agreed with the Owner. The supervisor shall be responsible for the overall day-to-day coordination on site between subtrades.

.2 The supervisor shall coordinate the work of all subcontractors, and provide such assistance as is necessary, including but not limited to;

.1 Layout,

.2 Rough carpentry work for blocking, strapping, nailers, etc.

.3 Project Meetings

.1 Attend all regular bi-weekly project progress meetings throughout progress of work.

.2 Consultant shall chair regular bi-weekly project progress meetings and shall record and distribute same to Owner, Contractor and Subconsultants. Contractor shall forward to appropriate subcontractors.

.4 Project Site Administration

.1 Maintain at job site, one copy each of the following:

.1 Contract drawings.

.2 Project manual.

.3 Addenda and Bid Revisions.

.4 Reviewed shop drawings.

.5 Change orders and other Contract modifications.

.6 Field test and inspection reports.

.7 Approved schedules.

.8 Manufacturer's installation and application instructions.

2 SCHEDULES

.1 Construction Progress Schedule.

.1 Prepare schedule in horizontal chart form, with weekly horizontal time scale identifying first/last work day of each week. Schedule must utilize "crtical path" method.

.2 Indicate separate line for each trade or operation of the Work. Arrange trades in chronological order for commencement of that part of the Work.

.3 Identify projected major milestones in the course of the Work such as completion of foundation work, structure, closing in, major inspections by building officials, Substantial Performance, etc.

.2 Submittal Schedule

.1 Provide schedule for submittal of all Shop Drawings, Product Data and Samples.

.2 Provide complete list of all manufacturered products to be used in the course of the Work, including those amended by addenda.

.3 Submission of Schedules

.1 Submit one copy of each schedule to the Consultant for review, prior to first progress billing. Amend schedule as required.

.2 Submit 4 copies of each subsequent issue of schedules to the Consultant.

.3 Update schedule on a regular basis or as requested by the Consultant.

3 ELECTRONIC FILE AGREEMENT

.1 Electronic files for this project will not be released until the Electronic Files Transfer Agreement, appended to this Section, has been completed and returned to the Consultant.

4 ADDITIONAL DOCUMENTS

.1 Consultant may issue additional documents in the form of drawings, specifications, schedules, or written instructions to assist proper execution of the Work. These documents shall take one of the following forms as defined in the Contract;

.1 Supplemental Instruction: no adjustment in Contract Price or Contract Time.

.2 Change Order: amendment to the Contract recommended by the Consultant, and agreed upon by the Owner and the Contractor.

5 SUBMITTAL PROCEDURES

.1 Submit to Consultant, all items specified for review, with reasonable promptness and in orderly sequence so as to not cause delay in the Work. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 The Contractor shall schedule a minimum of 10 working days in order for the Consultants to review each submission. This shall also apply to subsequent resubmissions.

.3 Do not proceed with work affected by the submittal until review is complete.

.4 Review all 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 coordinated with the requirements of the Work and the Contract Documents. Submittals not stamped, signed, and dated will be returned without review.

.5 Verify field measurements and affected adjacent work are coordinated.

.6 Contractor's responsibility for errors and omissions in submission, or deviations from requirements of Contract Documents, is not relieved by Consultant's review of submittals.

.7 Keep one reviewed copy of each submission on site.

.8 Shop Drawings

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by the Contractor to illustrate details of a portion of the Work.

.2 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, regardless of the Section under which the adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.3 Adjustments made on shop drawings by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the Work.

.4 Make changes in shop drawings as the Consultant may require, consistent with Contract Documents. When resubmitting, notify the Consultant in writing of any revisions other than those requested.

.5 Shop drawings shall be submitted electronically wherever possible. Files shall be in PDF format only.

.6 Shop drawings submitted by FAX, or as copies of FAX transmissions are not acceptable as shop drawings, and will not be reviewed.

.7 Reproductions of Consultants' drawings are not acceptable for the purpose of creating Shop Drawings. Any drawings submitted for review which contain drawings or any parts of drawings produced by the Consultant, will be rejected. The Consultant will not take responsibility for any resulting delays in construction as a result of the above.

.8 Shop drawings not submitted in the scale type of the contract documents (ie. metric for metric drawings) will not be reviewed.

.9 Product Data Sheets

.1 Manufacturer's standard schematics, catalogue sheets, diagrams, schedules, performance charts, illustrations and other descriptive data are acceptable in lieu of shop drawings, where specified.

.2 Product Data Sheets are acceptable provided they conform to the following:

.1 Information not applicable to project has been deleted.
.2 Supplement standard information to provide additional information applicable to project.
.3 Show dimensions and clearances required.
.4 Show performance characteristics and capacities.
.5 Show wiring diagrams, when requested, and controls.

.3 Submit product data sheets or brochures for requirements requested in specification Sections and as the Consultant may reasonably request where shop drawings will not be prepared due to standardized manufacture of product.

.4 Submit copies of all WHMIS Data Sheets.

.5 Submit 8 copies of Product Data Sheets.

.6 Product data sheets submitted by FAX, or as copies of FAX transmissions will not be accepted.

.10 Return of Submissions

.1 If upon review by the Consultant, no errors or omissions are discovered or if only minor corrections are made, the shop drawing transparency or one copy of the product data will be returned and fabrication and installation of Work may proceed.

.2 If shop drawings or data sheets are rejected, noted copy will be returned and resubmission of corrected shop drawings or data sheets through the same procedure indicated above, shall be performed before fabrication and installation of Work may proceed.

.11 Samples

.1 Submit samples for review, in duplicate, in sizes requested in respective specification sections. Label samples as to origin and intended use in the Work.

.2 Where colour, pattern or texture is criteria, submit full range of samples.

.3 Deliver samples prepaid to Consultant's office.

.4 Notify the Consultant in writing, at the time of submission of deviations in samples from requirements of Contract Documents.

.5 Adjustments made on samples by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the work.

.6 Make changes in samples which the Consultant may require, consistent with Contract Documents.

.7 Reviewed samples or mock-ups will become standards of workmanship and material against which installed work will be checked on project.

.12 Submission Requirements

.1 Accompany submissions with transmittal letter containing:

.1 Date,
.2 Project title and number,
.3 Contractor's name and address,
.4 Drawing/page numbers of each shop drawing or data sheet,
.5 Identification (ie. "Structural Steel Shop Dwgs."), and
.6 Number of copies submitted.

.2 Submissions shall include (where applicable) :

.1 Date and revision date,
.2 Project title and number,
.3 Name of Contractor, Subcontractor(s), Supplier/Manufacturer,
.4 Identification of product or material,
.5 Relation to adjacent structure or materials,
.6 Field dimensions, clearly identified as such,
.7 Reference standards (CSA, CGSB, ASTM, etc.), and
.8 Contractor's stamp, initialled or signed, certifying review of submission, and verification of field measurements.

.13 Distribution of Submittals after Review

.1 Distribute copies of shop drawings and product data which carry Consultant's stamp as follows (where applcable):

.1 Job site file (Record documents),
.2 General Contractor’s office,
.3 Subcontractors, and
.4 Suppliers or Fabricators.

END OF SECTION

Electronic Files Transfer Agreement

Architect of Record ("The Consultant"): salter pilon architecture inc.

Contractor ("The Contractor"): _____

Re ("The Owner"): City of Brampton Fire Station #201

The Contractor hereby acknowledges requesting from the Consultant, electronic data containing the graphic (electronic) representation of the Architectural Drawings *as per attached list of drawings*, subject to the condition that the said drawings are to be used only for information and reference in connection with the Owner's use and occupancy of the Project. The Contractor shall be responsible for checking and verifying all dimensions, details, and quantities of materials, and for the coordination of related elements as required to facilitate complete and accurate fabrication and installation. Any omissions or discrepancies shall be reported to the Consultant. The Contractor hereby warrants to the Consultant that the files will be used solely for the development of shop drawings. The drawings shall not be used for any other purpose on this project and shall not be used on any other project either by the Contractor or by others. The Contractor further warrants not to alter the electronic data or the information contained therein, in any way except for the above-noted purposes, and acknowledges that such unauthorized use or alteration of the original work is protected in accordance with the Copyright Act and subject to the penalties prescribed therein.

The Contractor hereby acknowledges that the said electronic data contain information which may be updated or altered at any time by the Consultant, and that it is the responsibility of the Contractor to make themselves aware of these changes, in a timely manner. In the event of a conflict between the drawings issued to the Contractor and the sealed contract drawings, the sealed contract drawings shall govern.

The Contractor agrees to pay the Consultant $200.00 per file, plus any and all applicable taxes. The fees are to cover the costs of preparation of the electronic data, and disbursements related to the preparation and shipment/forwarding of the electronic data only. By paying the fees, the Contractor has in no way purchased the drawings or any rights to the drawings or the information contained therein, and the Contractor may only alter the drawings for the purposes noted above.

The Contractor shall, to the fullest extent permitted by law, indemnify, defend and hold harmless the Consultant, and its sub-consultants from all claims, damages, losses, expenses, penalties and liabilities of any kind, including attorney's fees, arising out of, or resulting from the use of the electronic files by the Contractor, or by third party recipients of the electronic files from the Contractor.

The Consultant believes that no licensing or copyright fees are due to others on account of the transfer of the electronic files, but to the extent any are, the Contractor will pay the appropriate fees and hold the Consultant harmless from such claims.

Any purchase order number provided by the Contractor is for Contractor's accounting purposes only. Purchase order terms and conditions are void and are not a part of this agreement.

The laws of the Province of Ontario shall govern this agreement.

The conditions and undertakings expressed herein apply to partners, employees, agents, successors, assigns and legal or other representatives of the Contractor.

AUTHORIZED ACCEPTANCE

by Consultant

_____
Signature

_____
Print Name and Title

Date _____

by Contractor

_____
Signature

_____
Print Name and Title
(Authorized Signing Officer)

Date _____

1 GENERAL

.1 Provide construction photographs in accordance with procedures and submission requirements specified in this section.

.2 Photographs shall be taken using a digital camera.

2 PROGRESS PHOTOGRAPHS

.1 Provide 1 digital set of construction photographs, documenting progress of the Work. Submit one digital set with each monthly progress draw. Maintain one printed set on site, in clear plastic photo sleeves bound in 3-ring binder.

.2 Submit progress photographs with each monthly progress draw, and at the following milestones;

.1 Completion of excavation and pouring of footings,
.2 Completion of foundations prior to backfilling,
.3 Completion of structural frame,
.4 Completion of rough-in of mechanical and electrical services before concealment.
.5 Completion of each major portion of work
.6 Completion of each major finish item.

.3 Orientation of Photographs: provide photos from 4 general viewpoints, as well as specific views as required by milestones specified above, and as determined by Consultant prior to first Progress Draw.

3 FINAL PHOTOGRAPHS

.1 Submit site copy of printed progress photographs with Operations & Maintenance Manuals at the completion of the project.

.2 In addition to progress photographs, provide 1 digital set of images, and 2 printed sets, of final photographs of the completed project.

.3 Orientation of Photographs: provide final photos as follows:

.1 General viewpoints as defined above,
.2 Views of all exterior elevations,
.3 One view from each street,
.4 Views of site showing parking areas and play surfaces,
.5 Interior views of all major spaces,
.6 One set of views of a typical room,
.7 Specific views as determined by Consultant (Max. 48 views).

.4 Identification: Typewritten identification on 20 x 50mm white label on top left corner of all photographs indicating the following:

.1 Project name and number,
.2 Orientation,
.3 Date of exposure.

.5 Photo Print Finish: matte with binding margin at one long edge.

.6 Mounting & Binding: Final photos shall be mounted in clear plastic sleeves purpose-made for 3-ring binder storage. Bind sets individually into black, 3-ring binders, labelled on front and spine as follows:

PROJECT RECORD PHOTOGRAPHS
City of Brampton Fire Station #201
Completed to follow

END OF SECTION

1 GENERAL

1.1 SECTION INCLUDES
- .1 Requirements for quality of work.
- .2 Requirements for for material inspection and testing.
- .3 Requirements for determination of defective materials and work.

1.2 REFERENCE STANDARDS
- .1 CSA A23.1; Concrete Materials and Methods of Concrete Construction.
- .2 CSA A23.2; Methods of Test for Concrete.
- .3 CSA S16.1; Limit States Design of Steel Structures.
- .4 CSA W47.1; Certification of Companies for Fusion Welding of Steel Structures.
- .5 CSA W59; Welded Steel Construction (Metal Arc Welding).
- .6 CISC; Code of Standard Practice for Structural Steel.
- .7 OPSS; Ontario Provincial Standard Specifications.

1.3 REGULATORY REQUIREMENTS
- .1 Products and services provided to complete the Work shall meet or exceed requirements of specified standards, municipal by-laws, building codes and referenced documents.

1.4 INDEPENDENT INSPECTION AND TESTING
- .1 Independent Inspection and Testing Consultants will be engaged by the Owner for the purpose of inspecting and/or testing individual portions of the Work. The cost of such services will be paid by Cash Allowance.

1.5 RESPONSIBILITIES
- .1 Inspection and Testing Consultants
  - .1 Inspection and Testing Consultants shall;
    - .1 Provide inspection and testing specified,
    - .2 Inform the Contractor and Consultant immediately upon observance of materials, systems, or procedures not in compliance with the specifications, and
    - .3 Submit complete reports to the Contractor and the Consultant in a timely manner.

- .2 Contractor
  - .1 Contractor shall:
    - .1 Provide access to the Work for Inspection/Testing Consultants, and
    - .2 Inform the Inspection/Testing Consultants in advance of day and time required for inspection and tests.

  - .2 It is the responsibility of the General Contractor to ensure the quality control requirements of the Contract are implemented.

- .3 Consultant
  - .1 The Consultant will make final decisions on changes to the scope of work of inspection and testing that may affect the Contract Price.

.2 When informed of of any material procedure or test result that does not meet or exceed the specifications, the Consultant will respond in an expedient manner to resolve the issue.

1.6 ACCESS TO WORK

.1 Allow inspection & testing companies access to the Work, as well as off site manufacturing and fabrication plants.

1.7 REPORTS

.1 Submit three copies of inspection and test reports to the Consultant.

.2 Provide copies to Subcontractor of work being inspected or tested, manufacturer or fabricator of material being inspected or tested.

.3 Submit one copy of inspection and test reports to the Building Official having jurisdiction, where required by that official.

.4 The cost of tests beyond those called for in the Contract Documents or beyond those required by the law of the Place of Work shall be appraised by the Consultant and may be authorized as recoverable.

1.8 EARTHWORK

.1 All earthwork shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:

.1 Inspection of excavations for foundations.
.2 Inspection of subgrade and granular fill materials.
.3 Inspection of backfill operations.
.4 Inspection and testing of backfill compaction.
.5 Inspection of trenching and bedding associated with underground services.
.6 Inspection and testing of fill and compaction associated with underground services.

1.9 CAST-IN-PLACE CONCRETE

.1 All cast-in-place concrete shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:

.1 Verification of materials delivered to site.
.2 Slump tests.
.3 Sampling of cylinders, and compressive strength tests.

1.10 MASONRY MORTAR

.1 All masonry mortar shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:

.1 Visual inspection of all materials.
.2 Sampling and testing of mortar cubes.

1.11 STRUCTURAL STEEL

.1 All structural steel shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:

.1 Confirmation that materials supplied meet specifications.
.2 Shop inspection during fabrication of steel.

.3 Checking welders' CWB Certification.
.4 Checking fabricated members against design member shapes.
.5 Checking fabricated members against allowable sweep and camber.
.6 Checking fabricated members against specified camber.
.7 Visual inspection of all welded connections including spot checking of joint preparation and fit-up.
.8 Non-destructive testing of welding.
.9 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.
.10 Inspection of field cutting.
.11 Inspection and testing of all field bolted connections.
.12 Visual inspection of all welds securing steel deck to structural steel.
.13 Visual inspection of all bearing plate locations.

1.12 STRUCTURAL STEEL STUDS

.1 All structural steel studs shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
.1 Confirmation that materials supplied meet specifications.
.2 Shop inspection during fabrication.
.3 Checking welder’ CWB Certification.
.4 Checking fabricated members against design member shapes.
.5 Visual inspection of all welded connections including spot checking of joint preparation and fit-up.
.6 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.
.7 Inspection of all field bolted or welded connections.

1.13 SPRAY-IN-PLACE INSULATION

.1 All spray-in-place insulation shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
.1 Visual inspection of total application for defects.
.2 Visual inspection of all transitions and detailing at penetrations.
.3 Verification of applied thickness.

1.14 AIR/VAPOUR BARRIERS

.1 All building envelope air/vapour barrier components shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
.1 Visual inspection of total membrane for defects.
.2 Visual inspection of all transition membranes.
.3 Pull test to verify adhesion.

1.15 SPRAY APPLIED THERMAL BARRIER

.1 All spray applied thermal barrier shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
.1 Inspection of all spray applied thermal barrier materials to verify compliance with specifications.
.2 Inspection of spray applied themral barrier application.

1.16 ROOFING

.1 All roofing shall be subject to inspection as specified herein. Inspection and Testing shall include:

.1 Inspection of all roofing materials to verify compliance with specifications.

.2 Inspection of roofing application.

1.17 FIRESTOPS AND SMOKE SEALS

.1 All firestopping and smoke seals shall be subject to inspection as specified herein. Inspection and Testing shall include:

.1 Inspection of materials to verify compliance with specifications.

.2 Visual inspection of all applications.

1.18 CURTAIN WALL

.1 All curtain wall systems shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:

.1 Site inspection of materials and installation methods.

.2 Shop inspection of materials and fabrication, and

.3 Site testing for air/water penetration.

1.19 ASPHALT PAVING

.1 All asphalt paving shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:

.1 Inspection and compaction testing of all granular base courses.

.2 Marshal Density testing of asphalt material.

.3 Compaction testing of all courses of asphalt paving.

2 PRODUCTS

(RESERVED)

3 EXECUTION

3.1 INSPECTION AND TESTING - GENERAL

.1 Furnish test results and mix designs as may be requested.

.2 The cost of tests and mix designs beyond those called for in the Contract Documents or beyond those required by the law of the Place of Work shall be appraised by the Consultant and may be authorized as recoverable.

3.2 INSPECTION AND TESTING - PROCEDURES

.1 Notify the appropriate agency and Consultant in advance of the requirement for tests, in order that attendance arrangements can be made.

.2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in the Work.

.3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store, cure and inspect test samples.

3.3 QUALITY OF THE WORK

.1 Quality of the Work shall be first class, executed by workers experienced and skilled in the respective duties for which they are employed. Immediately notify the Consultant if required work is such as to make it impractical to produce required results.

.2 Do not employ any unfit person or anyone unskilled in their required duties. The Consultant reserves the right to require the dismissal from the site, of workers deemed incompetent, careless, insubordinate or otherwise objectionable.

3.4 DEFECTIVE MATERIALS AND WORK

.1 Refer to GC 2.4 of CCDC 2-2008.

.2 Where evidence exists that defective work has occurred, or that work has been carried out incorporating defective products, the Consultant may have independent tests, inspections, or surveys performed in order to determine if work is defective.

.3 Tests, inspections, or surveys carried out under these circumstances will be made at the Contractor's expense in the event of defective work, or at the Owner's expense where work is in conformance. Where tests incorporate a number of samples, payment will be assessed, by the Consultant, based on the ratio of conforming to non-conforming results. This does not include re-testing of soil compaction during placement, where evidence exists of non-conformance with the Contract documents, but rather only if re-testing is called for after completion of compaction.

END OF SECTION

1 GENERAL

1 SECTION INCLUDES
- .1 Codes and Standards.
- .2 Authority Having Jurisdiction.
- .3 Permits and Fees.
- .4 Relics, Antiquities and Human Remains.

2 CODES AND STANDARDS

.1 Codes

.1 All construction shall conform to the Ontario Building Code, the National Building Code (NBC) and the National Fire Code (NFC) latest editions including all supplements and amendments.

.2 Conform to all other codes, by-laws and regulations as specified within individual sections of the specifications.

.2 Industry Standards

.1 Industry Standards are specified within individual sections as applicable to those portions of the Work. The latest editions of all industry standards shall be the standards for which quality of work shall be assessed.

.2 Comply with all relevent codes, standards and industry-accepted practices, as specified herein, or as applicable to the Work.

3 AUTHORITIES HAVING JURISDICTION

.1 The Chief Building Official of the Municipality of the Place of the Work, is the primary Authority Having Jurisdiction for compliance with all codes, by-laws and regulations as they apply to all construction.

.2 Other Authorities Having Jurisdiction may be required to review and approve certain portions of the Work. The Chief Building Official of the Municipality of the Place of the Work, will determine the requirements for such involvement.

4 PERMITS AND FEES

.1 No construction work may commence without a valid, posted Building Permit.

.2 The Owner is responsible for obtaining all necessary information and applying for the Building Permit, including payment of associated fees.

.3 The Contractor is responsible for applying for, and obtaining all necessary permits, licenses, or certificates required by the Work.

.4 Authorities Having Jurisdiction may levy fees for issuing permits, licenses, or certificates under their jurisdiction. The Contractor shall pay all such fees as required, and shall include the cost of such fees in their Contract Price.

.5 Furnish certificates and permits from other Authorities Having Jurisdiction when so requested by the Consultant.

.6 Prior to commencement of construction, post the Building Permit at the Place of the Work.

5 RELICS, ANTIQUITIES AND HUMAN REMAINS

.1 Comply with the General Conditions of the Contract with respect to relics, antiquities, and human remains.

.2 Isolate and protect human remains, relics, antiquities, items of historical, archeological or scientific interest such as cornerstones, commemorative plaques, inscribed tablets and other similar objects found during the course of the Work.

.3 If such items are discovered in the course of construction, stop work in the immediate vicinity, and give immediate notice to the Consultant as to the nature of the discovery, and await written instructions before proceeding with work in the area.

.4 Resume work only after the conclusion of any inspection and evaluation by experts engaged by the Owner, and only after being given permission to do so.

.5 Relics, antiquities and items of historical or specific interest remain the Owner's property.

END OF SECTION

Abbreviations listed, when used in the Contract Documents, shall have the following meanings:

ABBREVIATION	MEANING
AA	ALUMINUM ASSOCIATION
AAMA	ARCHITECTURAL ALUMINUM MANUFACTURERS` ASSOCIATION
AASHO	AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS
ACI	AMERICAN CONCRETE INSTITUTE
AGA	AMERICAN GAS ASSOCIATION
AIA	AMERICAN INSTITUTE OF ARCHITECTS
AIMA	ACOUSTICAL & INSULATING MATERIALS ASSOCIATION
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISI	AMERICAN IRON AND STEEL INSTITUTE
AMCA	AIR MOVING AND CONDITIONING ASSOCIATION INC.
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
ASHRAE	AMERICAN SOCIETY OF HEATING, REFRIGERATING & AIR CONDITIONING ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AWI	ARCHITECTURAL WOODWORK INSTITUTE (USA)
AWMAC	ARCHITECTURAL WOODWORK MANUFACTURERS ASSOCIATION OF CANADA
AWS	AMERICAN WELDING SOCIETY
CCA	CANADIAN CONSTRUCTION ASSOCIATION
CCRC	CANADIAN CODE FOR RESIDENTIAL CONSTRUCTION
CEC	CANADIAN ELECTRICAL CODE
CFUA	CANADIAN FIRE UNDERWRITERS ASSOCIATION
CGA	CANADIAN GAS ASSOCIATION
CGSB	CANADIAN GENERAL STANDARDS BOARD
CIQS	CANADIAN INSTITUTE OF QUANTITY SURVEYORS
CISC	CANADIAN INSTITUTE OF STEEL CONSTRUCTION
CITC	CANADIAN INSTITUTE OF TIMBER CONSTRUCTION
CLA	CANADIAN LUMBERMEN`S ASSOCIATION
CMHC	CANADA MORTGAGE & HOUSING CORPORATION
COFI	COUNCIL OF FOREST INDUSTRIES OF BRITISH COLUMBIA
CPCI	CANADIAN PRESTRESSED CONCRETE INSTITUTE
CRCA	CANADIAN ROOFING CONTRACTORS ASSOCIATION
CSA	CANADIAN STANDARDS ASSOCIATION
CSC	CONSTRUCTION SPECIFICATIONS CANADA
CSI	CONSTRUCTION SPECIFICATIONS INSTITUTE (USA)
CSPI	CORRUGATED STEEL PIPE INSTITUTE
CSSBI	CANADIAN SHEET STEEL BUILDING INSTITUTE
CUA	CANADIAN UNDERWRITERS` ASSOCIATION
CWB	CANADIAN WELDING BUREAU
CWC	CANADIAN WOOD COUNCIL
DND	DEPARTMENT OF NATIONAL DEFENCE, CANADA
FM	FACTORY MUTUAL ENGINEERING CORPORATION
FS	FEDERAL SPECIFICATION (USA)
IES	ILLUMINATING ENGINEERING SOCIETY
IGMAC	INSULATED GLASS MANUFACTURERS ASSOCIATION OF CANADA
LTIC	LAMINATED TIMBER INSTITUTE OF CANADA
MIA	MARBLE INSTITUTE OF AMERICA
MPMDD	MODIFIED PROCTOR MAXIMUM DRY DENSITY
NAAMM	NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (USA)
NBFU	NATIONAL BOARD OF FIRE UNDERWRITERS
NBC	NATIONAL BUILDING CODE OF CANADA

NBS	NATIONAL BUREAU OF STANDARDS (USDC)
NEMA	NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NHLA	NATIONAL HARDWOOD LUMBER ASSOCIATION (USA)
NLGA	NATIONAL LUMBER GRADES AUTHORITY
NRC	NATIONAL RESEARCH COUNCIL
OBC	ONTARIO BUILDING CODE
OHSA	OCCUPATIONAL HEALTH AND SAFETY ACT
OPSS	ONTARIO PROVINCIAL STANDARD SPECIFICATIONS
PCA	PORTLAND CEMENT ASSOCIATION
PCI	PRESTRESSED CONCRETE INSTITUTE
SDI	STEEL DECK INSTITUTE
SPMDD	STANDARD PROCTOR MAXIMUM DRY DENSITY
SSPC	STEEL STRUCTURES PAINTING COUNCIL
TTMAC	TERRAZZO, TILE & MARBLE ASSOCIATION OF CANADA
ULC	UNDERWRITERS LABORATORIES CANADA
UL	UNDERWRITERS LABORATORIES (USA)
USAS	UNITED STATES OF AMERICA STANDARDS INSTITUTE
WSIB	WORKPLACE SAFETY AND INSURANCE BOARD

END OF SECTION

1 REFERENCES

.1 Occupational Health and Safety Act and Regulations for Construction Projects (2011) (Ontario Regulation 213/91, amended by Reg. 631/94, & Reg. 145/00).
.2 National Fire Code of Canada (2015)
.3 Ontario Fire Code (2007)
.4 Ontario Building Code (2012)

2 INSTALLATION AND REMOVAL

.1 Provide temporary utilities, facilities and controls in order to execute the work expeditiously. Remove from site all such work after use.

3 VEHICULAR ACCESS & PARKING

.1 Provide and maintain adequate access to project site.

.2 Build and maintain temporary access roads where indicated or required, and provide snow removal during period of work.

.3 If authorized to use existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractor's use of roads. Maintenance shall include requlars snow removal if not provided under separate contract, and regular power washing to remove mud and dirt.

.4 Where site access for construction vehicles necessitates use of public roads, remove mud and dirt from such roads where contaminated by construction vehicles.

.5 Traffic Control: Provide and maintain flagpersons, traffic signals, barricades and flares, lights, or lanterns as required to perform the work and protect the public.

.6 Construction Parking

.1 Parking for construction equipment vehicles will be limited to the site or immediate areas of work.

.2 Parking for Contractors' and Subcontactors' personal vehicles will be permitted on site provided it does not constitute a safety hazard nor disrupt the performance of Work. Parking areas will be designated by the Owner.

4 TEMPORARY UTILITIES

.1 Temporary Electricity and Lighting

.1 Arrange, pay for and maintain temporary electrical power supply in accordance with governing regulations and ordinances.

.2 Install temporary facilities for power such as pole line and underground cables to approval of local power supply authority.

.3 Electrical power and lighting systems installed under this contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage. Replace lamps which have been used more than a period of 3 months.

.4 Provide temporary lighting in all areas of construction, to the minimum requirements of the Occupational Health and Safety Act, and minimum requirements specified herein.

.2 Temporary Water Supply

.1 Arrange, pay for and maintain temporary water supply in accordance with governing regulations and ordinances.

.2 Permanent water supply system installed under this contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage.

.3 Temporary Heating and Ventilating

.1 Provide and maintain all temporary heat and ventilation necessary during construction, including cost of installation, fuel, operation, attendance and maintenance. Use of direct-fired heaters discharging waste products into work areas will not be permitted unless prior approval is given by Consultant.

.2 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.

.3 Maintain minimum temperature of 10°C or higher where construction is in progress and maintain until acceptance of structure by Consultant.

.4 Ventilating

.1 Prevent hazardous accumulation of dust, fumes, mists, vapours or gases in areas occupied during construction.
.2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
.3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
.4 Ventilate storage spaces containing hazardous or volatile materials.
.5 Ventilate temporary sanitary facilities.
.6 Continue operation of ventilation and exhaust system for a time after cessation of work process, to assure removal of harmful elements.

.5 Maintain strict supervision or operation of temporary heating and ventilating equipment.

.1 Conform with applicable codes and standards.
.2 Enforce safe practices.
.3 Prevent abuse of services.
.4 Prevent damage to finishes.

.5 Vent direct-fired combustion units to outside.

.6 The permanent HVAC systems of the building, or portions thereof, may not be used during construction.

5 CONSTRUCTION FACILITIES

.1 Field Office

.1 Provide minimum 2400 x 4800mm office and furnish with desk, drawing layout table, filing cabinet, and coat hooks.

.2 Provide minimum 750 Lx lighting level.

.3 Heat to maintain 22°C inside temperature.

.4 Provide 2 operable windows for cross ventilation, or air condition.

.2 Temporary Telephone and Facsimile

.1 Provide and pay for temporary telephone and FAX machine to be installed in Field Office.

.2 Provide separate data and telephone jacks for computer hook-up.

.3 Cellular telephones are acceptable. Pay telephone is not acceptable.

.3 Equipment, Tools and Materials Storage

.1 Provide adequate weathertight enclosures with raised floors, for storage of materials, tools, and equipment which are subject to damage by weather.

.2 Temporary enclosures required by subtrades as workshops shall be provided by those trades.

.4 Site Storage and Overloading

.1 Confine the Work and the operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the premises with products.

.2 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the Work.

.5 Sanitary Facilities

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances. Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition. Where portable toilet facilities are provided, empty and sanitize such facilities on a weekly basis, or more frequently if required.

.2 Permanent new facilities shall not used by the Contractor.

6 CONSTRUCTION SAFETY MEASURES

.1 Observe all construction safety measures as required by the General Conditions of the Contract, the Occupational Health and Safety Act and Regulations for Construction Projects, and by all authorities having juridiction, provided that in case of conflict or discrepancy, the more stringent requirements shall apply.

.2 Provide applicable spare safety equipment such as helmets, safety glasses, and harnesses, and enforce their use by Consultants, the Owner, their representatives and any authorized visitors to the site.

.3 Provide and maintain fences, gates and locks, covered walkways, guard rails, barriers, night lights, and appropriate warning signage as required for the protection of the public, and of public and private property; as required by the General Conditions of the Contract, the Occupational Health and Safety Act and Regulations for Construction Projects, and by all authorities having jurisdiction. Erect and maintain sturdy railings around shafts, and the like, to protect workmen and the public from injury.

.4 Workplace Hazardous Materials Information System

.1 Comply with all requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of material safety data sheets.

.2 Include copies of all WHMIS data sheets in Operations and Maintenance Manuals.

7 CONSTRUCTION AIDS

.1 Falsework

.1 Design and construct falsework in accordance with CSA S269.1.

.2 Scaffolding

.1 Design, construct and maintain scaffolding in accordance with CSA S269.2.

.2 Erect scaffolding independent of walls. Remove promptly when no longer required.

.3 Hoisting

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

.2 Hoists or cranes shall be operated by qualified operator.

8 TEMPORARY BARRIERS & ENCLOSURES

.1 Construction Isolation Fencing

.1 Erect isolation fencing around perimeter of construction areas to protect the public, workers, and the public from injury.

.2 Construction Isolation Fencing shall consist of:
.1 Temporary modular welded wire mesh fencing, minimum 1828 x 2440mm high, by CanFence Rentals Ltd., or equivalent.

.2 Provide lockable gates within hoarding / fencing for access to site by workers and vehicles.

.3 Provide barriers around trees and planting beds designated to remain. Protect from damage.

.4 Enclosure of Structure
.1 Provide temporary weathertight enclosures and protection for exterior openings until permanently enclosed.

.2 Erect enclosures to allow access for installation of materials and working inside enclosure.

.3 Erect enclosures to withstand wind pressure and snow loading.

.4 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work area for temporary heat.

.5 Dust Control
.1 Provide dust tight screens or partitions to localize dust generating activities, and for the protection of workers, or finished areas of Work.

.2 Dust screens shall consist of, as a minimum, 0.15mm thick polyethylene sheets secured to appropriate framing and sealed at all joints and at perimeter to prevent migration of dust.

.3 Maintain and relocate protection until such work is complete.

.4 Provide dust catching walk-off matting, at all construction entrances.

9 TEMPORARY CONTROLS
.1 Drainage & Erosion Control
.1 Refer to Civil Drawing (C2.3).

.2 Tree and Plant Protection
.1 Refer to Section 01 57 19 – Temporary Environmental Controls.

.3 Security Measures
.1 Where progress of construction reaches point where building exterior is fully enclosed, provide construction cylinders for doors, and secure building against intrusion. Where installation of fixtures and equipment, or storage of materials and equipment, inside the building has begun prior to installation of exterior windows and doors, provide temporary plywood enclosures for window and door openings to prevent intrusion until permanent closures are in place.

.4 Site Signs and Notices

.1 Maintain approved signs and notices in good condition for duration of project, and dispose of off site on completion of project or earlier if directed by Consultant.

.2 Project Sign: Provide one temporary project sign at location approved by Consultant.

.3 No other signs or advertisements of any description except notices regarding safety and instruction, shall be put up around the building, or site, without the approval of the Consultant.

END OF SECTION

1 REFERENCES

.1 National Building Code of Canada (2015)
.2 National Fire Code of Canada (2015)
.3 Ontario Fire Code (2007)
.4 Guidelines for Maintaining Fire Safety during Construction in Existing Buildings, (10/31/88) Ontario Ministry of the Solicitor General, Office of the Fire Marshal.
.5 Ontario Building Code (Regulation 350/06)

2 FIRE SAFETY

.1 Fire Fighting Equipment

.1 Provide and maintain in working order, ULC labelled, 9kg 4A 60BC type fire extinguishers, and locate in prominent positions to approval of authorities having jurisdiction.

.2 Fire Department Access

.1 Provide and maintain fire access routes as designed, as soon as construction sequence will allow. Access routes must have compacted granular subbase, and base in place before superstructure of building may proceed.

.2 Construction activities must not obstruct access routes designated for fire department equipment. If necessary that existing access be obstructed or deleted, alternative access, acceptable to the fire department, must be provided prior to commencement of construction, in accordance with Ontario Building Code location and design criteria for required access routes.

.3 Control of Combustible Materials

.1 The stockpiling of construction materials adjacent to the existing building must be carefully controlled in accordance with the Ontario Fire Code. Materials stored, and their proximity to, equipment used in construction may create a fire hazard. Control of combustibles on a construction site is regulated under the Occupational Health and Safety Act.

.4 Hot Work

.2 Conform to the requirements of the Occupational Health and Safety Act – Regulations for Construction Projects.

.3 Provide all necessary guards and barriers to protect workers, property, and the public when performing hot work such as torching, cutting or coring. Protect all adjacent combustible materials.

.4 Provide a "Fire Watch" for a minimum of 3 hours after each instance of discontinuing hot work.

END OF SECTION

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.

2 SUBMITTALS

.1 Submittals: in accordance with Submittal Procedures.

.2 Prior to commencing construction activities or delivery of materials to Site, submit Environmental Protection Plan for review and approval 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 Name(s) of person(s) responsible for ensuring adherence to Environmental Protection Plan;

.2 Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from Site;

.3 Name(s) and qualifications of person(s) responsible for training site personnel;

.4 Descriptions of environmental protection personnel training program;

.5 Erosion and sediment control plan which identifies type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial and Municipal laws and regulations;

.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-site;

.12 Contaminant prevention plan that: identifies potentially hazardous substances to be used on 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 Waste water 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;

.14 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands;

.15 Pesticide treatment plan: to be included and updated, as required.

3 FIRES

.1 Fires and burning of rubbish on Site is strictly prohibitted.

4 DISPOSAL OF WASTES

.1 Burying of rubbish and waste materials on Site is strictly prohibitted.

.2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

5 DRAINAGE & EROSION CONTROL

.1 Provide erosion and sediment control plan that identifies type and location of erosion and sediment controls to be provided. Plan: include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.

.2 Storm Water Pollution Prevention Plan (SWPPP) may 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, sewer or drainage systems.

.5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

.6 Provide and maintain temporary drainage and pumping as necessary to keep excavations and site free from excess water.

.7 Provide silt fencing at site perimeters and where required by local authorities to prevent contamination of adjoining properties from silt and water drainage.

6 TREE AND PLANT PROTECTION

.1 Protect existing trees and plants on all adjacent properties, where in close proximity to construction activities, or where construction access passes within 3m of trees or plants, whether indicated on drawings or not.

.2 Conform to all local By-Laws regarding tree preservation and protection.

.3 Protect existing trees and plants on site as indicated.

.4 Restrict tree removal to those designated by Consultant. Wrap in burlap trees and shrubs adjacent to construction work, storage areas and trucking lanes. Encase trees and shrubs with protective wood framework from grade level to height of 2134mm.

.5 Protect roots to minimum 1m beyond dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones of protected trees. Minimize stripping of topsoil and vegetation.

.6 The Minimum Tree Protection Zone will be the drip line. Within this tree protection zone there will also be no construction activity including but not limited to no root cutting, no alteration or disturbance to existing grades of any kind, no changes to the grade by adding fill, excavating or scraping, no storage of construction materials or equipment, no stockpiling of soil, debris or construction waste, & no movement or storage of heavy vehicles or equipment. Tree protection barriers must be included and priced as part of the project. For short term project (up to 2 months), standard T-bars and plastic safety fence can be used. For a longer term project, use 10 gauge chain link fence and standard T-bars. In all cases, standard T-bars should not be spaced more than 6 to 7 feet apart. These protection barriers must be erected before the project starts, must be maintained throughout the project, and taken down when final inspection and signoffs are completed.

7 WORK ADJACENT TO WATERWAYS/DRAINAGE DITCHES

.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 construction materials across waterways.

.6 Avoid indicated spawning beds constructing temporary crossings of waterways.

8 POLLUTION CONTROL

.1 Maintain temporary erosion and pollution control features installed under this Contract.

.2 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area, by providing temporary enclosures.

.3 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

9 HISTORICAL / ARCHAEOLOGICAL ARTIFACTS

.1 In the event that buried archaeological remains are encountered on the property during construction activities, the Heritage Operations Unit of the Ministry of Tourism and Culture be notified immediately at (416) 326-9326.

.2 In the event that human remains are encountered during construction, the Contractor shall immediately contact both the Ministry of Tourism and Culture, and the Registrar or Deputy Registrar of Cemeteries at the Cemeteries Regulation Unit, Ministry of Government Services, (416) 326-8404.

10 NOTIFICATION

.1 Consultant will notify Contractor in writing of observed non-compliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan. Contractor shall, after receipt of such notice, inform Consultant of proposed corrective action and take such action for approval by Consultant.

.2 Consultant will issue stop order of Work until satisfactory corrective action has been taken.

.3 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

END OF SECTION

1 PRODUCT OPTIONS

.1 Provide products specified under individual specification sections. Where Specification lists two or more products, or two or more manufacturers of the same product, the Contractor may select one of the listed products or manufacturers. Confirm selection of products and manufacturers when requested by the Consultant.

.2 When only one product or manufacturer is listed in the specifications, it is intended that only that product or manufacturer is acceptable.

2 PRODUCT SUBSTITUTION PROCEDURES

.1 Substitution Procedures During Construction

.1 Products may only be substituted during the Construction period for one or more of the following reasons:

.1 Insolvency of the product manufacturer.

.2 Inability of the manufacturer to provide the product(s) in the timeframe required to maintain the construction schedule.

.3 Product specified has been discontinued.

.4 Substitution proposed offers better performance than that specified, at no additional cost.

.5 Substitution offers equivalent performance to that specified, at a reduced cost to the Owner (reduction in Contract Price).

.2 Items 2.1.1.2, and 2.1.1.3 will require a letter from the manufacturer, confirming their inability to provide the products specified, or inability to meet the schedule.

.3 Items 2.1.1.4, and 2.1.1.5 will be at the discretion of the Owner.

3 AVAILABILITY

.1 Immediately upon signing Contract, review Product delivery requirements, and identify lead times for supply of all Products. If lead times in supply of Products may affect the Construction Schedule, notify the Consultant in order that appropriate action may be authorized in ample time to prevent delay in performance of the Work.

.2 The Contractor shall order Products and materials in a timely fashion so as to ensure that delivery of such Products and materials shall coincide with the Construction Schedule. Failure of the Contractor or their Subcontractors to order Products and materials in a timely fashion, shall not be cause for substitution in accordance with the criteria set out under Article 2 – Product Substitution Procedures.

.3 In the event of failure to notify the Consultant of Product delivery problems at the commencement of the Work, and should it appear that the Work may be delayed for such reason, the Consultant reserves the right to substitute more readily available Products of similar character of their chosing, at no increase in Contract Price.

4 REFERENCE STANDARDS

.1 Within the specifications, reference standards are identified. Conform to these standards, in whole or part, as specifically requested.

.2 If there is question as to whether any product or system is in conformance with applicable standards, the Consultant reserves the right to have such products or systems tested to prove or disprove conformance.

.3 The cost for such testing will be born by the Owner in the event of conformance with Contract Documents or by the Contractor in the event of non-conformance.

.4 Conform to latest date of issue of referenced standards in effect on date of submission of bids, except where a specific date of issue is specifically noted.

5 PRODUCT TRANSPORTATION & DELIVERY

.1 Transportation and delivery costs of Products required in the performance of the Work, are included in the Contract Price.

.2 Transportation and delivery costs of Products supplied by the Owner will be paid for by the Owner. Unload, handle, and store such Products on site.

.3 Products must be appropriately crated, skidded, boxed, shrink-wrapped, or otherwise packaged to protect such products from damage during shipment. Products which arrive at the site in a damaged condition must be rejected and returned to the supplier/manufacturer for immediate replacement.

.4 Advise the Owner 30 days in advance of anticipated delivery dates for materials and equipment supplied by the Owner.

6 PRODUCT STORAGE, HANDLING AND PROTECTION

.1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions.

.2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in the Work.

.3 Store products subject to damage from weather in weatherproof enclosures.

.4 Store cementitious products clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 Store paints in a heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged Products at own expense and to the satisfaction of the Consultant.

7 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in the specifications, install or erect Products in accordance with manufacturer's printed instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.

.2 Notify Consultant in writing, of conflicts between the specifications and manufacturer's instructions, so that Consultant may establish correct course of action.

.3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes the Consultant to require removal, replacement where necessary, and re-installation at no increase in Contract Price.

8 FASTENINGS

.1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in the affected specification Section.

.4 Space anchors within limits of load limit or shear capacity and ensure that they provide positive permanent anchorage. Wood or any other organic material plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

.7 Obtain Consultant's approval before using explosive actuated fastening devices.

9 QUALITY OF MATERIALS

.1 Products, materials, equipment and articles (referred to as Products throughout the specifications) incorporated in the Work shall be new, not damaged or defective, and of the best quality (compatible with specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.

.2 Products relying on uniformity of colour and pattern for appearance, such as resilient flooring, carpeting, fabrics, and vinyl wallcovering, shall be from one dye lot for the project. All products delivered to the site must be labeled as to dye lot, or production run number, as well as production date.

.3 Defective products, whenever identified prior to the completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is a precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.

.4 Should any dispute arise as to the quality or fitness of Products, the Consultant may request additional testing based upon the requirements of the Contract Documents, to confirm acceptability of products or materials. Refer to Article 10 - Defective Materials And Work, and Section 01 40 00.

.5 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the building.

.6 Permanent labels, trademarks and nameplates on Products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

10 DEFECTIVE MATERIALS AND WORK

.1 Where evidence exists that defective work has occurred, or that work has been carried out incorporating defective products, the Consultant may have independent tests, inspections, or surveys performed in order to determine if work is defective.

.2 Tests, inspections, or surveys carried out under these circumstances will be made at the Contractor's expense in the event of defective work, or at the Owner's expense where work is in conformance. Where tests incorporate a number of samples, payment will be assessed, by the Consultant, based on the ratio of conforming to non-conforming results. This does not include re-testing of soil compaction during placement, where evidence exists of non-conformance with the Contract documents, but rather only if re-testing is called for after completion of compaction.

11 WARRANTIES & GUARANTEES

.1 Warrant all products and labour forming part of the Work for the period specified in the Contract, unless otherwise specified herein.

.2 Warrant products and assemblies for the specified periods of time where in excess of the Contract Warranty, as specified within their respective sections.

.3 Guarantee aspects of the Work for the specified periods of time where in excess of the Contract Warranty, as specified within their respective sections.

.4 Warranties and Guarantees shall commence at Date of Substantial Performance of the Contract as certified by the Consultant.

.5 Warranties and Guarantees shall be original copies, printed on company letterhead, or on a standard company warranty certificate, bearing the name of the company.

.6 Warranties and Guarantees shall indicate:

.1 Name of the Principal (the Manufacturer/Subcontractor),
.2 Name of the Obligee (the Owner),
.3 Name and address of Project,
.4 Commencement date (Date of Substantial Performance),
.5 Duration of warranty or guarantee,

.6 Clear statement of what is included, and what if any exclusions there are, and

.7 Signature of Principal's representative having signing authority.

END OF SECTION

1 EXAMINATION

.1 Acceptance of Conditions

.1 The General Contractor shall examine all existing or pre-determined conditions, prior to commencing work in that area, and report to the Consultant all conditions unacceptable for work to proceed. Commencement of work shall imply acceptance of conditions as is.

.2 Subcontractors shall examine all existing or pre-determined conditions affecting their portion of the Work, prior to commencing such work, and report to the Contractor all conditions unacceptable for work to proceed. Commencement of work shall imply acceptance of conditions as is.

2 PREPARATION

.1 Field Engineering

.1 Locate, confirm and protect control points prior to starting the Work. Preserve permanent reference points during construction.

.2 Establish reference lines and elevations. Locate and lay out by instrumentation.

.2 Records

.1 Maintain a complete, accurate log of control points and survey work as work progresses.

3 CUTTING AND PATCHING

.1 Submit a written request in advance, for approval of cutting or alteration which affects:

.1 Structural integrity of any element of Project.
.2 Integrity of weather-exposed or moisture-resistant elements.
.3 Efficiency, maintenance, or safety of any operational element.
.4 Visual qualities of sight-exposed elements.
.5 Work of Owner or separate contractor.

.2 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

.3 After uncovering, inspect conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

.4 Perform cutting, fitting and patching, including excavation and fill, to complete the Work. Perform work to avoid damage to other work.

.5 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.

.6 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.

.7 Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces. At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with firestopping material, full thickness of construction element.

.8 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

.9 Provide all openings greater than 200mm in non-structural elements of work for penetrations of mechanical and electrical work. Mechanical and Electrical Subcontractors shall provide all sleeves and locations for sleeves. The cost of all cutting and patching required by Mechanical and Electrical Subcontractors shall be paid for by those trades.

.10 Ensure that all cutting and patching work, including that by Mechanical and Electrical Subcontractors, is properly performed by the respective trades skilled in that line of work. Restore work with new products in accordance with Contract Documents.

4 LOCATION OF EQUIPMENT AND FIXTURES

.1 Location of mechanical and electrical equipment, fixtures and devices indicated or specified, are to be considered as approximate. Final location of such items will be determined on site, based on integration with structural and architectural elements, and as required by coordination with other trades. In the event of a conflict, final determination of location of these items rests with the Consultant.

.2 Prepare and submit for review by the Consultant, interference field drawings, to indicate relative position of various services and equipment, at the following locations as a minimum:

.1 Under all rooftop mechanical units.
.2 At locations of all major ductwork, piping, and conduit crossovers.
.3 Where ductwork passes under major structural elements.

.3 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.

.4 Request a review of items by Consultant once rough-in is underway, prior to final installation, and obtain approval for actual locations.

5 CONCEALMENT

.1 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas, except where indicated otherwise.

6 LIGHTING FIXTURES AT SUSPENDED CEILINGS

.1 Ensure that secure support is provided for lighting fixtures by suspended ceilings, or by separate hangers, or by both.

.2 Coordinate the ceiling system and lighting fixture installations to provide adequate support.

.3 Submit affidavits with acceptable design information confirming that the installation of the suspended ceiling system and/or separate fixture hangers will provide adequate support for the lighting fixtures without exceeding specified deflection tolerances for the ceiling system.

.4 Conform to current requirements of the Electrical Safety Authority (ESA).

7 PROTECTION OF WORK IN PROGRESS

.1 Adequately protect Work completed or in progress. Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Consultant, at no increase in Contract Price.

.2 Prevent overloading of any part of the building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated, without written approval of Consultant.

.3 Protect finished surfaces with overlays of protective materials such as Kraft paper, cardboard, or plywood, as required for individual applications to provide adequate protection.

END OF SECTION

1 GENERAL

.1 Conduct cleaning and disposal operations to comply with local ordinances and environmental protection legislation.

.2 Store volatile wastes in covered metal containers, and remove from premises at end of each working day.

.3 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

2 CLEANING DURING CONSTRUCTION

.1 Maintain the Work in tidy condition, free from accumulation of waste products and debris.

.2 Remove waste material and debris from the work areas and deposit in waste container at the end of each working day.

.3 Vacuum clean interior areas prior to start of finishing work. Maintain areas free of dust and other contaminants during finishing operations.

.4 Individual Subcontractors are responsible for the daily clean-up and removal of debris related to, or generated by, their own work. The overall responsibility for project cleanliness rests with the Contractor.

3 WASTE MANAGEMENT

.1 Audit, separate and dispose of construction waste generated by new construction or by demolition of existing structures in whole or in part, in accordance with Ontario Regulations 102/94 and 103/94 made under the Environmental Protection Act.

.2 Fires, and burning of rubbish or waste on site is prohibited.

.3 Burying of rubbish or waste materials, except as specified herein, is prohibited.

.4 Disposal of waste or volatile materials such as mineral spirits, oil, gasoline or paint thinner into ground, waterways, or sewer systems is prohibited.

.5 Empty waste containers on a regular basis to prevent contamination of site and adjacent properties by wind-blown dust or debris.

4 FINAL CLEANING OPERATIONS

.1 Immediately following Date of Substantial Performance, and prior to Owner occupancy of the building or portion of the building affected by the Work, conduct full and complete final cleaning operations.

.2 Final cleaning operations shall be performed by an experienced professional cleaning company, possessing equipment and personnel sufficient to perform full building cleaning operations.

.3 Remove all surplus products, tools, construction machinery and equipment not required for the performance of remaining work, and thereafter remove any remaining materials, equipment, waste and debris.

.4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.5 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

.6 Cleaning operations shall include the removal of all stains, spots, scuff marks, dirt, dust, remaining labels, adhesives or other surface imperfections.

.7 Remove all paint spots or overspray from all affected surfaces.

.8 Clean and polish all glass and mirrors. Replace broken, scratched or disfigured glazing. Remove remaining manufacturer's and safety "X" labels.

.9 Clean and polish all finished metal surfaces such as enamelled or stainless steel, chrome, aluminum, brass, and bronze.

.10 Clean and polish all vitreous surfaces such as plumbing fixtures, ceramic tile, porcelain enamel, or other such materials.

.11 Clean all ceramic tile surfaces in accordance with the manufacturer's instructions, and apply final coat of sealer where specified.

.12 Clean inside of all millwork and cabinetry.

.13 Vacuum, clean and dust behind grilles, louvres and screens.

.14 Seal and wax all resilient floor surfaces as specified, and as recommended by the manufacturer.

.15 Broom clean and spray wash all exterior paved surfaces.

.16 Remove dirt and other disfiguration from exterior surfaces.

.17 Clean all roofs, gutters, downspouts, areaways, drywells, and drainage systems.

.18 Clean all equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment.

END OF SECTION

1 INSPECTION AND DECLARATION PROCEDURES

.1 Arrange for, conduct and document final inspections, close-out and commissioning at the completion of the Work in accordance with the procedures described in the General Conditions of the Contract, and OAA/OGCA Document 100.

2 SUBSTANTIAL PERFORMANCE

.1 Contractor's Inspection

.1 Refer to OAA/OGCA Document 100 – STAGE 2.

.2 The Contractor and all Subcontractors shall conduct an inspection of the work, identify deficiencies and defects, and make corrections as required to conform with the Contract Documents. Notify Consultant in writing of satisfactory completion of Contractor's Inspection and that corrections have been made. Request a Consultant's Inspection.

.2 Contractor's Application for Substantial Performance of the Work

.1 Refer to OAA/OGCA Document 100 – STAGE 3.

.2 When the Contractor has carried out the steps in Stage 2 of OAA/OGCA Document 100, and has determined that the requirements of the Contract have been substantially performed as defined by local Lien legislation, the Contractor shall make application for Substantial Performance of the Work.

.3 In addition to the requirements of OAA/OGCA Document 100, the following items shall accompany the Contractor's application for Substantial Performance. These items must be complete in all respects, and all verification certificates and reports having been submitted and approved by the Consultants:

.1 Completed (and accepted) Maintenance Manuals for all disciplines (No. of copies as specified),
.2 As-Built Drawings for all disciplines (No. of copies as specified),
.3 Mechanical, Sprinkler, and Electrical as-built CAD drawings,
.4 Occupancy Permit (where required by Municipality),
.5 Air Balance Report (legible technicians worksheets are acceptable),
.6 Gas fired appliances inspection,
.7 Plumbing Inspection,
.8 Domestic Water Quality Test Report,
.9 Sprinkler dry test verification letter stamped and signed by sprinkler design Engineer,
.10 Mechanical start-up reports (Boilers, HVAC Units, Chillers, Water Softeners, etc.),
.11 Fire Alarm verification (include legible technicians worksheets),
.12 Emergency Lighting verification,
.13 Electrical distribution system inspection,
.14 ESA Hydro Certificate, and
.15 Systems operations have been demonstrated to Owner's personnel.

.3 Consultant's Inspection

.1 The Consultants shall perform an inspection of the Work to assess the validity of the Contractors application, and shall identify in separate lists, unfinished work and deficiencies. Contractor shall correct work accordingly.

.4 Certificate of Substantial Performance

.1 Refer to OAA/OGCA Document 100 – STAGE 4.

.2 Should the Consultant concur with the Contractor's application for Substantial Performance, the Consultant shall notify the Contractor of approval of the application for Substantial Performance and issue a Certificate of Substantial Performance.

.3 The Contractor shall publish a copy of the Certificate of Substantial Performance in a construction trade newspaper, and shall provide the Consultant with proof of the date of publication.

3 LIEN PERIOD AND RELEASE OF BASIC HOLDBACK

.1 Refer to OAA/OGCA Document 100 – STAGE 5.

.2 Commencement of Lien Periods

.1 The day following the date of publication of Certificate of Substantial Performance shall be the date of commencement of the 60 day Lien Period prior to release of basic holdback, unless required otherwise by lien statute of the Place of the Work.

.2 When the Contractor has carried out the required steps in Stages 3 and 4 of OAA/OGCA Document 100, the Contractor shall make application for Release of Basic Holdback.

.3 The Consultant shall prepare the Certificate for Payment for release of basic holdback, and promptly upon receipt of the necessary documentation, issue the Certificate for Payment to the Owner.

4 FINAL INSPECTION AND PAYMENT

.1 Refer to OAA/OGCA Document 100 – STAGE 6.

.2 Submit a signed statement stating following have been performed:

.1 Work has been reviewed for compliance with Contract Documents,
.2 All defeciencies have been corrected,
.3 All unfinished work has been completed, and
.4 Work is complete and ready for Final Inspection.

.3 When items noted above are completed, a final inspection of the Work will be performed by the Owner, the Consultants, and the Contractor.

.4 If the Work is deemed to be incomplete, complete outstanding items and request a reinspection.

.5 If the Work is deemed to be complete, the Consultant will issue a Final Certificate for Payment.

5 DEFICIENCY REVIEW

.1 Following the issuance of the Certificate of Substantial Performance and prior to the Contractor's application for Final Payment and release of any monies retained as "Finishing Holdback", the Contractor shall continue to complete unfinished work and correct deficiencies. At the request of the Contractor, the Consultants shall conduct up to two general deficiency reviews during this period.

.2 The first review will be undertaken only if the Contractor has inspected the Work, and states in writing that the unfinished work noted in their application for Substantial Performance has been completed, and at least 50% of all deficiencies have been corrected.

.3 The second review will be undertaken only if the Contractor has inspected the Work, and states in writing that 90% of the deficiencies have been corrected.

.4 Should further review by Consultants be required due to failure of the Work to comply with Contract Documents or the criteria set out herein, the Owner will deduct amount of Consultant's compensation for reinspection services from monies owed to the Contractor.

END OF SECTION

1 REFERENCES

.1 OAA/OGCA Document 100; OAA/OGCA Take-Over Procedures.

2 OPERATION AND MAINTENANCE MANUALS

.1 General

.1 Prepare Operation and Maintenance Manual during the course of construction and have completed prior to Date of Substantial Performance.

.2 Submission

.1 Maintain one copy of the Operation and Maintenance Manual volume(s) for periodic review and comment, as requested by the Consultant during the course of construction.

.2 Submit two (2) final hard copies and one (1) USB device with PDF version of all documents of the final completed volume(s) with the application for Substantial Performance in accordance with OAA/OGCA Document 100.

.3 Format

.1 Bind data in commercial quality, 219 x 279mm, "D" ring binders, having clear cover and spline pockets.

.2 Identify each binder on the cover and spline with the following:

OPERATION & MAINTENANCE MANUALS
City of Brampton Fire Station #201
Brampton, Ontario
VOLUME ___ OF ___

.3 Provide table of contents and index tab sheets for each volume. Itemize and tabulate contents.

.4 Provide drawings with reinforced punched binder tab, or insert into clear sleeves in folded format. Group drawings as to content, and index for quick reference.

.4 Contents - Each Volume

.1 Table of Contents: provide title of Project, Date of submission and names:

.1 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties;

.2 Schedule of products and systems, indexed to content of volume.

.2 For each product or system: List names, addresses and telephone numbers of sub-contractors and suppliers, including local source of supplies and replacement parts.

.3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Operation and Maintenance Manuals shall contain, as a minimum, the following information:

.1 List of Contents; cross-referenced to each Volume.
.2 Contact information for maintenance and repairs
.3 Warranty and guarantee certificates
.4 Equipment start-up and troubleshooting instructions
.5 Equipment schematics & diagrams
.6 Catalogue of all maintenance materials and quantities
.7 Complete list of Contractor, Subcontractors and suppliers, indicating name, address, telephone & fax numbers, email addresses, name of contact person and description of work done.
.8 Complete list of products used in the work, indicating product name and manufacturer for each listing.
.9 Copy of Finish Hardware List, complete with all amendments and revisions, if applicable.
.10 Schedule of paints and coatings. Include sufficient explanation to fully identify each surface with the applicable paint or coating used. Enclose copy of Colour Schedule.
.11 All “reviewed” shop drawings.
.12 Maintenance instructions for all finished surfaces.
.13 Brochures and cuts of all equipment and fixtures.
.14 Operating and maintenance instructions for all equipment.
.15 All Warranties and Guarantees required by the Specifications for this Work.

.5 Refer to Division 21, 22 and 23 for more specific mechanical data required beyond the description of this paragraph.

.6 Refer to Division 26 for more specific electrical data required beyond the description of this paragraph.

.7 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.8 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3 AS-BUILT DRAWINGS

.1 Record information on a clean set of black line opaque drawings, provided by Owner.

.2 Maintain as-built drawings on site and update as construction progresses. Allow periodic review by Consultant as requested.

.3 Record information concurrently with construction progress. Do not conceal work until required information is recorded.

.4 Contract drawings and shop drawings: legibly 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.

4 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 start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, 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 coordination 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 all test and balancing reports

.15 Additional requirements: As specified in individual specification sections.

5 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.

6 MAINTENANCE MATERIALS, SPARE PARTS & TOOLS

.1 Provide spare parts in quantities specified in individual specification sections. Provide identical items to those installed in the Work.

.2 Provide maintenance materials in quantities specified in individual specification sections. Provide identical items of same manufacturer, dye lot or production run as items in the Work.

.3 Provide special tools in quantities specified in individual specification sections, and tag items identifying their function and equipment or products to which they are associated.

.4 Receive and catalogue all items. Check inventory and include approved listings in Operations and Maintenance Manual.

.5 Obtain receipts for delivered products and submit prior to Substantial Performance.

.6 Quality

.1 Spare parts, maintenance materials and special tools provided shall be new, not damaged or defective, and of the same quality and manufacture as products provided in the Work.

.2 If requested, furnish evidence as to type, source and quality of Products provided.

.3 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

.7 Delivery, Storage, And Handling

.1 Deliver all materials required as maintenance materials, spare parts or special tools, to the site, include shipping costs, and store as directed.

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

.3 Store in original and undamaged containers with manufacturer's seals or labels intact.

.4 Store materials subject to damage from severe climatic changes in a climate-controlled, weatherproof enclosure.

.5 Store paints and freezable materials in a moderately heated and ventilated room.

7 WARRANTIES AND BONDS

.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 the applicable item of work.

.4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.

.5 Verify that documents are in proper form, contain full information, and are notarized. Co-execute submittals when required.

.6 Retain warranties and bonds for 2 years of comprehensive material and labour warranty to be include for the entire project.

END OF SECTION

1 GEOTECHNICAL INFORMATION

1.1 A copy of the following detailed geotechnical information is appended to this Document:

.1 Report on Geotechnical Investigation
Propose Fire Hall
27 Rutherford Road South
Brampton, Ontario
Prepared by: SNC Lavalin Ontario Inc.
Report No.: 671835
Dated: June 11, 2020

1.2 This geotechnical information records properties of subsurface conditions and recommendations for the design of foundations, pavements and soil remediation as outlined in the information provided.

1.3 The geotechnical information by its nature, cannot reveal all conditions that exist or can occur on the Site. Should subsurface conditions be found to vary substantially from the report, immediately notify Consultant in writing and await instructions.

1.4 Contractor shall not be entitled to extra payment or extension of Contract Time for work which is required and which is reasonably inferable in the geotechnical information as being necessary.

1.5 In case of discrepancies between recommendations contained in geotechnical information and requirements of Contract Documents, the latter shall govern. Advise Consultant in writing of any discrepancies discovered.

END OF DOCUMENT

SNC·LAVALIN

Geotechnical Investigation: Proposed Fire Hall

25 Rutherford Road South, Brampton, ON

The City of Brampton

INFRASTRUCTURE

30 | July | 2021

FINAL REPORT

Internal ref. 671835

SNC-Lavalin GEM Ontario Inc.
401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

Geotechnical Investigation For Proposed Fire Hall

25 Rutherford Road South, Brampton, ON

City of Brampton
2 Wellington Street West
City Hall – West Tower 8th Floor
Brampton, Ontario
L6Y 4R2

Ali Khan, P.Eng.
Geotechnical Engineer

Sohel Rana, P.Eng.
Pavement Engineer

Mavara Turab, P.Eng., PMP
Geotechnical Project Manager

ASM Masud Karim, P.Eng.
Manager - Geotechnical

Our Reference: 671835

July 30, 2021

Distribution: Abed Yassine (1 PDF copy)

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NOTICE TO READER

This document contains the professional opinion *of SNC-Lavalin GEM Ontario Inc. (SNCL),* as to the matters set out herein, based on professional judgment and reasonable care. It is to be read in the context of the agreement (the "Agreement") between *SNCL* and the City of Brampton (herein after referred to as the "Client"), the methodology, procedures and techniques used *SNCL*'s assumptions, and the circumstances and constraints under which its mandate was performed. This document is written solely for the purpose stated in the Agreement, and for the sole and exclusive benefit of the Client, whose remedies are limited to those set out in the Agreement. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SNCL has, in preparing the geotechnical parameters and recommendations, followed accepted methodology and procedures, and exercised due care consistent with the intended level of accuracy, using its professional judgment and reasonable care, and is thus of the opinion that there is a high probability that actual site geotechnical conditions will fall within the predicted range. However, no warranty should be implied as to the accuracy of estimates. Unless expressly stated otherwise, assumptions, data, and information supplied by, or gathered from other sources (including the Client, other consultants, testing laboratories and equipment suppliers, etc.) upon which *SNCL*'s opinions as set out herein are based, have not been verified by *SNCL*; *SNCL* makes no representation as to their accuracy and disclaims all liability with respect thereto.

SNCL disclaims any liability to third parties in respect of the publication, reference, quotation, or distribution of this report or any of its contents to and reliance thereon by any third party.

1 Introduction

SNC-Lavalin Inc. (SNCL), was retained by the City of Brampton to conduct a geotechnical investigation for a proposed Fire Hall to be constructed at 25 Rutherford Road South, Brampton, Ontario (herein referred to as the Site), as shown in Figure 1 of **Appendix A**.

It is our understanding that the City intends to develop the Site with 10,500 sq. ft. Fire Hall, with either four (4) bay apparatus (tandem) or a three (3) bay apparatus (side by side) configuration, office space and service areas. The proposed Fire Hall will be a slab-on-grade building, without basement, and consist of above grade parking.

The purpose of this geotechnical investigation was to obtain information on the subsurface conditions at the site by means of advancing a limited number of boreholes with associated in-situ tests and laboratory tests of select soil samples. Based on SNCL's interpretation of the obtained field information, recommendations are provided on the geotechnical aspects of the project.

The geotechnical investigation was carried out in conjunction with supplementary Environmental Site Assessments, and their findings are presented under separate cover.

The geotechnical investigation was completed in accordance with SNCL's approved proposal (Ref. No. 634196-14007, dated January 15, 2020).

This report contains the findings of SNCL's geotechnical investigation, together with recommendations and comments. These recommendations and comments are based on factual information and are intended only for the use of the design engineers. The recommendations and opinions in this report are applicable only to the proposed project as described in this Section. The Report Limitations is an integral part of this report.

2 Site Description and Previous Developments

The site is located on the west side of Rutherford Road South, approximately 300 m south of the intersection with Queen Street East. It is generally triangular, with an approximate area of 0.95 hectares. Land uses in the surrounding properties include mixed commercial and industrial land. An unnamed creek/drainage channel lies along the southern side of the site and falls within 30 m of the property line.

The site was historically used for cardboard manufacturing in 1971, and bulk storage of paints in 2006 with one (1) industrial building. We understand that the building was demolished in 2010. Following demolishing of the build, the site was being used by the City as a storage yard for mulch, cinder blocks and lumber. Currently, no permanent buildings are located at the site. The site is generally levelled, with asphalt along the northwest and east property lines, and topsoil, mulch and fill making up the remainder of the site.

It is our understanding the City plans to severe the property for the purpose of developing a Fire Hall on the north/northwest side of the site and possible road extension along the south/southwest side.

3 Regional Geology

This site is located within the geological formation known as the Peel Plain (reference The Physiography of Southern Ontario, Third Edition, compiled 1984). The underlying geological material of the plain consists of Halton Till deposits (reference: Quaternary Geology of Brampton Area; Ontario Geological Survey Map 2223, 2005).

The Halton Till matrix is half silt with subequal proportions of sand and clay and generally described as sandy silt to clayey silt till. The thickness of the Halton Till varies from 0 m (surface) to more than 10 m within the Brampton Area. The Till overlies older till (Wentworth or Newmarket), interbedded glaciofluvial and glaciolacustrine sediments, and commonly bedrock (reference: Quaternary Geology – Brampton Area; Ontario Geological Survey Report 257, 2005).

The bedrock within the Brampton Area consists of red shale (Queenston Formation) and grey shale with limestone interbeds (Georgian Bay Formation). The drift thickness within the site ranges from approximately 10 mbgs to 19 mbgs (reference: Ontario Geological Survey, Publication M2179, 1969).

4 Method of Investigation

4.1 Fieldwork

The fieldwork for the geotechnical investigation was performed between March 3rd and 13th, 2020 and consisted of advancing a total of thirty-five (35) boreholes. SNCL conducted a survey for borehole elevations and coordinates, where borehole location UTM coordinates and geodetic above mean sea level (MASL) elevations were taken by Trimble RX 5800 high precision unit. It should be noted that the ground surface elevations and coordinates at the borehole locations are approximate and should not be used for design and construction purposes.

The summary of borehole identification, depths, elevations and coordinates is presented in the following Table. It should be noted that borehole numbering (300 series and 400 series) was selected based on recommendations from SNC's Environmental group. Deeper boreholes, BH301 through BH321, were drilled within the proposed Fire Hall building, whereas relatively shallower boreholes, BH401 through BH414, were drilled within the proposed roadways, parking areas and sidewalk areas.

Table 1: Summary of Borehole Depths, Elevations, and Coordinates

Borehole ID	Borehole Depth (m bgs*)	Approximate Ground Elevation (MASL)	Borehole Easting (UTM Zone 17)	Borehole Northing (UTM Zone 17)
BH301	9.3	215.99	601494.77	4839210.68
BH302	9.3	215.80	601501.60	4839203.50
BH303	7.7	215.74	601510.19	4839199.91
BH304	9.1	215.99	601506.77	4839234.66
BH305	9.3	216.18	601516.19	4839227.15
BH306	9.2	215.99	601530.01	4839221.95
BH307	9.2	215.95	601513.30	4839241.86
BH308	9.2	215.98	601524.36	4839236.62
BH309	9.2	215.91	601534.72	4839224.26
BH310	9.2	215.72	601521.70	4839252.52
BH311	9.2	216.04	601531.34	4839245.52
BH312	9.2	215.90	601540.21	4839237.16
BH313	9.2	215.73	601529.28	4839262.34
BH314	9.2	216.04	601538.55	4839254.72
BH315	9.2	215.91	601547.51	4839247.02
BH316	9.2	215.67	601538.68	4839269.36
BH317	7.7	215.83	601546.36	4839263.89
BH318	9.2	215.88	601554.86	4839256.16
BH319	9.3	215.52	601542.59	4839279.39
BH320	9.2	215.87	601551.43	4839269.85
BH321	8.5	215.96	601560.24	4839261.30

Borehole ID	Borehole Depth (m bgs*)	Approximate Ground Elevation (MASL)	Borehole Easting (UTM Zone 17)	Borehole Northing (UTM Zone 17)
BH401	3.1	215.45	601444.06	4839160.06
BH402	3.1	215.49	601460.18	4839173.78
BH403	3.1	215.30	601468.83	4839169.59
BH404	3.1	215.79	601478.69	4839192.15
BH405	3.1	215.78	601485.50	4839187.34
BH406	3.1	215.62	601493.70	4839181.12
BH407	3.1	215.93	601545.18	4839219.86
BH408	3.1	215.91	601552.71	4839227.78
BH409	3.7	215.91	601560.08	4839237.83
BH410	3.1	215.89	601567.59	4839246.00
BH411	3.1	215.90	601571.16	4839254.92
BH412	2.5	215.73	601551.00	4839290.60
BH413	3.1	215.71	601558.84	4839282.40
BH414	3.1	215.67	601568.34	4839273.99

* m bgs = meters below ground surface

The Borehole Location Plan (Figure 1) are presented in **Appendix A** of this report.

The boreholes were advanced, using a 100 mm solid-stem equipped track mounted drill rig, under the full-time supervision of experienced geotechnical personnel from SNCL. Details of hole diameters, augers and rig types are provided in the individual Borehole logs in **Appendix B**.

Soil samples were generally taken at 0.76 m intervals from the ground surface to 3.1 m bgs and at 1.5 m intervals thereafter to termination depths while performing the Standard Penetration Test (SPT) in accordance with ASTM D1586. This consisted of freely dropping a 63.5 kg (140 lbs.) hammer for a vertical distance of 0.76 m (30 inches) to drive a 51 mm (2 inches) outer diameter (O.D.) split-barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m (12 inches) was recorded as the SPT 'N' value of the soil which indicated the consistency of cohesive soils or the relative density of non-cohesive soils. Vane shear testing and advancement of thin-walled tubes/Shelby tube were not possible due to the nature of the till deposit (Vane and Shelby tube refusal).

Ten (10) monitoring wells were installed in boreholes BH302/MW302, BH304/MW304, BH306/MW306, BH307/MW307, BH309/MW309, BH311/MW311, BH312/MW312, BH313/MW313, BH315/MW315 and BH320/MW320 to enable us to measure a stabilized groundwater reading. Upon completion of drilling, the soil samples were transported to our soil laboratory in Vaughan for further examination and laboratory testing.

5 Laboratory Testing

Visual soil classifications made in the field were verified by peer review in the laboratory. Moisture content determinations were completed on all recovered samples.

Grain size analysis (sieve and hydrometer) was performed on seventeen (17) select samples. The results of these tests are summarized in Table 2 and are also presented in **Appendix C** of the report.

Table 2: Grain-Size Laboratory Testing Results

Sample ID	Sample Depth (m bgs)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH301 / SS07	6.1 – 6.3	25	18	36	21
BH302 / SS06	4.6 – 4.8	45	30	25	
BH304 / SS05	3.0 – 3.6	29	32	31	8
BH306 / SS05	3.0 – 3.6	10	10	57	23
BH306 / SS06	4.6 – 4.9	12	45	43	
BH308 / SS06	4.6 – 5.2	20	16	48	16
BH311 / SS06	4.6 – 5.2	19	22	20	19
BH312 / SS04	2.3 – 2.9	9	29	42	20
BH313 / SS03	1.5 – 2.1	7	22	45	26
BH317 / SS03	2.3 – 2.9	6	27	47	20
BH319 / SS02	1.5 – 2.1	3	24	48	25
BH321 / SS05	4.6 – 5.2	19	17	47	17
BH401 / SS02	0.8 – 1.4	54	35	11	
BH406 / SS03	1.5 – 2.1	7	35	58	
BH408 / SS03	1.5 – 2.1	8	19	46	27
BH411 / SS02	0.8 – 1.4	4	39	57	
BH413 / SS01	0.0 – 0.6	2	29	69	

Atterberg Limits tests were conducted on nine (9) select samples. The results of these tests are presented in Table 3 and presented in **Appendix C** of the report.

Table 3: Atterberg Limits Results

Sample ID	Sample Depth (m bgs)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Soil Classification (1)
BH301 / SS07	6.1 – 6.3	30	19	11	Low to Medium Plasticity Inorganic Clay (CL-CI)
BH308 / SS06	4.6 – 5.2	30	18	12	Low to Medium Plasticity Inorganic Clay (CL-CI)
BH311 / SS06	4.6 – 5.2	27	17	10	Low Plasticity Inorganic Clay (CL)
BH312 / SS04	2.3 – 2.9	23	14	9	Low Plasticity Inorganic Clay (CL)
BH313 / SS03	1.5 – 2.1	29	18	11	Low Plasticity Inorganic Clay (CL)
BH317 / SS03	1.5 – 2.1	25	15	10	Low Plasticity Inorganic Clay (CL)
BH319 / SS02	0.8 – 1.4	29	15	14	Low Plasticity Inorganic Clay (CL)
BH321 / SS05	4.6 – 5.2	30	20	10	Low to Medium Plasticity Inorganic Clay (CL-CI)
BH408 / SS03	1.5 – 2.1	33	17	16	Low to Medium Plasticity Inorganic Clay (CL-CI)

Notes:

(1) In accordance with Canadian Foundation Engineering Manual (CFEM), 4th Edition

5.1 Chemical Attack Potential

Four (4) samples of native soil, identified as in Table 4, were submitted to an external analytical laboratory (ALS Laboratories) to assess the potential for the attack to buried concrete and ductile iron. Laboratory results and certificates are attached in **Appendix D** of this report.

A summary of the test results is presented in Tables 4 and 5:

Table 4: Buried Metal Attack Parameters

Sample ID	Depth (m bgs)	Parameters					Total Points	Corrosivity Potential
		Resistivity (ohm.cm)	pH	Redox Potential (mv)	Moisture (%)	Sulphides (2) (%)		
BH301/SS01	0.0 – 0.6	2780	7.56	175	17.6	<0.02	4	No
BH315/SS04	2.3 – 2.9	4440	7.93	174	10.9	<0.02	4	No
BH317/SS02	0.8 – 1.4	3700	7.85	181	12.2	<0.02	4	No
BH319/SS01	0.8 – 1.4	1450	7.72	193	12.3	<0.02	14	Yes

Note:

(1) Soil test evaluation carried out using AWWA C105/A21.5-05. A score of ten points or more indicates the soil is corrosive to ductile iron. Additional protection would be recommended if the score is 10 or greater.

(2) It was assumed that samples with a laboratory result less than the reported detection limit (RDL) for sulphides would be considered a trace condition (score of 2) and results greater than the RDL would be considered positive (score of 3.5).

Table 5: Summary of Water-soluble Sulphate Content

Sample ID	Depth (m bgs)	Sulphate (%)
BH301/SS01	0.0 – 0.6	0.0021
BH315/SS04	2.3 – 2.9	0.0081
BH317/SS02	0.8 – 1.4	0.0046
BH319/SS01	0.8 – 1.4	<0.0020

The following Table, refereeing from CSA A23.1-04/A23.2-04 ‘Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Procedure for Concrete’, divides the degree of exposure of concrete structures to sulphate attack into the following classes:

Table 6: Sulphate Exposure Classes

Degree of Exposure (Class)	Water Soluble Sulphate (SO_4) in Soil Samples (%)
Very Severe (S-1)	> 0.20
Severe (S-2)	0.20 – 2.0
Moderate (S-3)	0.10 – 0.20

The laboratory results (Table 5 above) indicated that the sulphate content of samples identified are in the S-3 class, indicating a low potential for sulphate attack on concrete to be placed below the ground surface. Based on these results, standard Portland cement should be suitable for use on this project.

6 Subsoil Conditions

6.1 Overview

In general, as indicated by the geology maps, subsurface conditions at this site was found to be fairly uniform. The typical stratigraphic sequence consists of fill or pavement structure/topsoil over fill (mainly cohesionless) underlain by native deposits (in descending order): cohesive till and till/shale complex.

For details of the subsurface conditions encountered at the borehole locations, reference should be made to the individual borehole record sheets presented in **Appendix B**. The properties of the soils encountered in the boreholes are described in generalized terms in the following sections.

The following summary is to assist the designers of the project with an understanding of the anticipated soil conditions across the site. However, it should be noted that the soil and groundwater conditions may vary between and beyond the borehole locations.

6.2 Ground Cover

The boreholes BH303, BH305, BH309, and BH320 were advanced through an approximately 80 mm to 250 mm thick layer of topsoil at the ground surface. Asphalt concrete pavement was encountered in boreholes BH317, BH321 and BH412 with thickness ranging from 50 mm to 150 mm. It should be noted that ground cover (topsoil/pavement) thicknesses may vary between and beyond borehole locations.

6.3 Fill Materials

6.3.1 Gravelly Sand to Sand and Gravel Fill

A fill layer consisting predominantly of gravelly sand to sand and gravel, with trace silt, trace clay, and rootlet was encountered in most of the boreholes. The thickness of this layer ranged from 0.2 to 1.5 m. The recovered samples were generally described to be in moist to wet condition. Moisture content measurements obtained on the extracted samples were found to be approximately 4 to 21 % by weight.

SPT ‘N’ values for this stratum varied between 14 and 42 blows per 300 mm, indicating compact to dense relative density.

6.3.2 Silty Sand to Sand Fill

Silty sand to Sand Fill, with trace to some gravel, and occasional rootlet was encountered in boreholes BH305, BH306, BH311, BH315, BH317, BH321 and BH408. The thickness of this layer ranged from 0.3 m to 1.3 m. The recovered samples were generally described to be in a moist to wet condition. Moisture content measurements obtained on the extracted samples were found to be approximately 7 to 24 % by weight.

SPT ‘N’ values for this fill layer varied between 9 and greater than 50 blows per 300 mm, indicating loose to very dense relative density.

6.3.3 Sandy Silty Clay to Silty Clay Fill

A fill layer consisting of sandy silty clay to silty clay with some sand, trace gravel, and rootlet was encountered in boreholes BH304 to BH306, BH308, BH311, BH320, BH405 to BH408, and BH411 to BH414. The depth of this layer ranged generally between ground surface and 1.5 m bgs, except for borehole BH412 where the depth was from 0.3 to 2.3 m bgs. The recovered samples were generally described to be in a moist to wet condition. Moisture content measurements obtained on the extracted samples were found to be approximately 13 to 36 % by weight.

SPT 'N' values for this fill layer varied generally between 6 and 13 blows per 300 mm, indicating firm to stiff consistency. In boreholes BH413/SS01 and BH414/SS01, SPT 'N' values were noted to be between 1 and 4 blows per 300 mm indicating a very soft to soft consistency.

6.4 Native Strata

6.4.1 Sandy Silty Clay to Silty Clay Till

A heterogenous relatively thick stratum of native soil consisting predominantly of sandy silty clay with trace to some gravel was encountered in all boreholes, except borehole BH403, at various depths ranging from existing ground surface to 6.1m bgs. This stratum was observed to become gravelly between 4.6 to 6.1 m bgs in borehole BH308. Cobbles were encounter randomly at various depths in this layer.

The recovered samples of this till layer were generally described to be in a moist to wet condition. Moisture content measurements obtained on the extracted samples were found to be between 7% and 28% by weight indicating moist to wet state.

SPT 'N' Values for this stratum varied between 9 and more than 100 blows per 300 mm, indicating a stiff to hard consistency in general. SPT 'N' values between 5 and 7 blows per 300 mm was noted in boreholes BH306/SS03, BH404/SS02 and BH404/SS03 indicating a firm consistency. In borehole BH406/SS02, SPT 'N' value of 3 was noted indicating a soft consistency.

6.4.2 Silty Sand to Sand Till

A stratum of native cohesionless till consisting predominantly of silty sand to sand with trace to some clay and trace to some gravel was encountered at the depths from existing ground surface to 9.2 m bgs in various boreholes. The soil layer becomes gravelly in boreholes BH304, from surface to a depth of 0.8 m bgs and BH404, from 2.3 to 4.6 m bgs.

The recovered samples were generally described to be in a moist to wet condition. Moisture content measurements obtained on the extracted samples were found to be between 2% and 23%.

SPT 'N' Values for this stratum varied between 12 and more than 100 blows per 300 mm, indicating a compact to very dense relative density. SPT 'N' value of 7 per 300 mm was noted in BH401/SS03 indicating a loose relative density.

6.4.3 Till-Shale Complex

A heterogeneous matrix of either silty clay till or silty sand till and weathered shale fragments was encountered in boreholes BH303, BH305, BH310, BH311, BH314, BH315, BH316, and BH320 below till at depths between 6.1 and 9.1 m bgs. This stratum was relatively difficult to auger due to its hard consistency and contained fragmented shale pieces. This matrix is a transitional deposit between the overlying till and bedrock and may also represent completely to highly weathered bedrock shale.

SPT refusal was encountered within this layer, indicating a hard consistency.

7 Groundwater Conditions

Groundwater observations were made in the boreholes as drilling proceeded and upon completion of drilling. Ten (10) monitoring wells were installed in boreholes BH302/MW302, BH304/MW304, BH306/MW306, BH307/MW307, BH309/MW309, BH311/MW311, BH312/MW312, BH313/MW313, BH315/MW315 and BH320/MW320 to enable us to measure a stabilized groundwater reading. Details of groundwater level in open boreholes, cave-in conditions and groundwater level measurement in monitoring wells are provided in the borehole logs in **Appendix C**. A summary of groundwater and cave-in recordings is presented in Table 6. It should be noted that there was not sufficient time available for the groundwater to stabilize inside the open boreholes.

Table 7: Groundwater and Cave-in Conditions

Borehole ID	Drilling Completion date	Groundwater Level Upon Completion of Drilling (m bgs)	Groundwater Level on March 25, 2020 (m bgs)	Cave-in Level Upon Completion of Drilling (m bgs)
BH301	March 03, 2020	Dry	n/a	4.6
BH302/MW302	March 11, 2020	3.4	2.0	Open
BH303	March 02, 2020	Dry	n/a	Open
BH304/MW304	March 10, 2020	3.3	2.2	4.3
BH305	March 10, 2020	3.4	n/a	4.5
BH306/MW306	March 11, 2020	8.2	2.4	9.2
BH307/MW307	March 05, 2020	-	2.2	-
BH308	March 09, 2020	Dry	n/a	8.8
BH309/MW309	March 10, 2020	Dry	2.2	Open
BH310	March 09, 2020	4.2	n/a	6.7
BH311/MW311	March 09, 2020	3.5	2.2	Open
BH312/MW312	March 12, 2020	3.3	2.6	Open
BH313/MW313	March 06, 2020	Dry	2.0	Open
BH314	March 06, 2020	2.7	n/a	9.0
BH315/MW315	March 05, 2020	Dry	2.1	9.0
BH316	March 03, 2020	Dry	n/a	Open
BH317	March 04, 2020	5.8	n/a	Open
BH318	March 04, 2020	Dry	n/a	Open
BH319	March 03, 2020	Dry	n/a	Open
BH320/MW320	March 04, 2020	3.7	2.0	Open
BH321	March 02, 2020	Dry	n/a	Open
BH401	March 12, 2020	Dry	n/a	Open
BH402	March 11, 2020	1.4	n/a	Open

BH403	March 11, 2020	Dry	n/a	3.0
BH404	March 12, 2020	Dry	n/a	Open
BH405	March 12, 2020	Dry	n/a	Open
BH406	March 12, 2020	Dry	n/a	Open
BH407	March 13, 2020	Dry	n/a	Open
BH408	March 13, 2020	Dry	n/a	Open
BH409	March 05, 2020	Dry	n/a	Open
BH410	March 13, 2020	Dry	n/a	Open
BH411	March 13, 2020	Dry	n/a	Open
BH412	March 12, 2020	Dry	n/a	Open
BH413	March 12, 2020	Dry	n/a	Open
BH414	March 13, 2020	Dry	n/a	Open

The groundwater at the site would fluctuate seasonally and can be expected to be somewhat higher in response to major weather events. In addition, perched groundwater can accumulate during and after wet seasons within the more pervious fill and native soils. In adverse conditions, the perched groundwater table may raise to near the ground surface. No long-term groundwater monitoring provisions were made in this geotechnical investigation program.

8 Engineering Discussion and Recommendations

It is our understanding that the proposed development will consist of a Fire Hall on the north side of the Site, with possible road extension along the south side. The proposed Fire Hall will be a slab on grade building with at grade parking. Thirty-five (35) boreholes were advanced at the Site, with twenty-one (21) boreholes covering the proposed building footprint, (9) boreholes covering the surface parking areas and five (5) boreholes covering boulevards and/or sidewalks (See **Appendix A** for locations). Further details such as structural drawings, anticipated loading, Finished Floor Elevations (FFE), etc. were not available at the time of preparation of this report.

Fill materials up to 1.5 thickness (typically) with loose compactness condition and very soft consistency and occasionally mixed with rootlet were encountered either at surface or below cover materials which will pose some challenges to the proposed development. Freestanding groundwater was encountered in eleven (11) boreholes in the site upon completion of drilling. A detailed hydrogeological study was beyond the scope of work for this geotechnical investigation. However, based on groundwater observations, excavations for shallow foundations may be anticipated to encounter groundwater during construction.

Based on above comments and the borehole information, and assuming them to be representative of the subsoil conditions across the site, following comments and recommendations are offered.

8.1 Site Preparation and Grading

Based on the conditions encountered in the boreholes as summarized in Section 6, the proposed development areas of the site primarily consists of ground cover of topsoil and asphaltic concrete gravel underlain by fill materials extending to depths ranging between 0.2 and 1.5 m bgs, with the exception of BH317 where fill was encountered to a depth of 2.3 m bgs. The fill consisted of mostly cohesionless material (gravelly/silty sand), however cohesive fill (silty clay) was encountered in boreholes BH320, BH401, BH406, BH413 and BH414. In general, the existing earth fill was found to contain rootlet and broken cobble pieces.

Prior to any construction, the existing ground surface cover and fill materials are to be removed from the area of the proposed development. The asphaltic concrete gravel is not suitable for site grading or foundation purposes and should be removed entirely from the footprint of the building. Any organics, deleterious materials, asphaltic concrete, and unsuitable fill exposed must be removed from the area of the proposed building and parking lot. All subgrade surfaces for the building, roadways and sidewalks are to be examined by qualified geotechnical personnel.

The fill and native soils encountered at the Site are generally suitable for reuse as backfill, provided it is free of organic and deleterious material and is within the optimum moisture content. However, due to the high silt content within the native soils, difficulties in achieving desired compaction of the material should be expected.

Prior to any fill placement, the material needs to be inspected and approved by SNCL's qualified geotechnical engineer. Further comments regarding the use of backfill are discussed in Section 8.5. However, re-use of removed topsoil should be limited to landscaping areas (as applicable).

8.2 Proof Rolling

Upon completion of initial site preparation activities (as discussed above), proof rolling of the subgrade should be conducted to verify that competent and uniform soil subgrade support conditions have been achieved. Proof rolling should not be conducted during or shortly following precipitation events, and heavy equipment shall not be allowed to travel on wet/soft subgrade soils until adequate drying has occurred. Proof rolling should be performed by two passes of a dual-wheel truck (or comparable equipment) with a minimum of 80 kN single axle load. Soils which display rutting or appreciable deflections upon proof-rolling should be over-excavated to expose more competent soil and replaced with suitable engineered fill. Alternately, the use of geosynthetics (woven geotextile, geogrid in conjunction with non-woven geotextile, or, combination geotextile/geogrid products), possibly in conjunction with some over-excavation, may be an alternative. If geosynthetics are utilized, it is recommended that granular fill materials be placed directly over the geosynthetics. The geosynthetics should be placed in accordance with the manufacturer's recommendations. Construction techniques should be designed to minimize the potential for damage to the geosynthetics and underlying subgrade soils (i.e., end-dump and spread methods, use of long reach and/or low contact pressure equipment, etc.). SNC-Lavalin should be retained to provide guidance with respect to subgrade improvement measures.

Following efforts to stabilize the soil, proof rolling should be repeated. All proof rolling and compaction efforts should include documentation detailing the findings, including photographs where possible. All finished subgrades should be protected from construction traffic and erosion as soon as possible.

8.3 Building Foundations

The following section provides recommendations for geotechnical design of foundations for the proposed building based on the subsurface conditions encountered at the Site:

8.3.1 Conventional Spread Footings

The existing fill layers that overlay the proposed building footprint are unsuitable to support building foundations. Footings may be placed on the native strata at depths ranging approximately 1.5 m to 2.3 m, using a geotechnical bearing resistance of 200 kPa for a Serviceability Limit States (SLS) and 300 kPa for a factored Ultimate Limit State (ULS) design. The minimum founding depth at each of the borehole locations is provided in the Table below. Additional details regarding SLS and ULS bearing capacity, for cases were the grade is raised, are provided in Section 8.5.1.

Table 8: Recommended Minimum Footing Depth / Elevation

Borehole	Approximate Depth (m bgs)	Approximate Elevation (MASL)
BH301	1.5	214.5
BH302	1.5	214.3
BH303	1.5	214.2
BH304	2.3	213.7
BH305	2.3	213.9
BH306	2.3	213.6
BH307	1.5	214.4
BH308	1.5	214.5
BH309	1.5	214.4
BH310	1.5	214.2
BH311	1.5	214.5
BH312	1.5	214.4
BH313	2.3	213.4
BH314	1.5	214.5
BH315	1.5	214.4
BH316	1.5	214.2
BH317	2.3	213.5
BH318	1.5	214.4
BH319	1.5	214.0
BH320	1.5	214.4
BH321	1.5	214.5

Conventional spread footings must be founded at least 0.2 meters into the native stratum for the geotechnical bearing resistance values provided. Excavation for sump pits, utility trenches, footings, or similar should not intersect a zone which would extend downward and an angle of 10 horizontal to 7 vertical from the outside underside of existing or proposed footings. Exposed footing subgrades are to be inspected, evaluated and approved by SNCL's qualified geotechnical engineer or their designate.

Footings designed to the specified bearing capacity at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

A permanent soil cover of a minimum of 1.2 m or its thermal equivalent in insulation is required for frost protection of all foundations. Higher geotechnical bearing resistances would be available at a greater depth, if required. It is recommended that our office is allowed to review the structural drawings.

8.4 Dewatering

As discussed in Section 7, the measured groundwater levels in piezometers approximately two to three weeks after installation is about at 2 m depth below existing grade. Due to the relatively shallow static groundwater elevations and soils consisting of permeable deposits, active dewatering may be required for excavations at this site in areas where groundwater cannot be controlled through the use of gravity fed sumps and pumps.

Any form of dewatering must consider possible settlements that may be caused on the adjacent areas, including the possible adverse effects on the existing and nearby structures, roads,

underground services etc. It should also consider the large body of water present (e.g. the stream) as well as the relatively high permeability of the soils encountered in the boreholes.

The following general guidance is provided for designers of a dewatering system for this Site:

- Standby pumping capacity should be provided, in addition to an adequate primary capacity;
- Effective filters must be utilized in order to prevent migration of soil fines and ground loss;
- Pumped water must be discharged such that it will not interfere with excavations;
- Groundwater must be maintained at least 0.5 m below the base of any open excavations, including any progressively rising backfill during its placement in order to prevent 'pumping' of the base due to construction traffic/compaction efforts;
- Adequate monitoring of groundwater levels must be carried out – this may involve installation of additional monitoring wells prior to construction; and
- On completion of construction activities, dewatering systems should be gradually shut down to prevent the creation of transient critical exit gradient conditions, which may result in migration of fines.

It should be noted that if pumping volumes for construction dewatering are less than 400,000L per day, a Permit to Take Water (PTTW) from the Ontario Ministry of the Environment (MOE) is not required. However, registration under the Environmental Activity and Sector Registry (EASR) from the MOE will be required.

8.5 Backfill Considerations

Backfilling, if required can be accomplished by reusing the excavated soils or similar fill material provided the moisture content is maintained within 2 percent of optimum and the fill is free of topsoil, organics and any deleterious material. The fill placed in excavated foundations should be in thin lifts not exceeding 200 mm thick and compacted to not less than 98 percent of its Standard Proctor Maximum Dry Density (SPMDD) up to 500 mm below pavement structure or hardscaped areas.

In general, the on-site excavated clayey soils including silty clay and clayey fills, will be excavated in cohesive blocks and will be difficult to handle and compact, requiring the use of heavy compactors for proper compaction. For use as backfill, the cohesive blocks will have to be pulverized and placed in thin layers, provided their moisture contents are at or near the optimum moisture content. Unless the clayey soils are properly reduced in sized and compacted in sufficiently thin lifts, post-construction settlements could occur.

Backfill placed in the upper 500 mm below pavement structure or hardscaped areas should be compacted to 98 % to 100% of that material's SPMDD.

For any fill operation to be considered Engineered Fill, the following criteria must be satisfied:

- Engineered Fill should consist of uniform, homogeneous material. The fill material should also be free of organics, deleterious materials (i.e. building debris such as bricks, metal etc.). Materials meeting Ontario Provincial Standard Specification, such as Select Subgrade material, and/or OPSS Granular B Type I or II specifications or of better quality would be considered a suitable Engineered Fill material;

- Prior to the placement of Engineered Fill, it must be evaluated for suitability in the Geotechnical Laboratory. Samples should be provided to the Geotechnical Engineer and submitted for Standard Proctor, grain size analysis and moisture content determination;

- Engineered Fill must be compactable, and of a suitable moisture content such that it is within +/- 2.0% of its optimum moisture content, as determined through laboratory testing, and compacted to not less than 100% of the materials' Standard Proctor Maximum Dry Density (SPMDD), and placed and compacted in separate lifts up to 250mm in thickness or as otherwise noted;

- Engineered Fill must be placed under the continuous supervision of a Geotechnical Engineer or their designate;

- Field density tests must be taken under the supervision of the Geotechnical Engineer on each lift of Engineered Fill. Any Engineered Fill which is tested and found to be out of specification shall be either removed, reworked or retested;

- Material to be used as Engineered Fill must be environmentally acceptable, subject to confirmatory testing; and

- Engineered Fill placed underneath foundations must extend laterally a minimum of 0.6 D, but not less than 0.9 m from the outside edge of the footings, where D is the depth of Engineered Fill placed.

8.5.1 Engineered Fill Foundations

Engineered fill could be considered for supporting foundations or if grade raise is required. Due to the gentle slope at the site, if existing grades are required to be raised for general site grading, and to avoid stepping down footings, it is understood that proposed foundations for this building may be placed on engineered fill. If this is desired, the following procedure should be implemented.

- All existing fill and deleterious material within the proposed building area should be removed;

- The exposed subgrade should be inspected, evaluated and approved by a geotechnical engineer or designate. The exposed surface should be proof rolled using heavy construction equipment to identify any soft areas. These soft areas should be sub excavated and replaced with compacted engineered fill;

- Provided the underlying native soils are found suitable to support engineered fill, the subsequent engineered fill layers can be placed and compacted to raise Site grades; and

- If appropriate compaction is not achieved or if the native soils are deemed unacceptable, additional measures such as sub excavation will be required. These measures should be determined at the time of construction.

Provided the Engineered fill is used underneath the footings as noted above, the following bearing pressures can be used in the foundation design:

- Cohesive fill: a geotechnical bearing resistance of 100 kPa for a Serviceability Limit States (SLS) and 300 kPa for a factored Ultimate Limit State (ULS) design.

- Granular Fill: a geotechnical bearing resistance of 150 kPa for a Serviceability Limit States (SLS) and 350 kPa for a factored Ultimate Limit State (ULS) design

The selected backfill materials should reasonably match the existing soil profile within the zone of frost penetration (1.2 m below finished grades). Alternatively, if imported backfill (including granular material) are used, excavations should be provided with frost tapers – designers should refer to applicable OPSD for taper requirements.

8.6 Slab-on-Grade

In order to have a floor slab with minimum maintenance, we recommend that all objectionable materials (i.e. organic, wet, soft etc.) and fill soils are removed, and the exposed subgrade should be inspected, evaluated and approved and thoroughly proof rolled.

The existing fill is not suitable for supporting foundations as well as floor slabs. For the proposed building, the floor slab can be supported on grade provided all topsoil, fill, and surficial softened till are removed and the base thoroughly proof rolled. The engineered fill can consist of inorganic soil, placed in shallow lifts and compacted to not less than 100 percent of Standard Proctor Maximum Dry Density (SPMDD).

The slab-on-grade areas should be proof rolled. Underneath slabs, a minimum 200mm thick base layer consisting of Ontario Provincial Standard Specifications (OPSS) Granular A should be placed and compacted to 100% of its SPMDD. It is also recommended that the final lift of material beneath the slab consist of 150mm of clear stone material in order to provide a capillary break as well as for fine grading purposes.

The modulus of subgrade reaction appropriate for slab design would depend on the condition of the subgrade and the extent of sub-excavation required. If all unsuitable materials are removed beneath the proposed slab-on-grade and replaced with well-compacted Engineered Fill, then a modulus of subgrade reaction of 27,000 kN/m^2/m to 32,500 kN/m^2/m (100 to 120 pci) can be used for design purposes. Once the size of the slab is confirmed, SNCL needs to be notified and the modulus of subgrade reaction may need to be modified.

8.7 Seismic Site Classification

Buildings foundations are required to be structurally designed to resist a minimum earthquake force, as defined in the National Building Code of Canada, 2015 (NBCC).

In accordance with Section 4.1.8.4 of NBCC, the site classification for seismic site response was verified by measurement of the in-situ shear wave velocity by geophysical techniques. Geophysics GPR conducted multi-channel analysis of shear waves (MASW) at the project site, as shown in **Appendix E**. Based on the analysis, the average shear wave velocity for the top 30 m at the site was 796 m/s. Taking into account the estimated error in MASW and NBCC, a seismic site classification of 'C' can be considered at this project site.

8.8 Drainage

Perimeter drainage is not considered necessary for a structure with no basement and a floor slab set a minimum of 0.3 m above finished exterior grades. **Appendix F** presents typical sections of perimeter drains in accordance to the latest edition of the Canadian Foundation Engineering Manual. The drainage system should discharge to a protected and frost-resistant sump. The uppermost backfill should be impermeable soil.

It is generally recommended that all slabs-on-grade which are located at or near exterior grades be located a minimum of 300 mm above the final exterior grade, and that the ground surface around the perimeter of the buildings slope downward and away from the building walls.

Damp-proofing should be applied to exterior foundation walls in order to prevent moisture infiltration from the backfill materials. Waterproofing membranes could be considered as an additional precaution.

8.9 Excavation and Temporary Shoring

8.9.1 Open Cut

The OHSA regulations require that if workmen must enter an excavation deeper than 1.2 m, the excavation must be suitably sloped and/or braced in accordance with the OHSA requirements. OHSA specifies the maximum slope of the excavations for four broad soil types as summarized in the following table:

Table 9: Maximum Slope of Excavation for Soil Type

Soil Type	Base of Slope	Maximum Slope Inclination
Type 1	Within 1.2 metre of bottom	1 horizontal to 1 vertical
Type 2	Within 1.2 metre of bottom of trench	1 horizontal to 1 vertical
Type 3	From bottom of excavation	1 horizontal to 1 vertical
Type 4	From bottom of excavation	3 horizontal to 1 vertical

The fill at the Site above the groundwater can be classified as Type 3 soils. The Native clayey soils can be classified as Type 1 (hard) to 3 (firm to stiff) soils. The cohesionless soils encountered at depth at this site can be classified as Type 1 (very dense) to type 3 (compact) soils. If affected by groundwater or surface water seepage, the fill and native soils must be considered as Type 4 soils. The highest number of soil type identified in an excavation must govern the excavation slopes from top to bottom of the excavation.

If the above-recommended excavation side slopes cannot be maintained due to lack of space (i.e. due to building addition) or any other reason, the excavation sides must be supported by an engineered shoring system. The shoring system should be designed in accordance with relevant codes, standards, and regulations such as the latest version of the Canadian Engineering Foundation Manual and the OHSA Regulations for Construction Projects.

For all temporary construction excavation slopes, the stability of the cut slopes will have to be frequently monitored by the geotechnical engineer. If the temporary construction excavation slopes are subject to erosion (e.g., due to rainfall, high groundwater flow, etc.), slope stabilization measures (e.g., covering the slope/trench faces with plastic sheets, excavating flatter slope, etc.) will have to be implemented.

Stockpiles of excavated materials should be kept at least 3 m from the edge of the excavation to prevent slope instability, subject to confirmation by the geotechnical engineer. Care should also be taken to avoid overloading of any underground services/structures by stockpiles.

No major excavation difficulties are foreseen in the existing overburden soils within the depths drilled for this investigation, but allowance should be made for the possible presence of boulders and cobbles that may be found within the soil strata, so the use of appropriate equipment is recommended.

Temporary support for underground utilities (e.g. gas, water, cable, sewer, and telephone) and any existing footings/structures which may be exposed during the excavation may be required. Approval should be obtained from relevant authorities and utilities companies regarding excavation works around such services/footings.

8.9.2 Temporary Shoring and Lateral Earth Pressures

No basement is anticipated in proposed building area; however, service pits are anticipated. Any permanent walls or temporary shoring systems must be designed by a qualified engineer in order to resist unbalanced lateral earth pressures.

Cave-in conditions were noted in nine (9) boreholes at the Site at depths ranging from 3.0 to 9.2 m bgs. If required, shoring systems such as trench boxes could be employed for the site, if insufficient space is available to properly backslope excavation sidewalls. The temporary shoring system should be designed and provided in accordance with the latest version of the Canadian Foundation Engineering Manual, 4th Edition, and Ontario Health and Safety Regulations.

For design purposes, the following table presents geotechnical parameters related to lateral earth pressures can be considered:

Table 10: Lateral Earth Pressure Parameters

Soil Type	Bulk Unit Weight, γ (kN/m^3)	Angle of Internal Friction (Φ)	Coefficient of Lateral Earth Pressure		
			K_a	K_o	K_p
Existing Cohesionless Fill	19	30	0.33	0.50	3.00
Existing Cohesive Fill	19	26	0.39	0.56	2.56
Native Cohesionless Till	21	33	0.29	0.46	3.39
Native Cohesive Till	20	31	0.32	0.48	3.12
Compacted Granular 'B' Type II / "A"	22	35	0.27	0.43	3.69

Note: the above values were calculated considering a level surface behind the wall

Horizontal earth pressures can be calculated based on the following equation:

$P= K [\gamma(h-h_w) + \gamma' h_w + q] + \gamma_w.h_w$

where:

P = the horizontal pressure at depth, h (m)

K = the earth pressure coefficient,

γ = the bulk unit weight of soil, (kN/m3)

γ' = the submerged unit weight of soil, (kN/m3)

γ_w = the unit weight of water, (kN/m3)

h_w = the depth below the groundwater level (m)

q = the complete surcharge loading (kPa)

Where elevated groundwater level is not anticipated to be present or that a perimeter drainage system is used to eliminate hydrostatic pressures on the soil retaining structure, the above noted expression will be simplified as follows:

$P = K(\gamma h+ q)$

This equation assumes a drainage system which eliminates hydrostatic pressures would be present shoring system. It should be noted that shoring systems should be restrained and not allow lateral yielding, therefore the at-rest earth pressure coefficient should be used for their design. Surcharge loads related to compaction equipment should be taken into considerations for all designs.

8.10 Site Services

The boreholes showed that in their undisturbed state, the native soil will generally provide adequate support for utilities and allow the use of normal Class 'B' Type bedding (i.e. compacted granular bedding material - as per applicable OSPD standards e.g. OPSD 802.032). The recommended minimum thickness of granular bedding below proposed utilities is 150 mm. The thickness of the bedding may, however, have to be increased depending on the pipe diameter, as per specifications, or if wet or weak subgrade conditions are encountered. The Class 'B' Type bedding may need to be wrapped by a geotextile (e.g., Terrafix 270R or equivalent), as directed by the geotechnical engineer. HL6 clear stone wrapped in geo-textile and/or high-performance bedding (HBP) can be considered as alternative bedding if wet or unsuitable conditions are present at the subgrade.

In any event, after installing the pipe on the bedding, the compacted bedding material must surround the pipe and extend above the top of the pipe as set by the applicable standards, but not less than 300 mm, to avoid damage to the pipe during backfilling. Backfill immediately overlying the bedding must be compacted carefully using a suitable compactor to avoid damage to the pipe.

8.11 Pavement Design Selection and Recommendations

Based on the findings of the boreholes and visual condition of the project site, recommendations for the pavement design of the proposed parking areas and access road for fire truck are provided in this section. The pavement recommendations include a light-duty section for passenger vehicle parking areas, and a heavy-duty section for access roads (i.e. fire truck route). Flexible pavement design is recommended for both light-duty and heavy-duty traffic. In addition, rigid pavement option is recommended for heavy-duty traffic (fire hall).

The design recommendations for pavement structure for parking areas is as follows:

8.11.1 Design Considerations:

- It should be noted that the pavement designs are based on assumed traffic. If more accurate or reliable data are available, the pavement design should be revised.

- Based on MTO's Pavement Design and Rehabilitation Manual, 2nd Edition, the soils are considered as low to moderate frost susceptibility (LSFH to MSFH). The permanent ground water level should be at least 1.5 m below the proposed finished grade by providing positive drainage system (e.g. subdrains, storm sewer, etc.) to prevent frost heave. To promote effective surface drainage, the finished pavement surface must be free of depressions and sloped at a minimum grade of two percent towards a positive outlet for runoff. Surface water should not be allowed to pond at the outside edges of any pavement areas.

- All objectionable materials and surficial soft fill soils should be removed and the exposed subgrade thoroughly proof rolled. The pavement thicknesses recommended below considers that construction will be carried out during a dry seasonal period and that the subgrade soils are competent. If the subgrade becomes excessively wet or rutted during construction activities, sub-excavation and replacement with additional depth of granular sub-base material may be required. The disturbance of the subgrade material during site preparation, stripping,

proof rolling and granular fills must be avoided. If the granular pavement fill is placed on disturbed, undulating soils, water can be trapped and collect in the depression which could lead to differential frost heave and thus damage the asphaltic concrete surface.

8.11.2 Flexible Pavement: Light-Duty Parking Lot (Car Parking)

- Excavate/remove the existing topsoil/asphaltic concrete and underlying material in order to accommodate 540 mm pavement structure below the final grade of the proposed parking area;
- Perform subgrade preparation with 3% crossfall toward drainage outlets (catch basins, storm sewers, or ditch);
- Place and compact 300 mm Granular B Type II to minimum 100% of Standard Proctor Maximum Dry Density (SPMDD);
- Place and compact 150 mm of Granular A with 2% crossfall toward drainage outlets to minimum 100% SPMDD;
- Pave 50 mm Superpave 19.0 or HL8 binder course;
- Place SS-1 Tack Coat; and
- Pave 40 mm Superpave 12.5 or HL3 surface course.

8.11.3 Heavy Duty Traffic (Main Access Driveway to the Parking Lots,)

Option 1: Flexible Pavement

- Excavate/remove the existing topsoil/asphaltic concrete and underlying material in order to accommodate 650 mm pavement structure below the proposed final grade of the proposed parking area;
- Perform subgrade preparation with 3% crossfall toward drainage outlets (catch basins, storm sewers, or ditch);
- Place and compact 350 mm Granular B Type II to minimum 100% of Standard Proctor Maximum Dry Density (SPMDD);
- Place and compact 150 mm of Granular A with 2% crossfall toward drainage outlets to minimum 100% SPMDD;
- Pave 110 mm Superpave 19.0 or HL8 binder course in two lifts;
- Place SS-1 Tack Coat; and
- Pave 40 mm Superpave 12.5 or HL3 surface course.

Option 2: Rigid Pavement:

- Excavate/remove the existing topsoil/asphaltic concrete and underlying material in order to accommodate 730 mm (Granular A) or 630 mm (OGDL) pavement structure below the proposed final grade of the proposed parking area;
- Perform subgrade preparation with 3% crossfall toward drainage outlets (catch basins, storm sewers, or ditch);
- Place and compact 300 mm Granular B Type II to minimum 100% of Standard Proctor Maximum Dry Density (SPMDD);

- Place and compact 200 mm Granular A or 100 mm OGDL (Open Graded Drainage Layer), with 2% crossfall toward drainage outlets to minimum 100% SPMDD;
- Place 230 mm JPCP (Jointed Plain Concrete Pavement) in slabs not exceeding 4.5m in joint spacing, with 32mm dowel bars at slab joints (all directions) with 300mm dowel spacing.

8.11.4 Pavement Construction Material

Pavement construction material for new parking areas are summarized as follows:

Flexible Pavement

- The minimum grade of asphalt cement for this project should be PG 58-28, however, consideration may be given to a high-grade increase to PG 64-28 for the heavy-duty parking areas.
- New asphalt will be paved and compacted to minimum 92% of Maximum Relative Density (MRD)
- Tack coat should be applied to the top of binder course, as per OPSS PROV 308 and City of Brampton Specification.
- Civil designers and contractors should refer to and follow all applicable OPSS (Such as OPSS 310, 1010, 1150) and Peel Region/City standards regarding material specifications and construction procedures for new pavement construction.

Rigid Pavement

- The concrete should satisfy the requirements of CAN/CSA A23.1-04 Class C-2 concrete with a minimum compressive strength of 32 MPa and a minimum flexural strength of 5.0 MPa. The PCC concrete should meet the requirements of Peel Region/City specification.
- Dowel bars shall be plain round bars of grade 300 or better according to CSA G40.219 and shall be epoxy coated according to OPSS 1442.
- For concrete base specification, Dowel detail, Joint details, Concrete joint layout and Joint spacing, please refer to OPSS 350, OPSD 552.051, 552.010, 551.031 and 551.010, respectively.
- Wire shall be according to ATSM A 82M. Wire sizes shall be according to American Steel Wire Gauge.
- Standard subdrain should be installed as per OPSS and OPSD.

9 Closure

The recommendations provided in this report are based on subsoil data obtained at the sounding locations. Experience indicates that the subsoil and groundwater conditions can vary significantly between and beyond the sounding locations. For this reason, the recommendations given in this report are subject to a field verification of the subsoil conditions at the time of construction.

Should any site condition encountered differ from those at the tested locations or any changes in the project, we request that SNCL be notified immediately in order to permit reassessment of the recommendations.

10 General Conditions and Limitations

A. Use of the Report

A.1 The work performed in this report was carried out in accordance with the terms and conditions made part of our proposal and/or contract pursuant to which the report was issued. The conclusions presented in the report are based solely upon the scope of services, governed by the time and budgetary considerations to which this work is subject.

A.2 The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation or if the project is not initiated within twelve months of the date of the report, SNCL should be given an opportunity to confirm that the recommendations are still valid.

A.3 The comments given in this report are intended only for the guidance of the design engineer. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual test hole data, as to how subsurface conditions may affect their work.

A.4 The reader should be advised that geotechnical opinions, presented in this report, are subject to inherent uncertainties due to sampling limitations.

A.5 The report must be read as a whole, as sections taken out of context may be misleading. Drafts and working copies of study reports and other deliverables, whether or not marked "draft" and/or "for discussion purposes", do not necessarily reflect SNCL's final opinion following consideration of all matters which are the subject of the study giving rise thereto; they are issued for comment and information purposes only, and are subject to change. The reader should not rely on such documents for any purpose.

B. Follow-up

B.1 All details of the design and proposed construction may not be known at the time of submission of SNCL's report. It is recommended that SNCL be retained during the final design stage to review the design drawings and specifications related to foundations, earthworks, retaining systems and drainage, to determine that they are consistent with the intent of SNCL's report.

B.2 Retention of SNCL during construction is recommended to confirm and document that the subsurface conditions throughout the site do not materially differ from those given in SNCL's report and to confirm and document that construction activities did not adversely affect the design intent of SNCL's recommendations.

C. Soil and Rock Conditions

C.1 Soils and/or rock descriptions in this report are based on commonly accepted methods of classification and identification employed in professional geotechnical practice. Classification and identification of soil and rock involves judgment and

SNCL does not guarantee descriptions as exact but infers accuracy only to the extent that is common in current geotechnical practice.

C.2 The soils and rock conditions described in this report are those observed at the time of the study. Unless otherwise noted, those conditions form the basis of the recommendations in the report. The condition of the soil and rock may be significantly altered by construction activities (traffic, excavation, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting or drying. Unless otherwise indicated the soil and rock must be protected from these changes or disturbances during construction.

D. Logs of Test Holes and Subsurface Interpretations

D.1 The test hole logs indicate the approximate subsurface stratigraphy and conditions only at the locations of the test holes. Soil and rock formations are variable to a greater or lesser extent. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface stratigraphy and conditions are indicated depends on the method of boring, the frequency of sampling, the method of sampling and the uniformity of subsurface stratigraphy and conditions.

D.2 Subsurface stratigraphy and conditions between test holes are inferred and may vary significantly from stratigraphy and conditions encountered at the test holes.

D.3 Groundwater elevations and conditions described in this report refer only to those observed at the place and time of observation noted in the report. These elevations and conditions may vary seasonally or as a consequence of construction activities on the site or adjacent sites.

E. Changed Conditions

E.1 Where conditions encountered at the site differ significantly from those described or anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the use or reliance by the client on this report that SNCL is notified of the changes and provided with an opportunity to review the recommendations of this report. Recognition of changed soil and rock conditions requires experience and it is recommended that an experienced geotechnical engineer be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

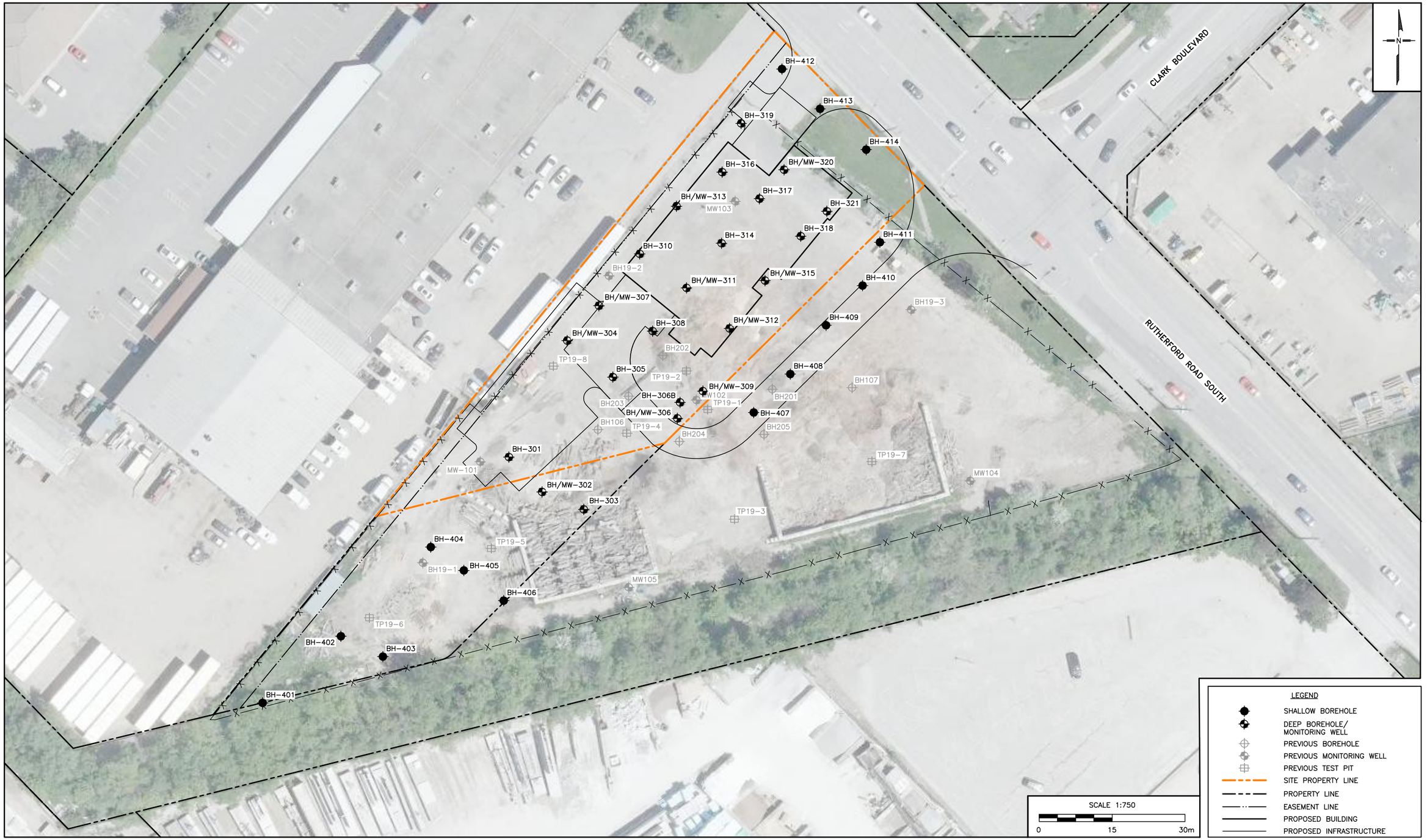
F. Drainage

F.1 Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage can have serious consequences. SNCL can take no responsibility for the effects of drainage unless SNCL is specifically involved in the detailed design and follow-up site services during construction of the system.

END OF DOCUMENT

Appendix A

Site and Borehole Location Plan (1 pages)



NOTE(S):
1. SCALE AND SITE INFRASTRUCTURE LOCATIONS ARE APPROXIMATE
2. INFORMATION ON THIS FIGURE MAY BE LOST IF IT IS PRINTED, PHOTOCOPIED OR FAXED IN OTHER THAN ITS ORIGINAL SIZE AND COLOURS
3. 'm' : METRES

SOURCE(S):
1. CITY OF BRAMPTON, ONLINE MAP, JANUARY 2020
2. WOOD ENVIRONMENT AND INFRASTRUCTURE SOLUTIONS, PHASE TWO ENVIRONMENTAL SITE ASSESSMENT, BOREHOLE/MONITORING WELL AND TEST PIT LOCATION PLAN, FIGURE 5, PROJECT No. TOR190020.3000, OCTOBER 2019

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Client/Location: CITY OF BRAMPTON 25 RUTHERFORD ROAD SOUTH, BRAMPTON, ON			Title: BOREHOLE/MONITORING WELL LOCATION PLAN
Project No: 671835	Filename: 007F01_671835	Date: JUNE 2020	Dwg No: FIGURE 1
Drawn: DM	Verified: WW	Project Manager: AY	

PAGE FORMAT: 11x17

FILENAME: P:\City of Brampton\Rutherford Rd South\671835\40_Execution\47_Wrkg_Vers\CAD_GIS\007 (GEM)\007F01_671835.dwg

Appendix B

Record of Borehole Logs (36 pages)

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NOTES TO RECORD OF BOREHOLES

DRILLING DATA

Method:

SolSt Auguring	-	Solid Stem Auguring
HolSt Auguring	-	Hollow Stem Auguring
WB	-	Washed Boring

SAMPLES TYPE

SS	-	Split Spoon
AS	-	Auger Sample
TW	-	Thin wall Open
TP	-	Thin wall Piston
WS	-	Washed Sample
BS	-	Block Sample
RC	-	Rock Core
PH	-	Sample Advanced Hydraulically
PM	-	Sample Advanced Manually

LABORATORY DATA

W_P	-	Plastic Limit
W	-	Water Content (%)
W_L	-	Liquid Limit
γ	-	Natural Unit Weight (kN/m^3)
UNDR STRNG or c_u	-	Undrained Shear Strength (kPa) Field Vane: St-sensitivity
pp	-	Pocket Penetrometer
UC	-	Unconfined Compression
UU	-	Unconsolidated Undrained at Overburden Pressure
CU	-	Consolidated Undrained
CD	-	Consolidated Drained
TOV	-	Total Organic Vapors

Standard Penetration Test, 'N'- Values: The Standard Penetration Test (SPT) 'N'-values are the number of blows required to cause a standard 51 millimeters o.d. split barrel sampler to penetrate 0.3 meter into undisturbed ground in a borehole when driven by a hammer with a mass of 63.5 kilograms falling freely a distance of a 0.76 meter. For penetrations of less than 0.3 meter, N-values are indicated as the number of blows for the penetration achieved (e.g. 50/25: 50 blows for 25 centimeters penetration).

Dynamic Cone Penetration Test: Continuous penetration of a conical steel point (51 millimeters o.d. 60^o cone angle) driven by 475 J impact energy on a size drill rods. The resistance to cone penetration is measured as the number of blows for each 0.3 meter advance of the conical point into the undisturbed ground.

Soils are described by their composition and consistency or relative density

CONSISTENCY: Cohesive soils are described on the basis of their undrained shear strength (c_u) or 'N'-values as follows:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*
N (blows/0.3 meter)	0 - 2	2 - 4	4 - 8	8 - 15	15 - 30	>30

COMPACTNESS CONDITION: Cohesionless soils are described on the basis of compactness condition as indicated by 'N'–values as follows:

N (blows/0.3 meters)	0 - 4	4 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

Rocks are described by their composition and structural features and/or strength

RECOVERY: Sum of all recovered rock core pieces from a coring run expressed as a percent of the total length of the coring run.

ROCK QUALITY DESIGNATION (RQD): Sum of those intact core pieces, 100 millimeters in length expressed as a percent of the length of the coring run. Classification of a rock based on the RQD value as follows:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50 mm	50 - 300 mm	0.3 - 1.0 m	1.0 - 3.0 m	>3.0 m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

RECORD OF BOREHOLE No. BH301

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 3, 2020 Date Completed: Mar 3, 2020	Revision No.:	0

EASTING: 601494.769
NORTHING: 4839210.682

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.99 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Unit Weight (kN/m³)	COMMENTS
	FILL Brown, dense, gravelly SAND, trace silt, wet. 215.4	SS	01	59	42				
	NATIVE TILL 0.6 Brown, stiff to very stiff, sandy silty CLAY, trace gravel, trace oxidation, moist.	SS	02	51	11	1	215		
		SS	03	100	27	2	214	22.17	
		SS	04	144	100/ 250mm				SPT Refusal due to possible cobbles/boulders
		SS	05	111	50/ 125mm	3	213		SPT Refusal due to possible cobbles/boulders
		SS	06	100	50/ 100mm	4	212		
						5	211		
	209.9 SHALE-TILL COMPLEX 6.1 Grey, hard, gravelly silty CLAY, some sand, some shale particles, moist. GA: 25%, SA:18%, SI:36%, CL:21%	SS	07	87	50/ 75mm	6	210		SPT Refusal due to possible weathered bedrock
						7	209		
		SS	08	100	50/ 100mm	8	208		SPT Refusal due to possible weathered bedrock
	206.7	SS	09	100	50/ 125mm	9	207		SPT Refusal due to possible weathered bedrock
	End of borehole 9.3								

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

INSTRUMENTATION INSTALLATION

No freestanding groundwater measured in open borehole upon completion of drilling. Cave in depth recorded on completion of drilling: 4.6 m.

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Scale: 1 : 58

RECORD OF BOREHOLE No. BH302(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 11, 2020 Date Completed: Mar 11, 2020	Revision No.:	0

EASTING: 601485.784
NORTHING: 4839187.368

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (Intact △ / Remould ▲); Nilcon Vane* (Intact ◇ / Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P ■ ○ W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.80 m											
	FILL Grey, compact, gravelly SAND, moist. 215.5	SS	01	67	15				10			
	NATIVE TILL 0.3 Brown, stiff to hard, sandy silty CLAY, trace to some gravel, oxidized, moist.						215					
		SS	02	84	10	1			20			
	trace broken cobble pieces	SS	03	77	47		214		15			
	213.5					2						
	Brown, dense to very dense, silty SAND, trace clay, trace gravel, moist 2.3	SS	04	100	36				9			
						3	213					
		SS	05	100	50/ 125mm				8			SPT Refusal due to possible cobbles/boulders
	211.2					4	212					
	SHALE-TILL COMPLEX 4.6 Grey, very dense, silty SAND, some gravel, trace clay, trace broken cobble pieces, shale pieces, moist.	SS	06	100	50/ 125mm				5			SPT Refusal due to possible weathered bedrock
						5	211					
		SS	07	100	50/ 50 mm	6	210		10			SPT Refusal due to possible weathered bedrock
						7	209					
		SS	08	100	50/ 100mm		208		17			SPT Refusal due to possible weathered bedrock
						8						
						9	207					
	206.5	SS	09	100	50/ 125mm				19			SPT Refusal due to possible weathered bedrock
	End of borehole 9.3											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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▽ **Groundwater depth on completion of drilling:** 3.4 m

▼ **Groundwater depth observed on** 3/25/2020 **at a depth of:** 2.0 m.

Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH303

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 2, 2020 Date Completed: Mar 2, 2020	Revision No.:	0

EASTING: 601510.188
NORTHING: 4839199.907

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.74 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Unit Weight (kN/m³)	COMMENTS
	TOPSOIL ~ 250 mm (215.5)								
	NATIVE TILL (0.3) Dark brown to brown, firm to very stiff, sandy silty CLAY, trace gravel, trace oxidation, wet to moist.	SS	01	67	7				
		SS	02	67	17	1	215		
		SS	03	84	28	2	214	21.91	
	(213.4) Brown, very dense, silty SAND, some gravel, some clay, trace broken cobble pieces, trace oxidation, wet. (2.3)	SS	04	75	71	3	213		
		SS	05	100	95/ 250mm				SPT Refusal due to possible cobble/boulders
	(211.2) Grey, hard, sandy silty CLAY, some gravel, moist. (4.6)	SS	06	67	71	5	211		
	becomes gravelly, trace cobble pieces.	SS	07	59	84	6	210		
	(208.1) Highly weathered Shale (7.7)	SS	08	100	50/ 25mm	7	209		SPT Refusal due to possible weathered bedrock
	End of borehole								

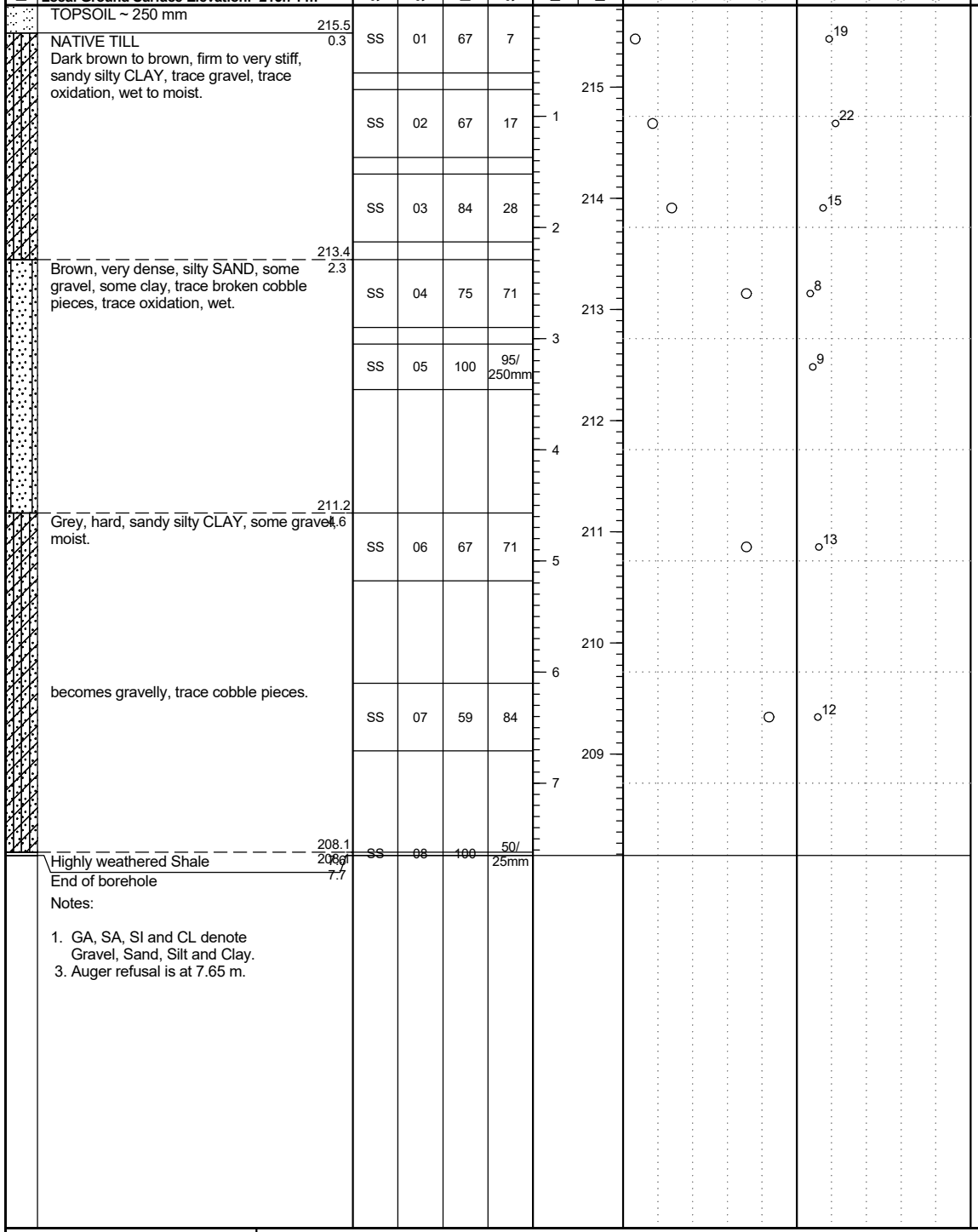
Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.
3. Auger refusal is at 7.65 m.

FIELD TESTING
Penetration Testing: ○ SPT ● DCPT
MTO Vane*: △ Intact ▲ Remould
Nilcon Vane*: ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING
★ Pocket Penetrometer (kg/cm²) 1 2 3 4
Soil Vapour Reading: △ parts per million (ppm) 100 200 300 400
▲ Lower Explosive Limit (LEL)
✱ Passing 75 um (%)
○ Moisture Content (%)
Atterberg Limits: W_P 20 40 60 80 W_L

INSTRUMENTATION INSTALLATION



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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commisioned and the accompanying'Notes to Record of Boreholes'.

Scale: 1 : 58

RECORD OF BOREHOLE No. BH304(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 10, 2020 Date Completed: Mar 10, 2020	Revision No.:	0

EASTING: 601506.765
NORTHING: 4839234.664

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Undrained Shear Strength (kPa)	LAB TESTING: Moisture Content (%)	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.99 m											
	FILL Grey, compact, SAND and GRAVEL, wet. 215.7	SS	01	54	10				15			
	Dark brown, stiff, silty CLAY, trace sand, trace gravel, rootlet, moist to wet. 0.3								7			
		SS	02	67	13	1	215		28			
	214.5 1.5											
	Grey, hard, sandy silty CLAY, trace to some gravel, trace oxidation,moist to wet.	SS	03	62	38	2	214		21			
	213.7											
	NATIVE TILL 2.3 Brown to grey, compact to dense, gravelly silty SAND, trace clay, trace broken cobble pieces, moist to wet.	SS	04	79	21				15			
	GA:29%, SA:32%, SI:31%, CL:8%	SS	05	59	30	3	213		12			
	211.4					4	212					
	Grey, very dense, silty SAND, some gravel, some broken cobble pieces, trace oxidation,moist to wet. 4.6	SS	06	46	73	5	211		9			
	209.9					6	210					
	Grey, hard, sandy silty CLAY, some gravel to gravelly, trace broken cobble pieces, moist. 6.1	SS	07	100	50/ 75mm				10			SPT Refusal due to possible cobble/boulders
						7	209					
		SS	08	100	50/ 25mm				15			SPT Refusal due to possible cobble/boulders
						8	208					
	206.9					9	207					
	End of borehole 9.1	SS	09		50/ 00mm				17			SPT Refusal due to possible cobble/boulders

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

Groundwater depth on completion of drilling: 3.3 m

Cave in depth recorded on completion of drilling: 4.3 m.

Groundwater depth observed on 3/25/2020 at a depth of: 2.2 m.

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RECORD OF BOREHOLE No. BH305

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 10, 2020 Date Completed: Mar 10, 2020	Revision No.:	0

EASTING: 601516.186
NORTHING: 4839227.152

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 216.18 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT / DCPT), MTO Vane* (Intact / Remould), Nilcon Vane* (Intact / Remould), * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading parts per million (ppm) 100 200 300 400; Lower Explosive Limit (LEL); * Passing 75 um (%); Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	TOPSOIL Topsoil ~ 80 mm 216.1 / 0.1											
	FILL Brown, compact, SAND, some gravel, trace silt, moist to wet. 215.6 / 0.6	SS	01	67	20		216		24			
	Dark Grey, firm, silty CLAY, trace gravel, trace rootlet, trace sand, moist. 214.7	SS	02	67	7	1	215		20			
	NATIVE TILL 1.5 Brownish grey, very stiff, sandy silty CLAY, trace to some gravel, trace oxidized, moist. 213.9	SS	03	100	16	2	214		17		21.69	
	Brown, compact to very dense, gravelly SAND, some silt, trace to some clay, trace oxidation, moist. 2.3	SS	04	100	29				12			
	broken cobble pieces	SS	05	100	50/ 100mm	3	213		13	▽		SPT Refusal due to possible cobble/boulder
		SS	06	100	50/ 25mm	4	212		10			SPT Refusal due to possible cobble/boulder
	210.1				50/	5	211					
	SHALE-TILL COMPLEX 6.1 Dark grey, hard, clayey SILT, some sand, trace broken cobble pieces, moist	SS	07	100	125 mm	6	210		10			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		SS	08	100	50/ 25mm	7	209		14			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	206.9	SS	09	100	50/ 125mm	8	208		8			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole 9.3					9	207					

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ Groundwater depth on completion of drilling: 3.4 m

■ Cave in depth recorded on completion of drilling: 4.5 m.

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RECORD OF BOREHOLE No. BH306(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 11, 2020 Date Completed: Mar 11, 2020	Revision No.:	0

EASTING: 601529.457
NORTHING: 4839218.653

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.91 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT / DCPT), MTO Vane* (Intact / Remould), Nilcon Vane* (Intact / Remould), * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading parts per million (ppm) 100 200 300 400; Lower Explosive Limit (LEL); * Passing 75 um (%); Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Brownish grey, dense, SAND, some silt, trace to some gravel, trace organic, moist.	SS	01	70	42				9			
	215.3 Dark Brown, firm to stiff, silty CLAY, trace sand, trace gravel, trace rootlet, moist. 0.6	SS	02	54	8	1	215		13			
	214.4 NATIVE TILL 1.5 Brownish grey, firm to hard, silty CLAY, trace to some sand, trace gravel, trace oxidation, moist.	SS	03	54	7	2	214		25			
	becomes sandy	SS	04	100	50/ 100mm				28			SPT Refusal due to possible cobble/boulder
	212.9 Grey, very stiff, silty CLAY, trace sand, trace gravel, trace broken cobble pieces, moist to wet. 3.1 GA: 10%, SA: 10%, SI: 57%, CL:3%	SS	05	100	29	3	213		12			
	211.3 Grey, hard, sandy silty, CLAY, trace gravel, 4.6 moist to wet. GA: 12%, SA:45%, SI&CL: 43%.	SS	06	100	90/ 200mm	4	212		12			SPT Refusal due to possible cobble/boulder
		SS	07	100	50/ 100mm	5	211		7			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		SS	08	100	50/ 25mm	6	210		20			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	206.7 End of borehole 9.2	SS	09	100	50/ 25mm	7	209		29			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	Notes: 1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.					8	208					
						9	207					

Groundwater depth on completion of drilling: 8.2 m
Cave in depth recorded on completion of drilling: 9.2 m.
Groundwater depth observed on 3/25/2020 at a depth of: 2.4 m.

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RECORD OF BOREHOLE No. BH307(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 5, 2020 Date Completed: Mar 5, 2020	Revision No.:	0

EASTING: 601513.298
NORTHING: 4839241.863

Lithology Plot	DESCRIPTION	Elev.	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	ELEVATION (m)	DEPTH (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.95 m									Penetration Testing: ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); * Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P ■ ○ W_L 20 40 60 80			
	ASPHALT PAVEMENT ~ Thickness Assumed	215.9 / 0.7												
	Granular Pavement Structure ~ Thickness Assumed	215.2		AS	01									
	NATIVE TILL Grey, stiff to very stiff, sandy silty CLAY, trace gravel, trace oxidation,moist to wet.	0.8		SS	02	62	13	215	1	○	○15			
				SS	03	67	27	214	2	○	○18			
		213.7												
	Brown, very dense, silty SAND, some gravel, trace clay, moist.	2.3		SS	04	75	55			○	○5			
		212.9						213	3					
	Brown to grey, hard, sandy silty CLAY, some gravel, broken cobble pieces, moist.	3.1		SS	05	93	50/ 250mm	212	4		○15			SPT Refusal due to possible cobble/boulder
		211.4												
	Grey, hard, sandy silty CLAY, some gravel, broken cobble pieces, moist.	4.6		SS	06	67	36	211	5	○	○13			
		209.9						210	6					
	SHALE-TILL COMPLEX Grey, hard, sandy silty CLAY, some gravel broken cobble pieces, trace shale fragments, moist to wet.	6.1		SS	07	100	50/ 125mm				○11			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
				SS	08	100	50/ 25mm	209	7		○26			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
								208	8					
		206.8		SS	09	100	50/ 50mm	207	9		○18			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole	9.2												

Notes:

1. Borehole information based on environmental log
2. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ **No freestanding groundwater measured in open borehole upon completion of drilling** ■ **Cave in depth recorded on completion of drilling: Open m.**

▼ **Groundwater depth observed on 3/25/2020 at a depth of: 2.2 m.**

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Scale: 1 : 58

RECORD OF BOREHOLE No. BH308

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 9, 2020 Date Completed: Mar 9, 2020	Revision No.:	0

EASTING: 601524.357
NORTHING: 4839236.621

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.98 m)	Elev.	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Unit Weight (kN/m³)	COMMENTS
	FILL Grey, compact, gravelly SAND, some silt, moist to wet.	215.4	0.6	SS	01	67	18		
	Brownish grey, firm to stiff, silty CLAY, trace sand, trace gravel, trace rootlet, trace oxidation, wet to moist.	214.5	1.5	SS	02	62	8		
	NATIVE TILL Brown, very stiff to hard, sandy silty CLAY, trace gravel, moist.			SS	03	84	23		
				SS	04	100	50/ 50mm		SPT Refusal due to possible cobble/boulder
				SS	05	92	55		
	Brown to grey, hard, gravelly silty CLAY,, some sand, some broken cobble pieces, moist. GA: 20%, SA: 16%, SI: 45%, CL:16%	211.4	4.6	SS	06	92	42		
	SHALE-TILL COMPLEX Grey, very dense, silty SAND, some clay, trace broken cobble pieces, moist.	209.9	6.1	SS	07	100	50/ 50mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
				SS	08	100	50/ 100mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		206.8	9.2	SS	09	100	50/ 75mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole								

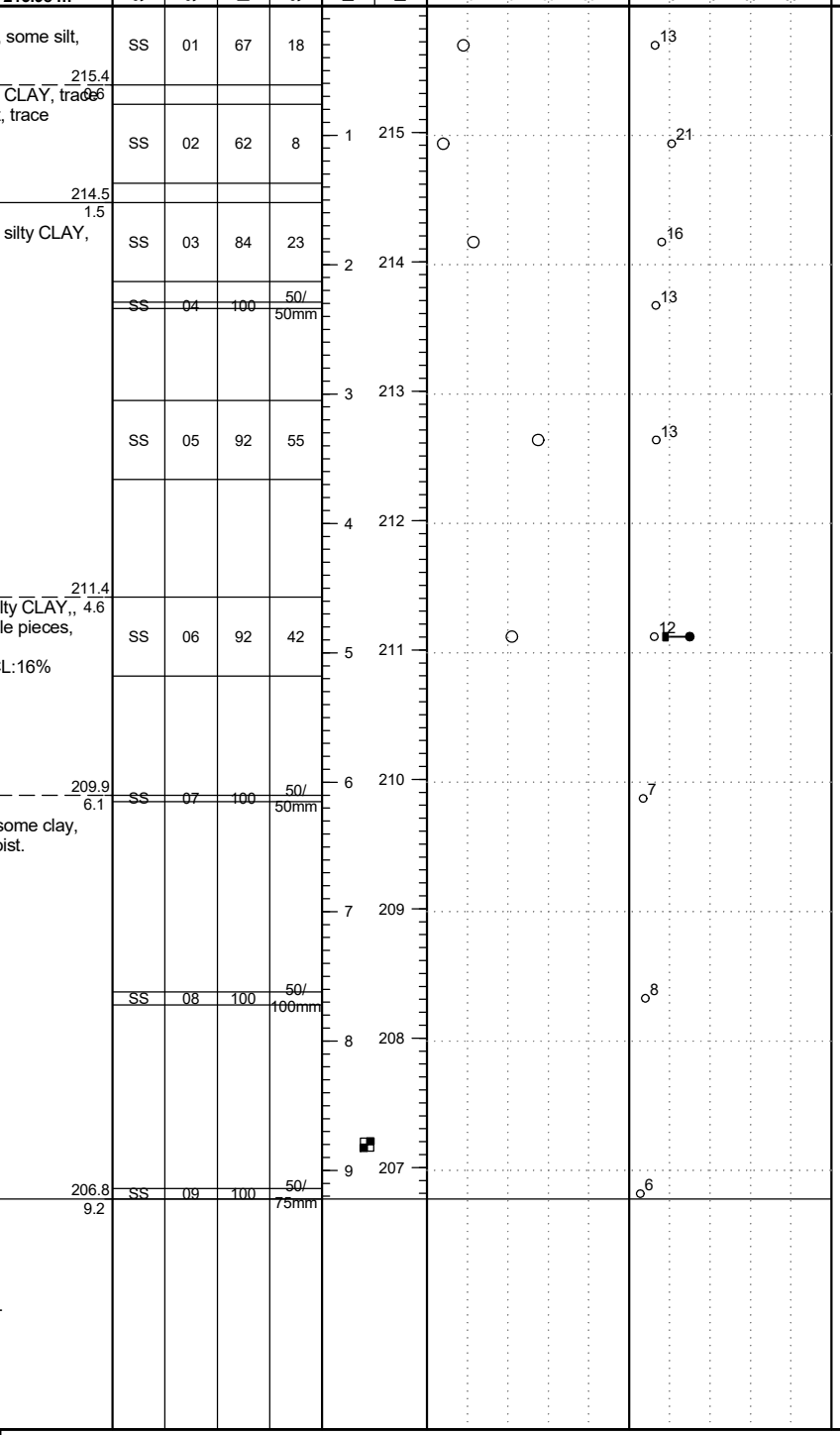
Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

FIELD TESTING: Penetration Testing (SPT, DCPT); MTO Vane* (Intact, Remould); Nilcon Vane* (Intact, Remould); * Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING: Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading parts per million (ppm) 100 200 300 400; Lower Explosive Limit (LEL); * Passing 75 um (%); Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L

INSTRUMENTATION INSTALLATION



No freestanding groundwater measured in open borehole upon completion of drilling. Cave in depth recorded on completion of drilling: 8.8 m.

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Scale: 1 : 58

RECORD OF BOREHOLE No. BH309(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 10, 2020 Date Completed: Mar 10, 2020	Revision No.:	0

EASTING: 601534.718
NORTHING: 4839224.258

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Undrained Shear Strength (kPa)	LAB TESTING: Moisture Content (%)	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.91 m											
	TOPSOIL>> ~ 25 mm 215.9											
	FILL 215.6	SS	01	92	23				16			
	Brown, compact, gravelly SAND, trace silt, moist. 0.3											
	215.3 0.6											
	Brown, compact, SAND, some silt, trace clay, moist.	SS	02	75	9	1	215		23			
	NATIVE TILL											
	Brown to Dark Brown, stiff to hard, sandy silty CLAY, trace gravel, trace oxidation, moist.	SS	03	100	18	2	214		15			
		SS	04	56	50/ 200mm				15			SPT Refusal due to possible cobble/boulder
		SS	05	100	43	3	213		12			
	211.3					4	212					
	SHALE-TILL COMPLEX 4.6	SS	06	78	67/ 300mm				12 11			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	Grey, hard, sandy silty CLAY, trace gravel, weathered shale fragments, trace broken cobble pieces, moist.					5	211					
		SS	07	100	50/ 75mm	6	210		6			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
						7	209					
		SS	08	100	50/ 25mm				4			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
						8	208					
	206.7	SS	09	100	50/ 30mm	9	207		15			
	End of borehole 9.2											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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No freestanding groundwater measured in open borehole upon completion of drilling. Cave in depth recorded on completion of drilling: Open

Groundwater depth observed on 3/25/2020 at a depth of: 2.2 m.

RECORD OF BOREHOLE No. BH310

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 9, 2020 Date Completed: Mar 9, 2020	Revision No.:	0

EASTING: 601521.704
NORTHING: 4839252.523

Local Ground Surface Elevation: 215.72 m

Depth (m)	Elevation (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Unit Weight (kN/m³)	Comments
	215.4	FILL Brown, compact, gravelly SAND, some silt, moist. 0.3	SS	01	67	22		
1	214	NATIVE TILL Brownish grey, stiff to hard, sandy silty CLAY, trace to some gravel, trace oxidation, moist.	SS	02	100	12		
2			SS	03	84	26		
			SS	04	100	67		
	212.7							
3	212.5	Grey, compact, silty SAND, trace to some clay, trace gravel, trace broken cobble pieces, moist. 3.2	SS	05	111	50/ 125mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
4	212	SHALE-TILL COMPLEX Grey, hard, sandy silty CLAY, trace gravel, trace weathered shale, trace broken cobble pieces, moist.						
5	211		SS	06	100	34		
	209.6							
6		Grey, hard, weathered Shale, moist. 6.1	SS	07	100	50/ 25mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
7	209							
8	208		SS	08	100	50/ 10mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	206.5		SS	09	100	50/ 25mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
9	207	End of borehole 9.2						

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

Groundwater depth on completion of drilling: 4.2 m

Cave in depth recorded on completion of drilling: 6.7 m.

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RECORD OF BOREHOLE No. BH311(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 9, 2020 Date Completed: Mar 9, 2020	Revision No.:	0

EASTING: 601531.342
NORTHING: 4839245.519

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (△ Intact / ▲ Remould); Nilcon Vane* (◇ Intact / ◆ Remould); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 216.04 m											
	FILL Brown, compact, gravelly SAND, trace silt, trace clay, moist. 0.3	SS	01	79	24		216	○	12			
	Brown, compact, SAND, some silt, trace gravel, trace clay, moist. 215.4 0.6											
	Brownish grey, stiff, sandy silty CLAY, trace gravel, trace to some rootlet, moist. 214.5	SS	02	70	11	1	215	○	22			
	NATIVE TILL 1.5 Brownish grey, very stiff to hard, sandy silty CLAY, trace gravel, trace broken cobble pieces, oxidized, moist.	SS	03	79	25	2	214	○	15			
		SS	04	100	66			○	10			
	211.5	SS	05	100	85	3	213	○	9			
	Grey, hard, sandy silty CLAY, trace to some gravel, moist. 4.6 GA: 19%, SA: 22%, SI: 20%, CL: 19%	SS	06	70	44	4	212	○	10			
	209.9					5	211					
	SHALE-TILL COMPLEX 6.1 <<Grey, hard, sandy silty CLAY, trace gravel, weathered shale fragments, trace broken cobble pieces, moist.	SS	07	180	50/ 50mm	6	210		7			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		SS	08	100	50/ 30mm	7	209		6			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	206.9	SS	09	100	50/ 50mm	8	208		15			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole 9.2					9	207					
	Notes: 1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.											

▽ **Groundwater depth on completion of drilling:** 3.5 m
▼ **Groundwater depth observed on** 3/25/2020 **at a depth of:** 2.2 m.
Cave in depth recorded on completion of drilling: Open

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RECORD OF BOREHOLE No. BH312(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 12, 2020 Date Completed: Mar 12, 2020	Revision No.:	0

EASTING: 601540.205
NORTHING: 4839237.157

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.90 m								
	FILL Brown, compact, gravelly SAND, some silt, some rootlet, moist. 215.3	SS	01	33	17				
	NATIVE TILL 0.6 Brown, very stiff, sandy silty CLAY, trace gravel, trace oxidation, moist to wet.	SS	02	75	17	1	215		
		SS	03	84	30	2	214		
	GA: 9%, SA: 29%, SI: 42%, CL:20%	SS	04	95	30				
	212.9					3	213		
	Brown, very dense, silty SAND, some gravel, trace clay, trace broken cobble pieces, moist. 3.0 211.3	SS	05	67	50/ 110mm				SPT Refusal due to possible cobble/boulder
	Grey, dense to very dense, sandy silty CLAY, some gravel, trace broken cobble pieces, moist. 4.6	SS	06	100	31	4 5	212 211	20.91	
		SS	07	100	50/ 25mm	6	210		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		SS	08		50/ 00mm	7 8	209 208		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	206.7	SS	09	100	50/ 25mm	9	207		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole 9.2 Notes: 1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.								

FIELD TESTING
Penetration Testing: ○ SPT ● DCPT
MTO Vane*: △ Intact ▲ Remould
Nilcon Vane*: ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING
★ Pocket Penetrometer (kg/cm²) 1 2 3 4
Soil Vapour Reading: △ parts per million (ppm) 100 200 300 400
▲ Lower Explosive Limit (LEL)
✱ Passing 75 um (%)
○ Moisture Content (%)
Atterberg Limits: W_P 20 40 60 80 W_L

INSTRUMENTATION INSTALLATION

Groundwater depth on completion of drilling: 3.3 m
Cave in depth recorded on completion of drilling: Open.
Groundwater depth observed on 3/25/2020 **at a depth of:** 2.6 m.

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RECORD OF BOREHOLE No. BH313(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 6, 2020 Date Completed: Mar 6, 2020	Revision No.:	0

EASTING: 601521.259
NORTHING: 4839252.573

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.73 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT / DCPT), MTO Vane* (Intact / Remould), Nilcon Vane* (Intact / Remould), * Undrained Shear Strength (kPa)	LAB TESTING: Pocket Penetrometer (kg/cm²), Soil Vapour Reading (parts per million (ppm)), Lower Explosive Limit (LEL), * Passing 75 um (%), Moisture Content (%), Atterberg Limits	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	NATIVE TILL Brownish grey, stiff to hard, sandy silty CLAY, trace gravel, trace oxidation, moist.	SS	01	79	10				14			
		SS	02	100	16	1	215					
	GA: 7%, SA: 22%, SI:45%, CL:26%.	SS	03	100	10	2	214		15			
		SS	04	100	46	3	213		9			
	trace broken cobble pieces.	SS	05	95	51	4	212		10			
		SS	06	100	39	5	211		9			
	becomes gravelly.	SS	07	154	50/ 125mm	6	210		15		20.5	SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		SS	08	267	50/ 25mm	7	209		9			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	206.6	SS	09	1000	50/ 10mm	8	208		8			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole 9.2					9	207					

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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No freestanding groundwater measured in open borehole upon completion of drilling. Cave in depth recorded on completion of drilling: Open

Groundwater depth observed on 3/25/2020 at a depth of: 2.0 m.

RECORD OF BOREHOLE No. BH314

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 6, 2020 Date Completed: Mar 6, 2020	Revision No.:	0

EASTING: 601531.303
NORTHING: 4839245.522

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 216.04 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (Intact △ / Remould ▲); Nilcon Vane* (Intact ◇ / Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P ■ ○ W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Grey, dense, gravelly SAND, trace silt, trace clay, moist. 215.4	SS	01	67	33				13			
	NATIVE TILL 0.6 Brown, very stiff to hard, sandy, silty CLAY, trace gravel, trace oxidation, moist.	SS	02	62	16	1	215		17			
		SS	03	95	24	2	214		14			
	trace broken cobble pieces.	SS	04	217	50/ 60mm				13			SPT Refusal due to possible cobble/boulder
	211.5	SS	05	100	77	3	213		12	▽		
	SHALE-TILL COMPLEX 4.6 Grey, hard, sandy, silty CLAY, trace gravel, trace broken cobble pieces, trace weathered shale fragment, moist.	SS	06	46	59	4 5	212 211		9			
		SS	07	220	50/ 130mm	6	210		6			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		SS	08	650	50/ 15mm	7 8	209 208		21			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	206.9	SS	09	650	50/ 15mm	9 ■	207		14			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole 9.1 Notes: 1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.											

▽ **Groundwater depth on completion of drilling: 2.7 m**

■ **Cave in depth recorded on completion of drilling: 9.0 m.**

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Scale: 1 : 58

RECORD OF BOREHOLE No. BH315(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 5, 2020 Date Completed: Mar 5, 2020	Revision No.:	0

EASTING: 601547.506
NORTHING: 4839247.015

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.91 m)	Elev.	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Unit Weight (kN/m³)	COMMENTS
	FILL	215.7							
	Brown, loose, gravelly SAND, wet.	0.2		SS	01	84	16		
	Brown, compact to very dense, SAND, trace gravel, trace broken cobble pieces, trace oxidation, wet.			SS	02	178	66/ 75mm		SPT Refusal due to possible cobble/boulder
		214.4	1						
	NATIVE TILL	1.5							
	Brown, sandy silty CLAY, trace to some gravel, trace oxidation, moist.			SS	03	95	23		
			2	SS	04	51	46		
			3	SS	05	84	43		
		211.3	4						
	SHALE-TILL COMPLEX	4.6							
	Grey, hard, sandy silty CLAY, trace to some gravel, trace broken cobble pieces, trace weathered shale fragments, moist.		5	SS	06	84	43		
		209.8	6						
	grey, highly weathered shale	6.1		SS	07	71	50/ 60mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	Grey, hard, weathered Shale, moist.		7						
			8	SS	08	63	50/ 75mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		206.7	9						
	End of borehole	9.2		SS	09	100	50/ 75mm		SPT Refusal due to possible cobble/boulder and/or weathered bedrock

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

FIELD TESTING: Penetration Testing (○ SPT ● DCPT); MTO Vane* (△ Intact ▲ Remould); Nilcon Vane* (◇ Intact ◆ Remould); * Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L

INSTRUMENTATION INSTALLATION

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: 9.0 m.

▼ Groundwater depth observed on 3/25/2020 at a depth of: 2.1 m.

RECORD OF BOREHOLE No. BH316

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augers	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 3, 2020 Date Completed: Mar 3, 2020	Revision No.:	0

EASTING: 601538.68
NORTHING: 4839269.36

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.67 m)	Elev.	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Field Testing	Lab Testing	Instrumentation Installation	Unit Weight (kN/m³)	COMMENTS
	FILL Brown, gravelly SAND, wet.	214.9										
	NATIVE TILL Brown to grey, stiff to hard, sandy silty CLAY, trace to some gravel, trace oxidation, moist.	0.8		SS	01	33	14		15			
	trace broken cobble pieces.		1	SS	02	67	38		13			
			2	SS	03	87	50/ 75mm		13			SPT Refusal due to possible cobble/boulder
			3	SS	04	100	50/ 100mm		13			
		211.1	4									
	Grey, stiff to hard, sandy silty CLAY, trace gravel, moist.	4.6		SS	05	33	37		16			
		209.6	5									
	SHALE-TILL COMPLEX Grey, stiff to hard, sandy silty CLAY, trace gravel, trace shale fragments, moist.	6.1	6	SS	06	100	100/ 100mm		7			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
			7	SS	07	0	50/ 50mm					SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		206.4	8									
	End of borehole	9.2	9	SS	08	100	50/ 100mm		18			SPT Refusal due to possible cobble/boulder and/or weathered bedrock

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

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RECORD OF BOREHOLE No. BH317

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 4, 2020 Date Completed: Mar 4, 2020	Revision No.:	0

EASTING: 601546.357
NORTHING: 4839263.891

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.83 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●), MTO Vane* (△ Intact / ▲ Remould), Nilcon Vane* (◇ Intact / ◆ Remould), * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	ASPHALT PAVEMENT ~ 150 mm (215.7)											
	FILL (0.2) Brown, compact, gravelly SAND, some silt, moist. (215.1)	SS	01	33	16			○	○ 16			
	FILL (0.8) Brown, compact, silty SAND, trace gravel, trace clay, moist.	SS	02	41	12	1	215	○	○ 12			
		SS	03	100	23	2	214	○	○ 12			
	(213.5) NATIVE TILL (2.3) Brown to grey, hard, sandy silty CLAY, trace gravel, moist. GA: 6%, SA:27%, SI:47%, CL:20%. some broken cobble pieces	SS	04	33	57	3	213	○	○ 9			
		SS	05	92	54			○	○ 8			
	some broken cobble pieces	SS	06	50	50/ 100mm	4	212		○ 9			SPT Refusal due to possible cobble/boulder
						5	211					
		SS	07	100	50/ 50mm	6	210		○ 8	▽		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	(208.2)											
		SS	08	0	50/ 50mm	7	209					SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole (7.7)											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ Groundwater depth on completion of drilling: 5.8 m

■ Cave in depth recorded on completion of drilling: Open

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Scale: 1 : 58

RECORD OF BOREHOLE No. BH318

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 4, 2020 Date Completed: Mar 4, 2020	Revision No.:	0

EASTING: 601554.855
NORTHING: 4839256.161

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.88 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT / DCPT), MTO Vane* (Intact / Remould), Nilcon Vane* (Intact / Remould), * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading parts per million (ppm) 100 200 300 400; Lower Explosive Limit (LEL); * Passing 75 um (%); Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Brown, compact, gravelly SAND, trace silt, wet.	SS	01	75	14				10			
	215.0											
	NATIVE TILL 0.9 Brown to grey, stiff to hard, sandy silty CLAY, trace to some gravel, trace oxidation, moist.	SS	02	84	14	1	215		17			
		SS	03	41	28	2	214		13			
	trace broken cobble pieces	SS	04	61	72/ 250mm				8			SPT Refusal due to possible cobble/boulder
						3	213					
	trace broken cobble pieces	SS	05	88	78/ 250mm				11			SPT Refusal due to possible cobble/boulder
	211.3					4	212					
	SHALE-TILL COMPLEX 4.6 Grey, hard, sandy silty CLAY, trace to some gravel, trace to some shale fragments, moist.	SS	06	84	33				11			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
						5	211					
		SS	07	65	50/ 75mm	6	210		7			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
						7	209					
		SS	08	60	50/ 50mm				4			SPT Refusal due to possible cobble/boulder and/or weathered bedrock
						8	208					
	206.7					9	207					
	End of borehole 9.2	SS	09	0	50/ 25mm							SPT Refusal due to possible cobble/boulder and/or weathered bedrock

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

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Scale: 1 : 58

RECORD OF BOREHOLE No. BH319

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 3, 2020 Date Completed: Mar 3, 2020	Revision No.:	0

EASTING: 601542.589
NORTHING: 4839279.39

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.52 m)	Elev.	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	COMMENTS
	FILL Brown, gravelly SAND, wet.	214.8						
	NATIVE TILL Brown to grey, stiff to hard, sandy silty CLAY, trace gravel, trace cobble, trace oxidation, moist.	0.8		SS	01	67	14	
	GA:3%, SA:4%, SI:48%, CL:25%			SS	02	75	24	
				SS	03	124	90/ 250mm	SPT Refusal due to possible cobble/boulder
				SS	04	150	50/ 100mm	SPT Refusal due to possible cobble/boulder
		210.9						
	SHALE-TILL COMPLEX Grey, hard, sandy silty CLAY, trace gravel, trace cobble, trace shale fragments, moist.	4.6		SS	05	100	50/ 75mm	SPT Refusal due to possible cobble/boulder and/or weathered bedrock
				SS	06	100	50/ 50mm	SPT Refusal due to possible cobble/boulder and/or weathered bedrock
				SS	07	100	50/ 25mm	SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		206.2		SS	08	100	50/ 125mm	SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	End of borehole	9.3						

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

FIELD TESTING: Penetration Testing (SPT, DCPT); MTO Vane* (Intact, Remould); Nilcon Vane* (Intact, Remould); * Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING: Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading parts per million (ppm) 100 200 300 400; Lower Explosive Limit (LEL); * Passing 75 um (%); Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L

INSTRUMENTATION INSTALLATION

Unit Weight (kN/m³)

No freestanding groundwater measured in open borehole upon completion of drilling. Cave in depth recorded on completion of drilling: Open

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RECORD OF BOREHOLE No. BH320(MW)

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 4, 2020 Date Completed: Mar 4, 2020	Revision No.:	0

EASTING: 601551.428
NORTHING: 4839269.847

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.87 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (Intact △ / Remould ▲); Nilcon Vane* (Intact ◇ / Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P ■ ○ W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	TOPSOIL ~ 150 mm (215.7)										
	FILL (0.2) Brown, firm, silty CLAY, trace gravel, trace oxidation, rootlet, moist. (215.1)	SS	01	75	5			○	16		
	Brown, loose, silty CLAY, some sand to sandy, trace gravel, trace oxidation, moist. (0.8) (214.4)	SS	02	84	9	1	215	○	18		
	NATIVE TILL (1.5) Brown to grey, very stiff to hard, sandy silty CLAY, some gravel, trace oxidation, moist.	SS	03	84	23	2	214	○	13		21.95
		SS	04	124	70/ 250mm				9		SPT Refusal due to possible cobble/boulder
		SS	05	124	95/ 250mm	3	213		13		SPT Refusal due to possible cobble/boulder
	(211.3) SHALE-TILL COMPLEX (4.6) Grey, hard, sandy silty CLAY, trace gravel, trace cobble, trace shale fragments, moist.	SS	06	25	48	4	212				
		SS	07	72	98/ 275mm	5	211	○	9		
		SS	08	0	50/ 25mm	6	210		8		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	(206.7) Grey, highly weathered shale. (9.2) (206.7) End of borehole	SS	09	0	50/ 15mm	7	209				SPT Refusal due to possible cobble/boulder and/or weathered bedrock
						8	208				
						9	207				

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

Groundwater depth on completion of drilling: 3.7 m
Cave in depth recorded on completion of drilling: Open
Groundwater depth observed on 3/25/2020 at a depth of: 2.0 m.

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RECORD OF BOREHOLE No. BH321

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 2, 2020 Date Completed: Mar 2, 2020	Revision No.:	0

EASTING: 601560.241
NORTHING: 4839261.3

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.96 m								
	Asphalt Pavement ~ 150 mm 215.8								
	FILL 0.2 Brown, SAND and GRAVEL, moist.								
	215.2								
	FILL 0.8 Brown, loose to compact, silty SAND, some clay, trace gravel, moist.	SS	01	51	10	1	215		
	214.4								
	NATIVE TILL 1.5 Brown to grey, very stiff to hard, sandy silty CLAY, trace to some gravel, trace oxidation, moist.	SS	02	100	24	2	214		
	trace broken cobble pieces	SS	03	100	50/ 50mm				SPT Refusal due to possible cobble/boulder
	212.9					3	213		
	SHALE-TILL COMPLEX 3.1 Grey, hard, sandy silty CLAY, trace gravel, trace cobble, trace shale fragments, moist.	SS	04	40	50/ 100mm				SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	GA: 19%, SA: 17%, SI: 47%, CL: 17%	SS	05	75	50	4 5	212 211		Higher percentage of GA likely due to shale fragments.
		SS	06	100	50/ 150mm	6	210		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
		SS	07	100	50/ 50mm	7 8	209 208		SPT Refusal due to possible cobble/boulder and/or weathered bedrock
	207.4								
	End of borehole 8.5	SS	08		50/ 0mm				SPT Refusal due to possible cobble/boulder and/or weathered bedrock

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

FIELD TESTING
Penetration Testing: ○ SPT ● DCPT
MTO Vane*: △ Intact ▲ Remould
Nilcon Vane*: ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING
★ Pocket Penetrometer (kg/cm²) 1 2 3 4
Soil Vapour Reading: △ parts per million (ppm) 100 200 300 400
▲ Lower Explosive Limit (LEL)
✱ Passing 75 um (%)
○ Moisture Content (%)
Atterberg Limits: W_P 20 40 60 80 W_L

INSTRUMENTATION INSTALLATION

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH401

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 12, 2020 Date Completed: Mar 12, 2020	Revision No.:	0

EASTING: 601444.056
NORTHING: 4839160.062

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.45 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (Intact △ / Remould ▲); Nilcon Vane* (Intact ◇ / Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P ■ ○ ● W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Dark brown, soft to firm, silty CLAY, some sand, some rootlet, moist.	SS	01	67	4		215	○	20			
		SS	02	75	11	1		○	23			
	213.9						214					
	NATIVE TILL 1.5 Dark brown to brown, loose to very dense, silty SAND, trace clay, trace gravel, trace broken cobble pieces, wet.	SS	03	84	7	2		○	19			
		SS	04	86	90/ 200mm		213		18			SPT Refusal due to possible cobble/boulder
	212.4					3						
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

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Scale: 1 : 26

RECORD OF BOREHOLE No. BH402

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 11, 2020 Date Completed: Mar 11, 2020	Revision No.:	0

EASTING: 601460.177
NORTHING: 4839173.781

Lithology Plot	DESCRIPTION Local Ground Surface Elevation: 215.49 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING Penetration Testing: ○ SPT ● DCPT MTO Vane*: △ Intact ▲ Remould Nilcon Vane*: ◇ Intact ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING ★ Pocket Penetrometer (kg/cm²) 1 2 3 4 Soil Vapour Reading: △ parts per million (ppm) 100 200 300 400 ▲ Lower Explosive Limit (LEL) ✱ Passing 75 um (%) ○ Moisture Content (%) Atterberg Limits: W_P ■ ○ ● W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Brown, loose to compact, SAND & GRAVEL, trace silt, trace clay, trace rootlet, wet.	SS	01	84	8		215	○	16		
	GA: 54%, SA: 35%, SI & CL: 11%	SS	02	75	10	1		○	25	▽	
	214.0 NATIVE TILL 1.5 Brown, compact, silty SAND, some clay, trace gravel, trace broken cobble pieces, wet.	SS	03	25	20		214	○	17		
	213.2 Brown, very dense, SAND, some silt, trace gravel, wet. 2.3	SS	04	75	75	2	213	○	11		
	212.4 End of borehole 3.1					3					

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ Groundwater depth on completion of drilling: 1.4 m

Cave in depth recorded on completion of drilling: Open

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RECORD OF BOREHOLE No. BH403

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 11, 2020 Date Completed: Mar 11, 2020	Revision No.:	0

EASTING: 601468.827
NORTHING: 4839169.59

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (△ Intact / ▲ Remould); Nilcon Vane* (◇ Intact / ◆ Remould); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.30 m											
	NATIVE STRATA Brown, loose to compact, SAND, some silt, some gravel, trace broken cobble pieces, moist.	SS	01	70	10		215	○	○ 14			
	214.4											
	Brown, compact to very dense, silty SAND, trace to some clay, trace to some gravel, trace oxidation, moist. 0.9	SS	02	75	16	1	214	○	○ 4			
	becomes moist to wet. some broken cobble pieces.	SS	03	100	19	2	213	○	○ 11			
		SS	04	100	76			○	○ 11			
	212.3					3						
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: 3.0 m.

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RECORD OF BOREHOLE No. BH404

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 12, 2020 Date Completed: Mar 12, 2020	Revision No.:	0

EASTING: 601478.693
NORTHING: 4839192.152

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (△ Intact / ▲ Remould); Nilcon Vane* (◇ Intact / ◆ Remould); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.79 m											
	NATIVE TILL Dark brown, compact, gravelly SAND, some silt, moist.	SS	01	59	25			○	○ 16			
	215.0											
	Brown, firm, sandy silty CLAY, trace gravel, trace broken cobble pieces, moist. 0.8	SS	02	51	7	1	215	○	○ 16			
		SS	03	41	5		214	○	○ 20			
	becomes hard.	SS	04	100	40	2		○	○ 21			
	212.7						213					
	End of borehole 3.1					3						

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH405

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 12, 2020 Date Completed: Mar 12, 2020	Revision No.:	0

EASTING: 601485.498
NORTHING: 4839187.336

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.78 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (Intact △ / Remould ▲); Nilcon Vane* (Intact ◇ / Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); * Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P ■ ○ W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Brown, compact, gravelly SAND, some brocken cobble pieces, moist. 215.5											
	Brown, stiff to very stiff, silty CLAY, trace gravel, trace sand, moist. 0.3 215.0	SS	01	46	18				○ 15			
	NATVE TILL 0.8 Brown, stiff to hard, sandy silty CLAY, trace gravel, trace oxidation, moist.	SS	02	92	19	1	215		○ 18			
	trace broken cobble pieces	SS	03	100	14	2	214		○ 13			
		SS	04	70	72		213		○ 12			
	212.7					3						
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH406

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 12, 2020 Date Completed: Mar 12, 2020	Revision No.:	0

EASTING: 601493.704
NORTHING: 4839181.121

Lithology Plot	DESCRIPTION Local Ground Surface Elevation: 215.62 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING Penetration Testing: ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Brown, stiff, silty CLAY, some sand, trace to some gravel, trace broken cobble pieces, moist to wet.	SS	01	67	10		215	○	○ 30			
	214.9											
	NATIVE TILL 0.8 Brown, soft to very stiff, sandy silty CLAY, trace gravel, trace oxidation, moist..	SS	02	67	3	1		○	○ 18			
	becomes stiff trace oxidation GA: 6%, SA: 36%, SI & CL: 58%	SS	03	100	10	2	214	○	○ 14			
		SS	04	100	21		213	○	○ 13			
	212.6					3						
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH407

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 13, 2020 Date Completed: Mar 13, 2020	Revision No.:	0

EASTING: 601545.178
NORTHING: 4839219.856

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.93 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●), MTO Vane* (△ Intact / ▲ Remould), Nilcon Vane* (◇ Intact / ◆ Remould), * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; △ Soil Vapour Reading parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Dark Grey, compact to loose, gravelly SAND, trace to some silt, trace, trace broken cobble pieces, moist.	SS	01	67	24			○	7			
							215					
		SS	02	100	8	1		○	20			
	214.4											
	Dark brown, firm to stiff, silty CLAY, some sand, trace gravel, rootlet, moist to wet. 1.5	SS	03	100	8			○	36		22.68	
							214					
						2						
	213.6											
	NATIVE TILL 2.3 Brown, compact, silty SAND, trace clay, trace gravel, moist.	SS	04	84	12			○	19			Unit Weight = 23.1 kN/m3
							213					
						3						
	212.9											
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

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RECORD OF BOREHOLE No. BH408

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 13, 2020 Date Completed: Mar 13, 2020	Revision No.:	0

EASTING: 601552.709
NORTHING: 4839227.777

Lithology Plot	DESCRIPTION Local Ground Surface Elevation: 215.91 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○, DCPT ●); MTO Vane* (Intact △, Remould ▲); Nilcon Vane* (Intact ◇, Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P ■ ○ ● W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Grey, compact, SAND, trace silt, trace gravel, trace broken cobble pieces, trace rootlet, moist.	SS	01	62	19			○	7			
	215.1											
	Grey, firm to stiff, silty CLAY, some sand, trace gravel, trace oxidation, moist. 0.8	SS	02	75	8	1	215	○	18			
	214.4											
	NATIVE TILL 1.5 Brown, stiff to very stiff, sandy silty CLAY, trace gravel, trace broken cobble pieces, trace oxidation, moist. GA: 8%, SA: 19%, SI: 46%, CL:27%.	SS	03	100	14	2	214	○	19			
		SS	04	100	30			○	12			
	212.9					3	213					
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH409

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 5, 2020 Date Completed: Mar 5, 2020	Revision No.:	0

EASTING: 601560.075
NORTHING: 4839237.826

Lithology Plot	DESCRIPTION (Local Ground Surface Elevation: 215.91 m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)
	FILL Brown, dense, SAND & GRAVEL, some silt, trace clay, moist. 215.6						
	NATIVE TILL 0.3 Brown, very stiff to hard, sandy silty CLAY, trace gravel, trace oxidation, moist.	SS	01	67	32		
		SS	02	92	20	1	215
		SS	03	100	25	2	214
		SS	04	100	67		
		SS	05	92	37	3	213
	212.3 End of borehole 3.7						

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

FIELD TESTING: Penetration Testing (○ SPT ● DCPT); MTO Vane* (△ Intact ▲ Remould); Nilcon Vane* (◇ Intact ◆ Remould); * Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L

INSTRUMENTATION INSTALLATION

Unit Weight (kN/m³)

COMMENTS

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH410

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 13, 2020 Date Completed: Mar 13, 2020	Revision No.:	0

EASTING: 601567.591
NORTHING: 4839246

Lithology Plot	DESCRIPTION Local Ground Surface Elevation: 215.89 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○, DCPT ●); MTO Vane* (Intact △, Remould ▲); Nilcon Vane* (Intact ◇, Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); * Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P W_L 20 40 60 80	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	NATIVE TILL Brown, compact, silty SAND, trace to some clay, trace gravel, moist.	SS	01	67	19			○	○ 21			
	215.1											
	NATIVE TILL Brown, very stiff to hard, sandy silty CLAY, trace gravel, moist. 0.8	SS	02	70	18	1	215	○	○ 23			
		SS	03	100	24	2	214	○	○ 14			
	trace broken cobble pieces	SS	04	84	31			○	○ 12		21.82	
	212.8					3	213					
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH411

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 13, 2020 Date Completed: Mar 13, 2020	Revision No.:	0

EASTING: 601571.155
NORTHING: 4839254.918

Lithology Plot	DESCRIPTION Local Ground Surface Elevation: 215.90 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING Penetration Testing: ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	FILL Brown, loose to compact, gravelly SAND, trace rootlet, trace organics, moist	SS	01	67	10			○	13			
	215.1											
	Brown, firm, sandy silty CLAY, trace gravel, trace organics, moist. GA: 4%, SA: 40%, SI & CL: 56%	SS	02	100	5	1	215	○	18			
	214.4											
	NATIVE TILL Brown, very stiff, sandy silty CLAY, trace gravel, trace broken cobble pieces, moist.	SS	03	100	22	2	214	○	15			
	213.6											
	Brown, very dense, silty SAND, some gravel, trace clay, trace broken cobble pieces, moist.	SS	04	100	55		213	○	10			
	212.9					3						
	End of borehole											

1.8
1.5
2.3
3.1

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH412

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 12, 2020 Date Completed: Mar 12, 2020	Revision No.:	0

EASTING: 601566.37
NORTHING: 4839268.681

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (△ Intact / ▲ Remould); Nilcon Vane* (◇ Intact / ◆ Remould); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); * Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.73 m											
	ASPHALT PAVEMENT ~ 50 mm 215.7 / 0.1 FILL Brown, compact, gravelly SAND, moist.											
	215.4 / 0.3 Brown to brownish grey, firm to very soft, sandy silty CLAY, trace gravel, trace oxidation, trace rootlet, moist	SS	01	79	11			○	5			
							215					
		SS	02	59	6	1		○	14			
		SS	03	70	2		214	○	21			
						2						
	213.4											
	NATIVE TILL 2.3 Brown, very dense, silty SAND, trace clay, trace gravel, trace broken cobble pieces, moist. 213.2 / 2.5	SS	04	100	50/ 50mm				2			
	End of borehole											
	Notes: 1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.											

▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

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RECORD OF BOREHOLE No. BH413

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 12, 2020 Date Completed: Mar 12, 2020	Revision No.:	0

EASTING: 601558.836
NORTHING: 4839282.401

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (Intact △ / Remould ▲); Nilcon Vane* (Intact ◇ / Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.71 m											
	FILL Dark grey, very soft to very stiff, sandy silty CLAY, trace gravel, trace rootlet, moist.	SS	01	79	1			○	23			
	GA: 2%, SA: 29%, SI & CL: 69%.						215					
		SS	02	100	26	1		○	17			
	214.2											
	NATIVE TILL 1.5 Brown, very stiff to hard, sandy silty CLAY, trace gravel, trace oxidation, moist.	SS	03	100	23		214	○	14			
						2						
		SS	04	79	62			○	12			
	trace broken cobble pieces						213					
	212.7					3						
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

RECORD OF BOREHOLE No. BH414

Project Number:	671835	Drilling Location:	As per Borehole layout	Logged by:	RM
Client:	Region of Peel	Drilling Method:	100 mm Solid Stem Augering	Compiled by:	SR
Project Name:	Geotechnical Investigation: 25 Rutherford Road South	Drilling Machine:	Track Mounted Drill	Reviewed by:	MT
Location:	25 Rutherford Rd. South, Brampton, ON	Date Started:	Mar 13, 2020 Date Completed: Mar 13, 2020	Revision No.:	0

EASTING: 601568.339
NORTHING: 4839273.994

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT ○ / DCPT ●); MTO Vane* (Intact △ / Remould ▲); Nilcon Vane* (Intact ◇ / Remould ◆); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: ★ Pocket Penetrometer (kg/cm²) 1 2 3 4; Soil Vapour Reading △ parts per million (ppm) 100 200 300 400; ▲ Lower Explosive Limit (LEL); ✱ Passing 75 um (%); ○ Moisture Content (%); Atterberg Limits W_P 20 40 60 80 W_L	INSTRUMENTATION INSTALLATION	Unit Weight (kN/m³)	COMMENTS
	Local Ground Surface Elevation: 215.67 m											
	FILL Dark brown, soft to firm, silty CLAY, trace sand, trace gravel, rootlets, moist.	SS	01	84	4			○	26			
	214.9						215					
	NATIVE TILL 0.8 Brown, very stiff to hard, sandy silty CLAY, trace gravel, trace broken cobble pieces, trace oxidation, moist.	SS	02	100	19	1		○	17			
		SS	03	84	24		214	○	14		21.68	
		SS	04	100	77	2		○	10			
							213					
	212.6					3						
	End of borehole 3.1											

Notes:

1. GA, SA, SI and CL denote Gravel, Sand, Silt and Clay.

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Tel: 905-851-0090

▽ No freestanding groundwater measured in open borehole upon completion of drilling ■ Cave in depth recorded on completion of drilling: Open

Appendix C

Laboratory Testing Results (19 pages)

SNC·LAVALIN

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401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

Grain Size Analysis Test Report

Project No.: 671835 **Description:** Environmental and Geotechnical Consulting Services **Date:** Apr 20, 2020

Project Location: 25 Rutherford South, Brampton, ON **Contract No.:**

SAMPLE DATA

Material: Soil
Date Sampled: Apr 20, 2020
Time Sampled:
Sample Type: Borehole
Sample Location: BH 302 SS06B
Lot: **Sublot:** **Station**
Source: Insitu
Sampled By: Technician

LAB DATA

Lab No.: **1521** **Date Tested:** Apr 20, 2020

Specification: OPSS 1010, SSM

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		
% Flat and Elongated		

WASH PASS 0.075mm

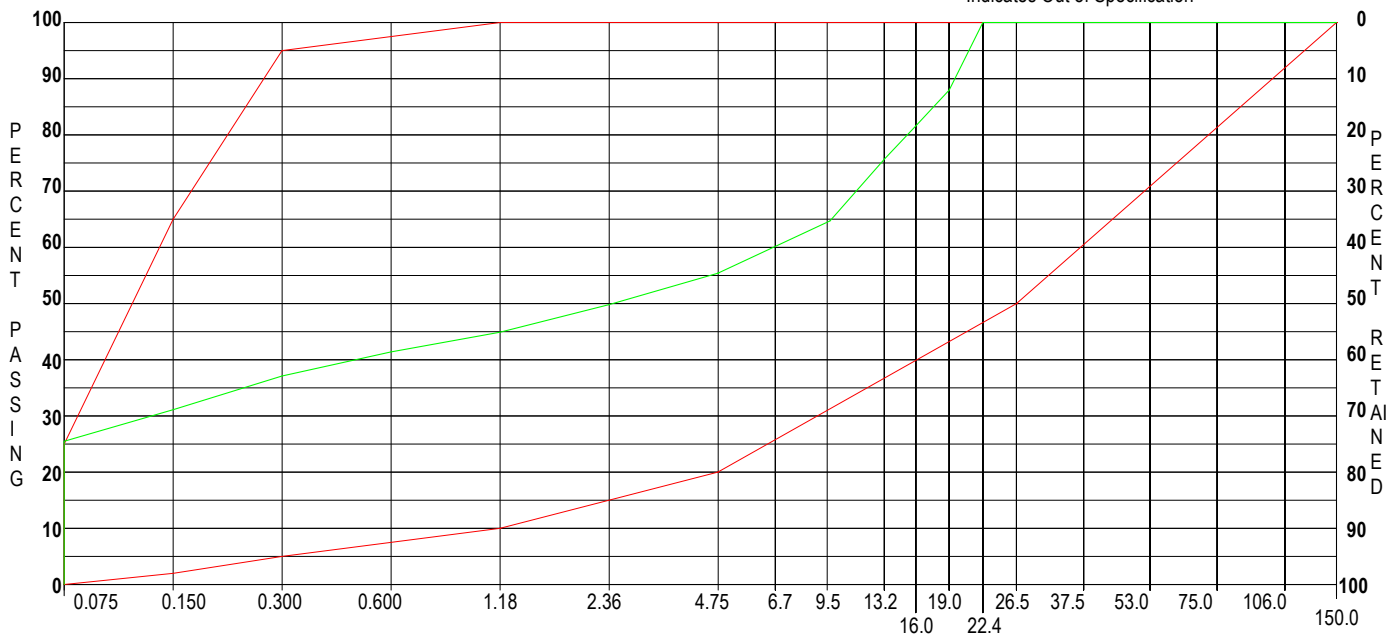
TEST	Sample	Specs
Wash Pass 0.075 mm:		
FINENESS MODULUS	3.88	

Comments:

Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**100**	-
53.0	**100**	-
37.5	**100**	-
26.5	**100**	50 - 100
22.4	**100**	-
19.0	**88**	-
16.0	**81.6**	-
13.2	**75.7**	-
9.5	**64.7**	-
6.7		-
4.75	**55.4**	20 - 100
2.36	**49.8**	-
1.18	**44.9**	10 - 100
0.600	**41.4**	-
0.300	**37.1**	5 - 95
0.150	**31.1**	2 - 65
0.075	**25.5***	0 - 25

* Indicates Out of Specification



Project Manager: Mavara Turab

SNC·LAVALIN

SNC-Lavalin GEM Ontario Inc.
401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

Grain Size Analysis Test Report

Project No.: 671835 **Description:** Environmental and Geotechnical Consulting Services **Date:** Apr 20, 2020

Project Location: 25 Rutherford South, Brampton, ON

Contract No.:

SAMPLE DATA

Material: Soil
Date Sampled: Apr 20, 2020
Time Sampled:
Sample Type: Borehole
Sample Location: BH306 SS06
Lot: **Sublot:** **Station**
Source: Insitu
Sampled By: Technician

LAB DATA

Lab No.: **1522** **Date Tested:** Apr 20, 2020

Specification: OPSS 1010, SSM

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		
% Flat and Elongated		

WASH PASS 0.075mm

TEST	Sample	Specs
Wash Pass 0.075 mm:		

FINENESS MODULUS	2.37

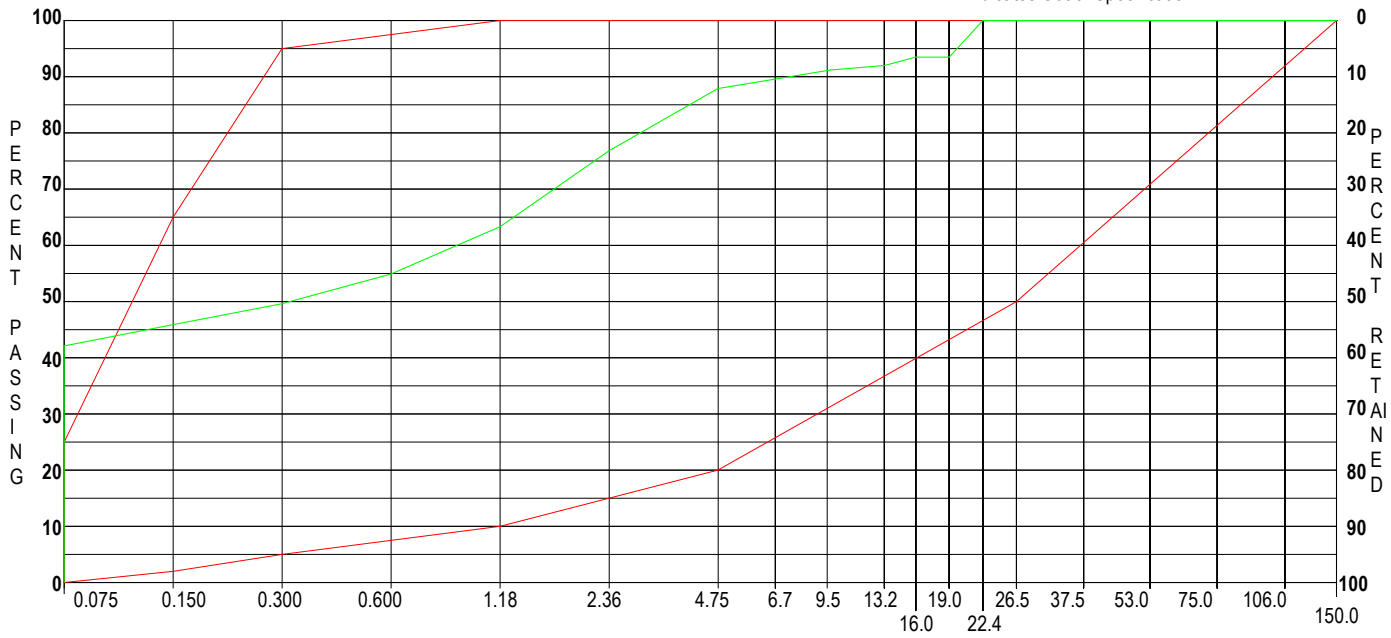
Comments:

Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**100**	-
53.0	**100**	-
37.5	**100**	-
26.5	**100**	50 - 100
22.4	**100**	-
19.0	**93.5**	-
16.0	**93.5**	-
13.2	**92**	-
9.5	**91.2**	-
6.7		-
4.75	**87.9**	20 - 100
2.36	**76.8**	-
1.18	**63.3**	10 - 100
0.600	**54.9**	-
0.300	**49.6**	5 - 95
0.150	**45.9**	2 - 65
0.075	**42.1***	0 - 25

* Indicates Out of Specification

Sample: **Specs:**



Project Manager: Mavara Turab

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401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

Grain Size Analysis Test Report

Project No.: 671835 **Description:** Environmental and Geotechnical Consulting Services **Date:** Apr 20, 2020

Project Location: 25 Rutherford South, Brampton, ON

Contract No.:

SAMPLE DATA

Material: Soil
Date Sampled: Apr 20, 2020
Time Sampled:
Sample Type: Borehole
Sample Location: BH402 SS02B
Lot: **Sublot:** **Station**
Source: Insitu
Sampled By: Technician

LAB DATA

Lab No.: **1523** **Date Tested:** Apr 20, 2020

Specification: OPSS 1010, SSM

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		
% Flat and Elongated		

WASH PASS 0.075mm

TEST	Sample	Specs
Wash Pass 0.075 mm:		

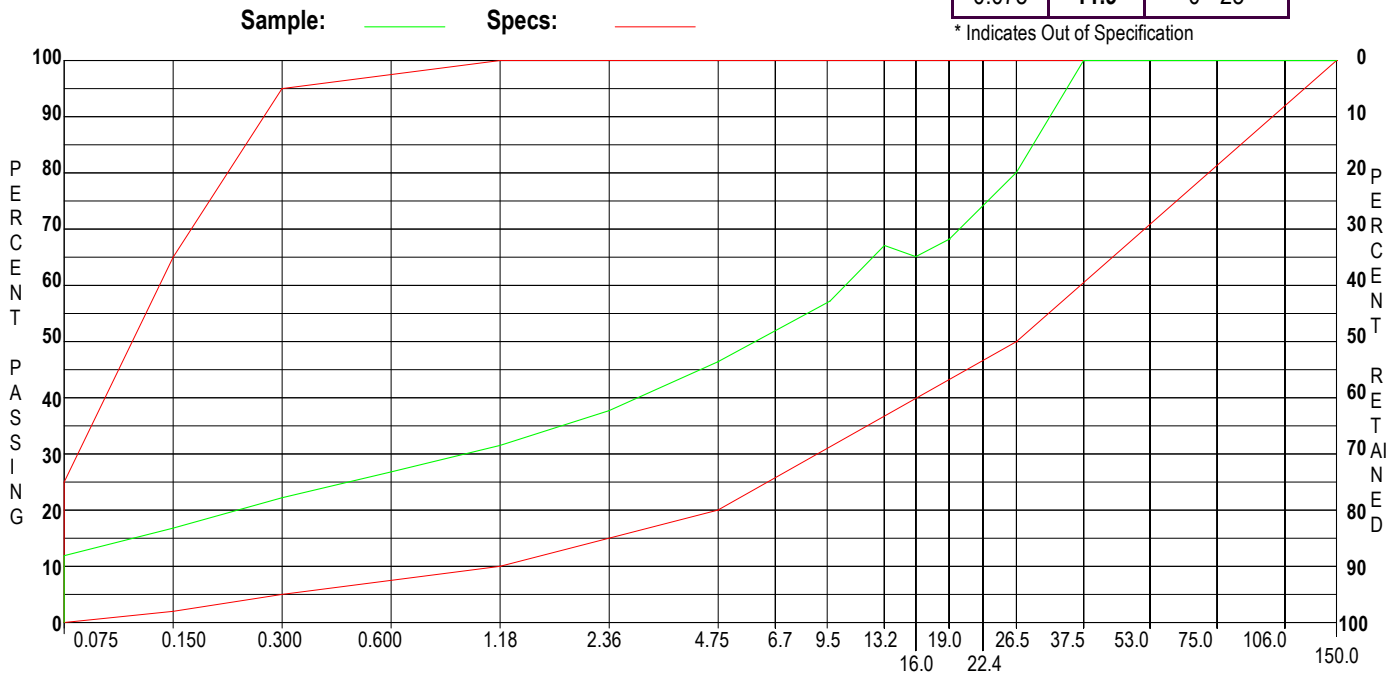
FINENESS MODULUS	4.93

Comments:

Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**100**	-
53.0	**100**	-
37.5	**100**	-
26.5	**80.1**	50 - 100
22.4		-
19.0	**68.2**	-
16.0	**65.1**	-
13.2	**67.1**	-
9.5	**57.2**	-
6.7		-
4.75	**46.4**	20 - 100
2.36	**37.7**	-
1.18	**31.5**	10 - 100
0.600	**26.8**	-
0.300	**22.2**	5 - 95
0.150	**16.8**	2 - 65
0.075	**11.9**	0 - 25

* Indicates Out of Specification



Project Manager: Mavara Turab

SNC·LAVALIN

SNC-Lavalin GEM Ontario Inc.
401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

Grain Size Analysis Test Report

Project No.: 671835 **Description:** Environmental and Geotechnical Consulting Services **Date:** Apr 20, 2020

Project Location: 25 Rutherford South, Brampton, ON

Contract No.:

SAMPLE DATA

Material: Soil
Date Sampled: Apr 20, 2020
Time Sampled:
Sample Type: Borehole
Sample Location: BH406 SS03A
Lot: **Sublot:** **Station**
Source: Insitu
Sampled By: Technician

LAB DATA

Lab No.: **1524** **Date Tested:** Apr 20, 2020

Specification: OPSS 1010, SSM

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		
% Flat and Elongated		

WASH PASS 0.075mm

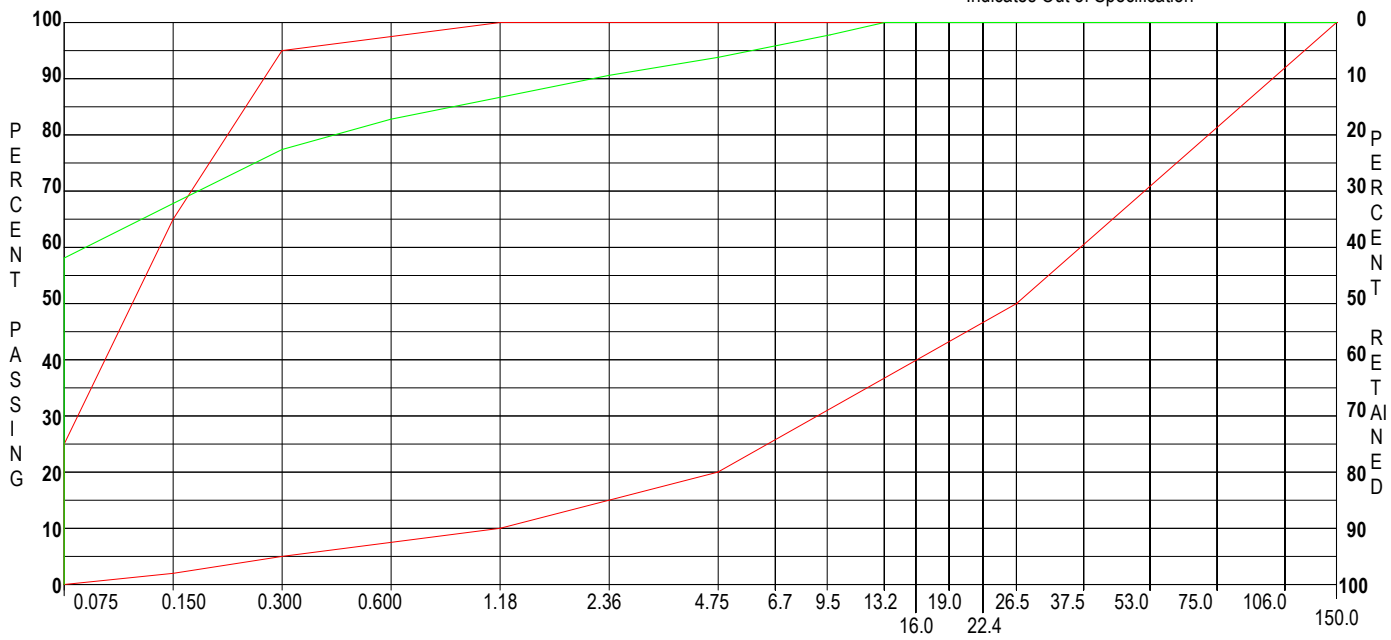
TEST	Sample	Specs
Wash Pass 0.075 mm:		
FINENESS MODULUS	1.03	

Comments:

Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**100**	-
53.0	**100**	-
37.5	**100**	-
26.5	**100**	50 - 100
22.4	**100**	-
19.0	**100**	-
16.0	**100**	-
13.2	**100**	-
9.5	**97.8**	-
6.7		-
4.75	**93.8**	20 - 100
2.36	**90.6**	-
1.18	**86.7**	10 - 100
0.600	**82.8**	-
0.300	**77.4**	5 - 95
0.150	**67.8***	2 - 65
0.075	**58.1***	0 - 25

* Indicates Out of Specification



Project Manager: Mavara Turab

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401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
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Grain Size Analysis Test Report

Project No.: 671835 **Description:** Environmental and Geotechnical Consulting Services **Date:** Apr 20, 2020

Project Location: 25 Rutherford South, Brampton, ON

Contract No.:

SAMPLE DATA

Material: Soil
Date Sampled: Apr 20, 2020
Time Sampled:
Sample Type: Borehole
Sample Location: BH411 SS02
Lot: **Sublot:** **Station**
Source: Insitu
Sampled By: Technician

LAB DATA

Lab No.: **1525** **Date Tested:** Apr 20, 2020

Specification: OPSS 1010, SSM

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		
% Flat and Elongated		

WASH PASS 0.075mm

TEST	Sample	Specs
Wash Pass 0.075 mm:		

FINENESS MODULUS	0.87

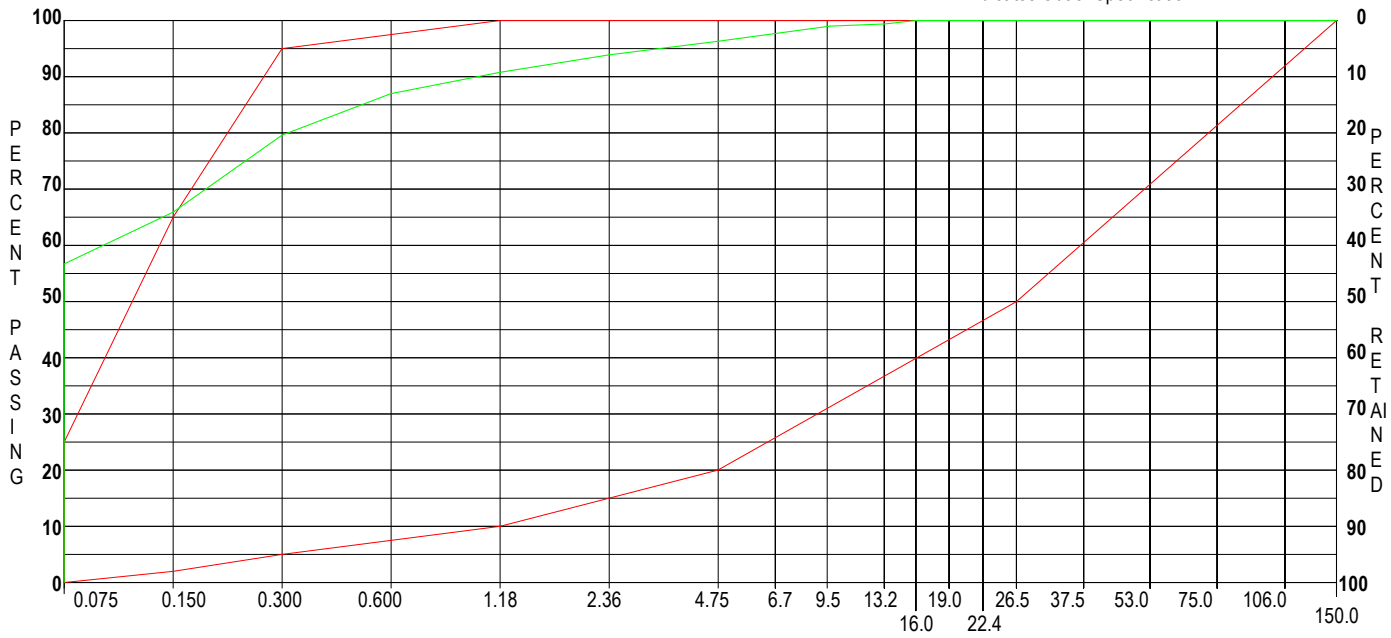
Comments:

Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**100**	-
53.0	**100**	-
37.5	**100**	-
26.5	**100**	50 - 100
22.4	**100**	-
19.0	**100**	-
16.0	**100**	-
13.2	**99.4**	-
9.5	**99**	-
6.7		-
4.75	**96.3**	20 - 100
2.36	**93.9**	-
1.18	**90.8**	10 - 100
0.600	**87**	-
0.300	**79.6**	5 - 95
0.150	**65.9***	2 - 65
0.075	**56.7***	0 - 25

* Indicates Out of Specification

Sample: **Specs:**



Project Manager: Mavara Turab

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Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

Grain Size Analysis Test Report

Project No.: 671835 **Description:** Environmental and Geotechnical Consulting Services **Date:** Apr 20, 2020

Project Location: 25 Rutherford South, Brampton, ON **Contract No.:**

SAMPLE DATA

Material: Soil
Date Sampled: Apr 20, 2020
Time Sampled:
Sample Type: Borehole
Sample Location: BH4133 SS01
Lot: **Sublot:** **Station**
Source: Insitu
Sampled By: Technician

LAB DATA

Lab No.: **1526** **Date Tested:** Apr 20, 2020

Specification: OPSS 1010, SSM

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		
% Flat and Elongated		

WASH PASS 0.075mm

TEST	Sample	Specs
Wash Pass 0.075 mm:		
FINENESS MODULUS	0.58	

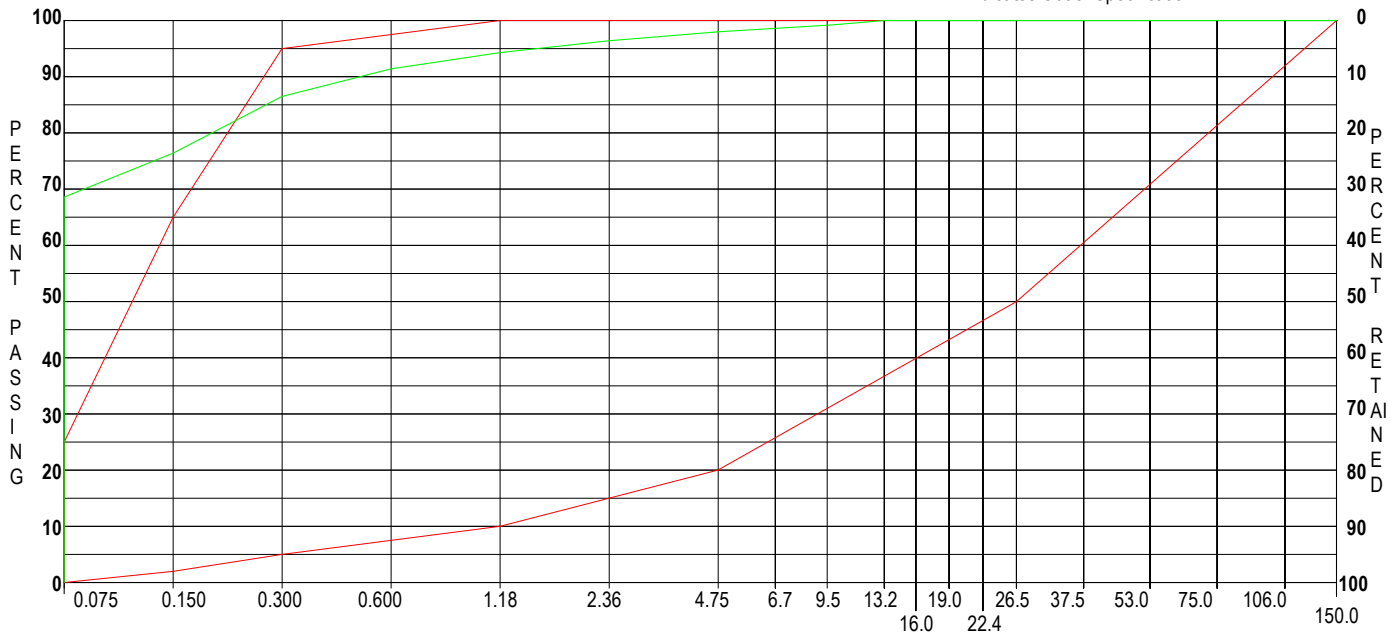
Comments:

Grain Size Analysis

Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0	**100**	100 - 100
106.0	**100**	-
75.0	**100**	-
53.0	**100**	-
37.5	**100**	-
26.5	**100**	50 - 100
22.4	**100**	-
19.0	**100**	-
16.0	**100**	-
13.2	**100**	-
9.5	**99.2**	-
6.7		-
4.75	**98**	20 - 100
2.36	**96.4**	-
1.18	**94.3**	10 - 100
0.600	**91.4**	-
0.300	**86.5**	5 - 95
0.150	**76.4***	2 - 65
0.075	**68.6***	0 - 25

* Indicates Out of Specification

Sample: **Specs:**



Project Manager: Mavara Turab

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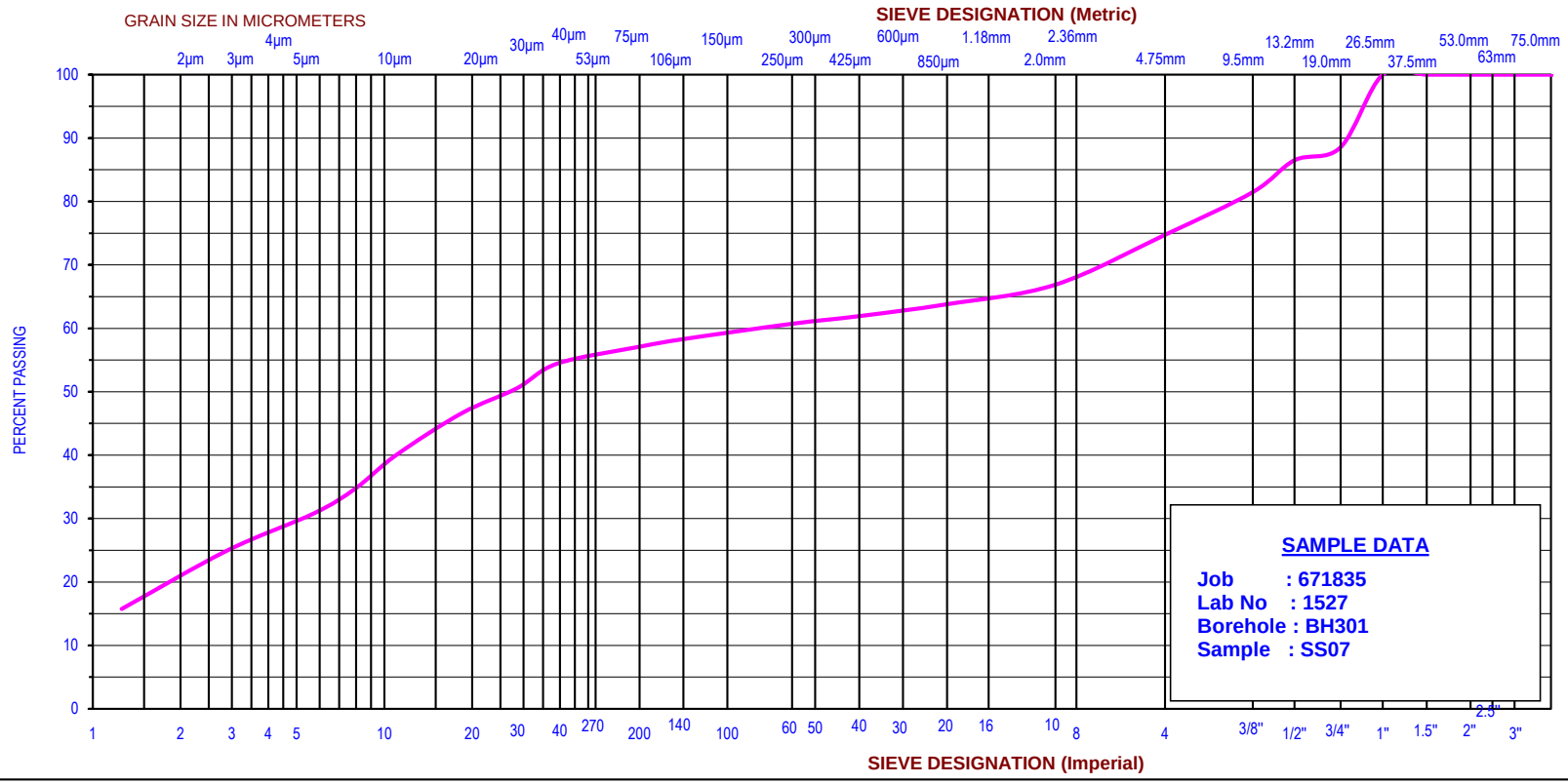
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	11	14	8	5	5	36	21

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GRAIN SIZE DISTRIBUTION

GRAVELLY / CLAYEY SILT

some sand

Client: City of Brampton

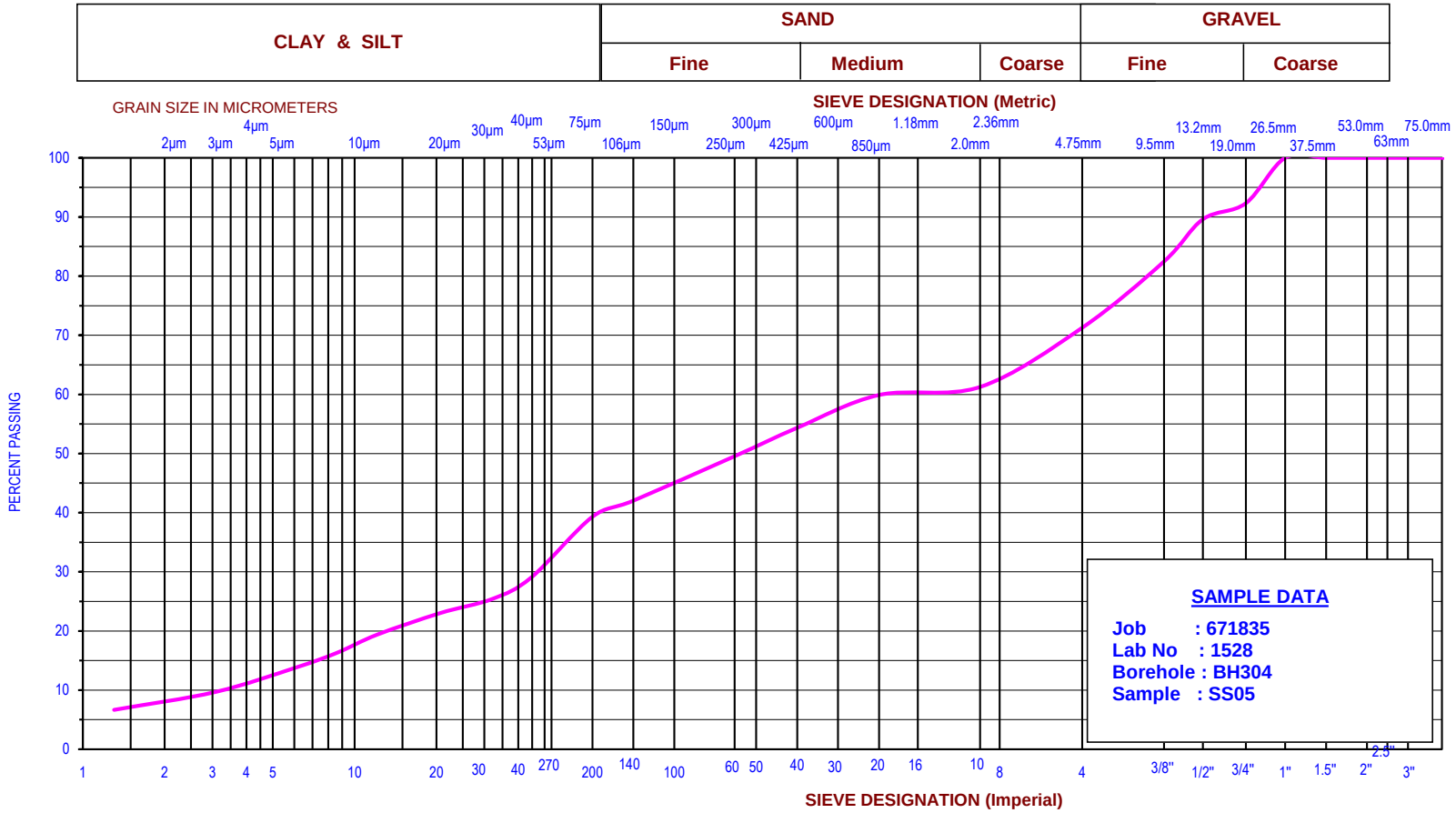
Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	8	21	10	7	15	31	8

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GRAIN SIZE DISTRIBUTION

GRAVELLY SAND AND SILT

trace clay

Client: City of Brampton

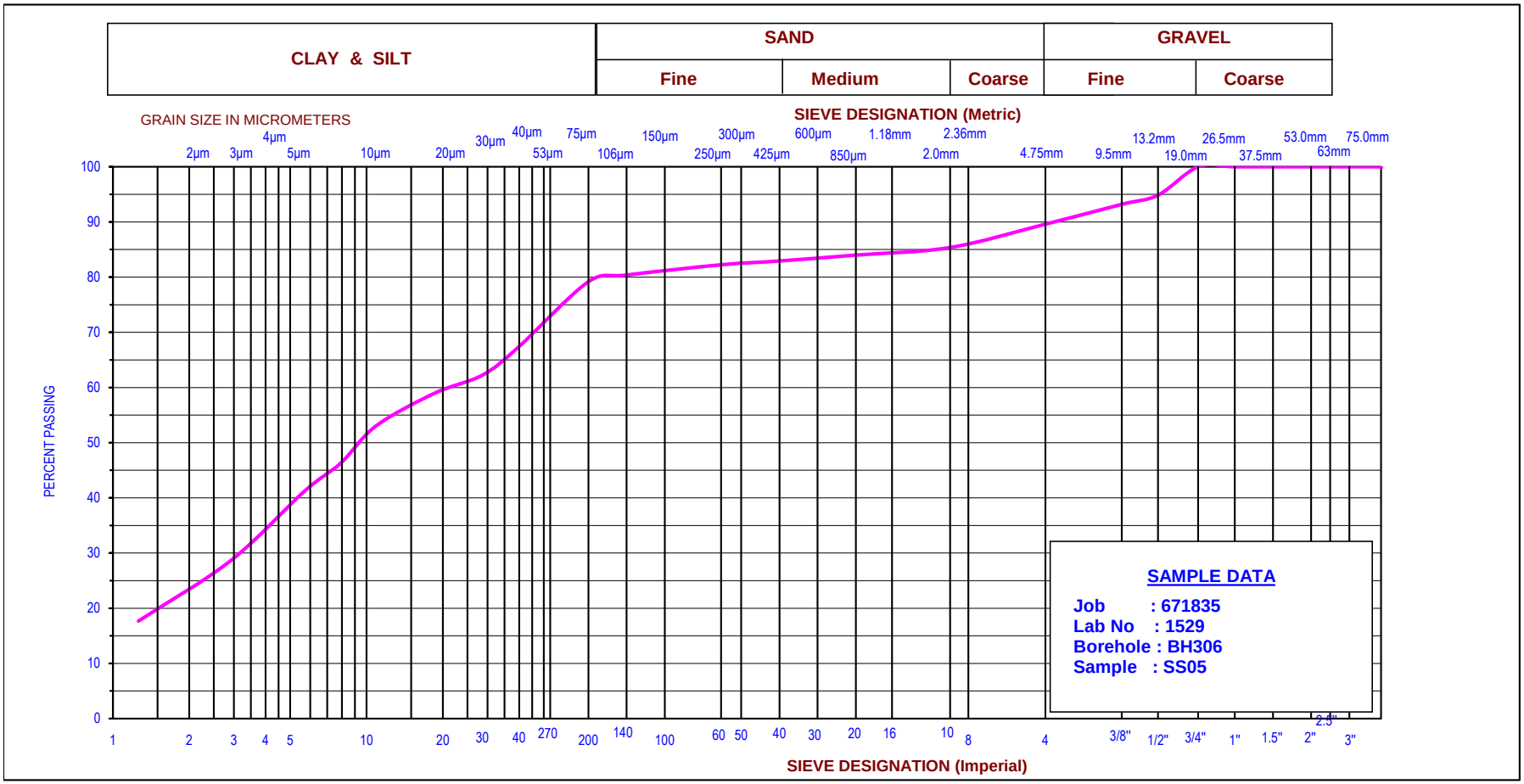
Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	10	4	2	4	57	23

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GRAIN SIZE DISTRIBUTION

CLAYEY SILT

some gravel, some sand

Client: City of Brampton

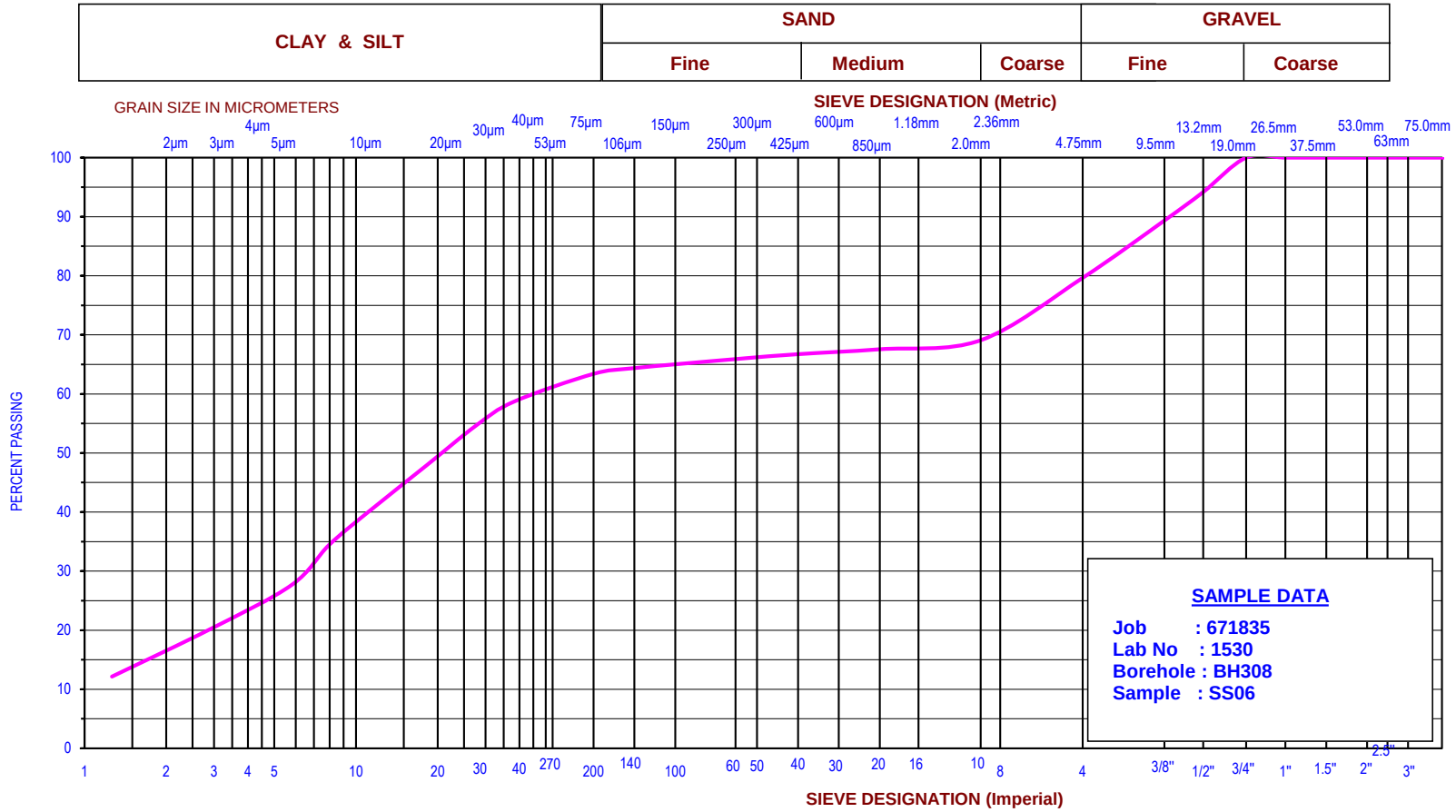
Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	20	11	2	3	48	16

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GRAIN SIZE DISTRIBUTION

SILT (MIXED SHALE)

some gravel, some sand, some clay

Client: City of Brampton

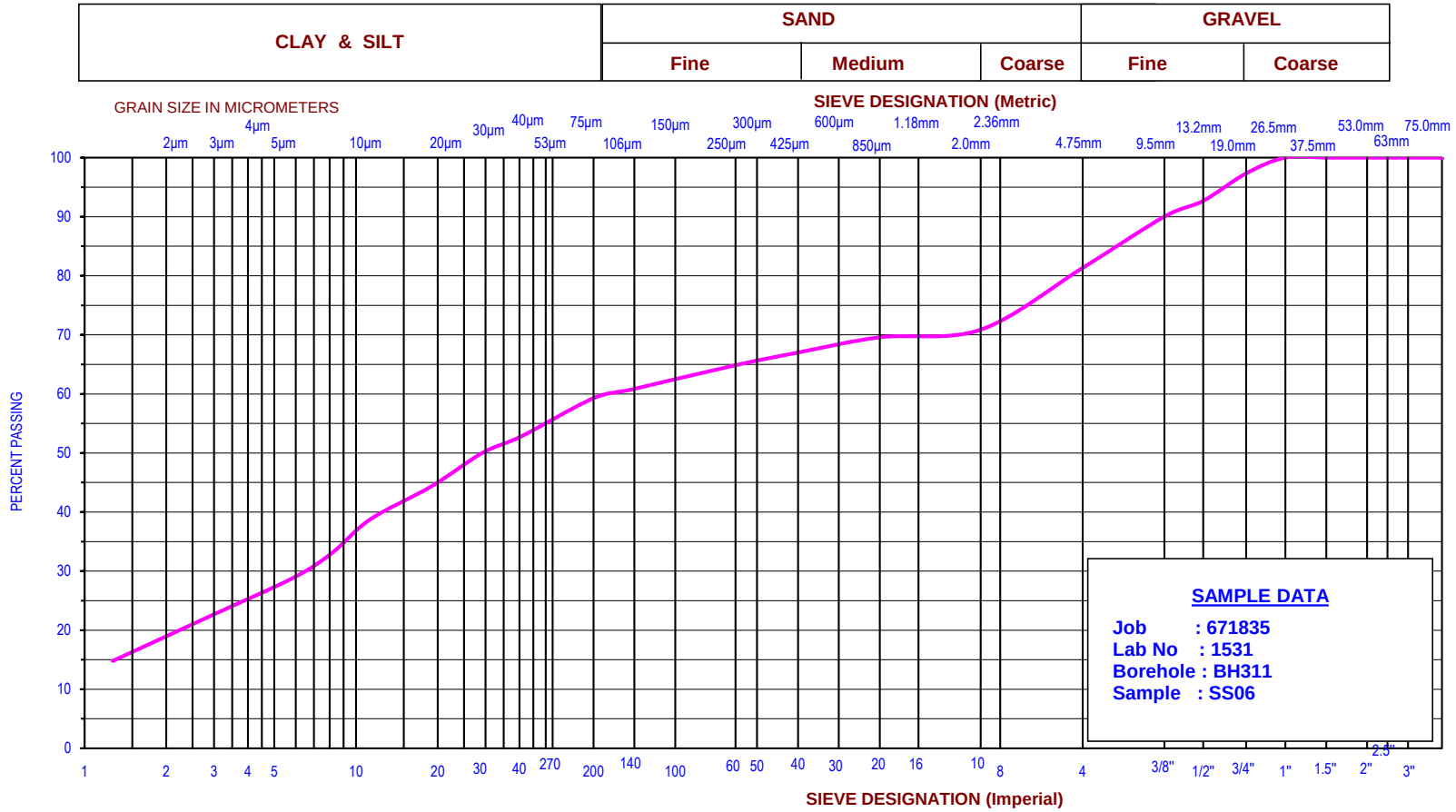
Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	3	16	10	4	8	40	19

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GRAIN SIZE DISTRIBUTION

SANDY SILT

some gravel, some clay

Client: City of Brampton

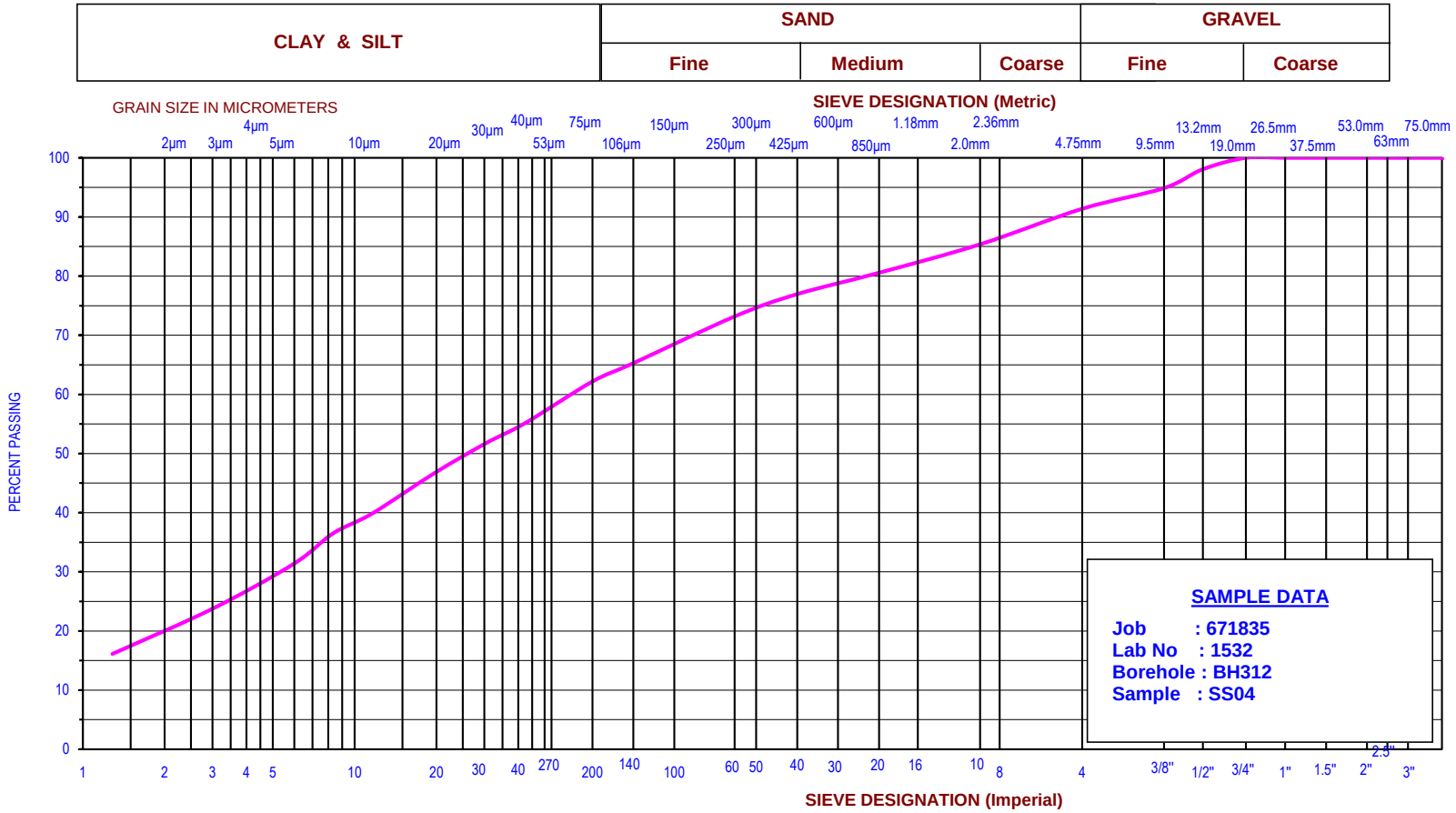
Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	9	6	8	15	42	20

SNC-Lavalin GEM Ontario Inc.
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GRAIN SIZE DISTRIBUTION

SANDY / CLAYEY SILT

trace gravel

Client: City of Brampton

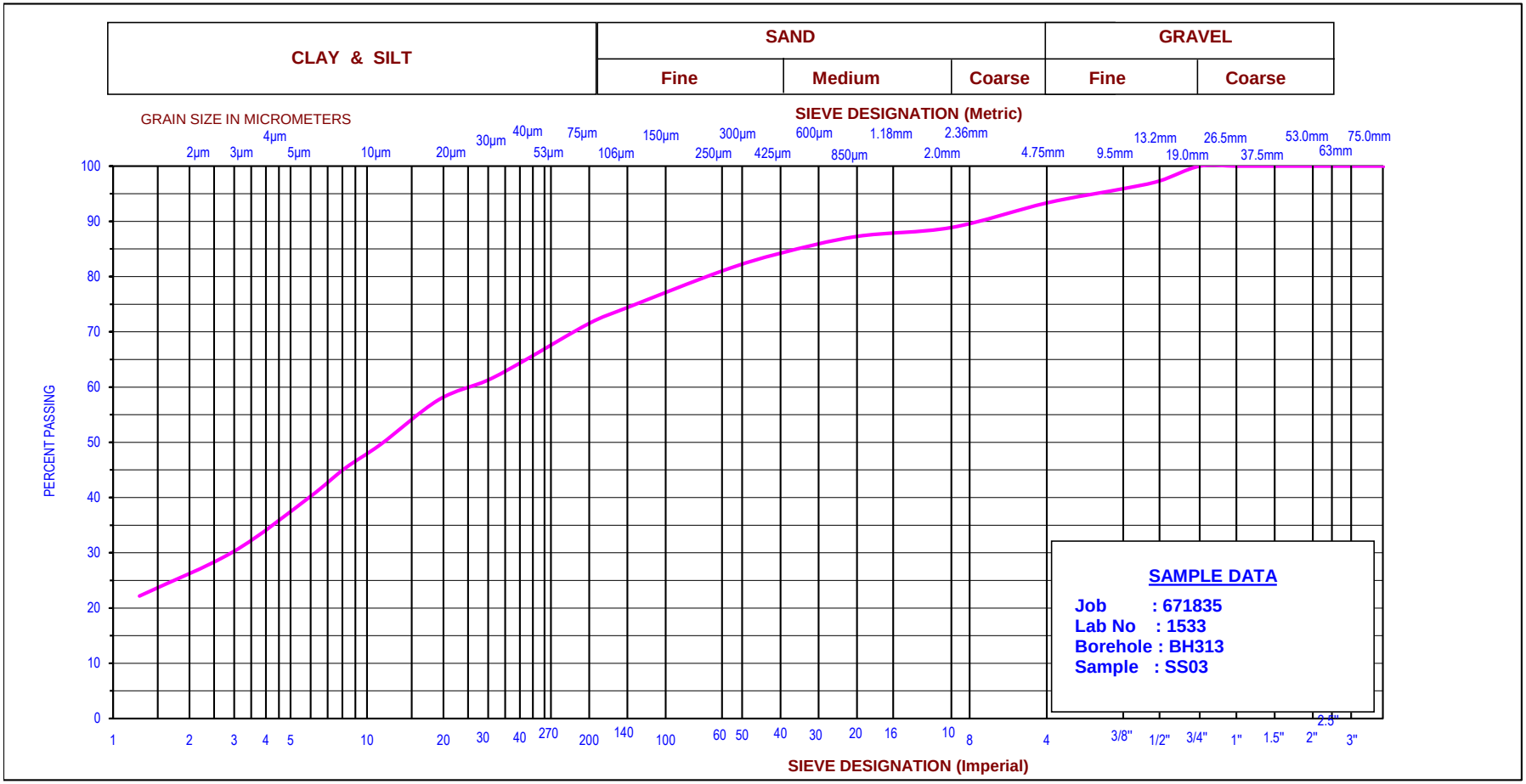
Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	7	4	5	13	45	26

SNC-Lavalin GEM Ontario Inc.
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GRAIN SIZE DISTRIBUTION

CLAYEY / SANDY SILT

trace gravel

Client: City of Brampton

Project: Rutherford Rd South Brampton Geotechnical

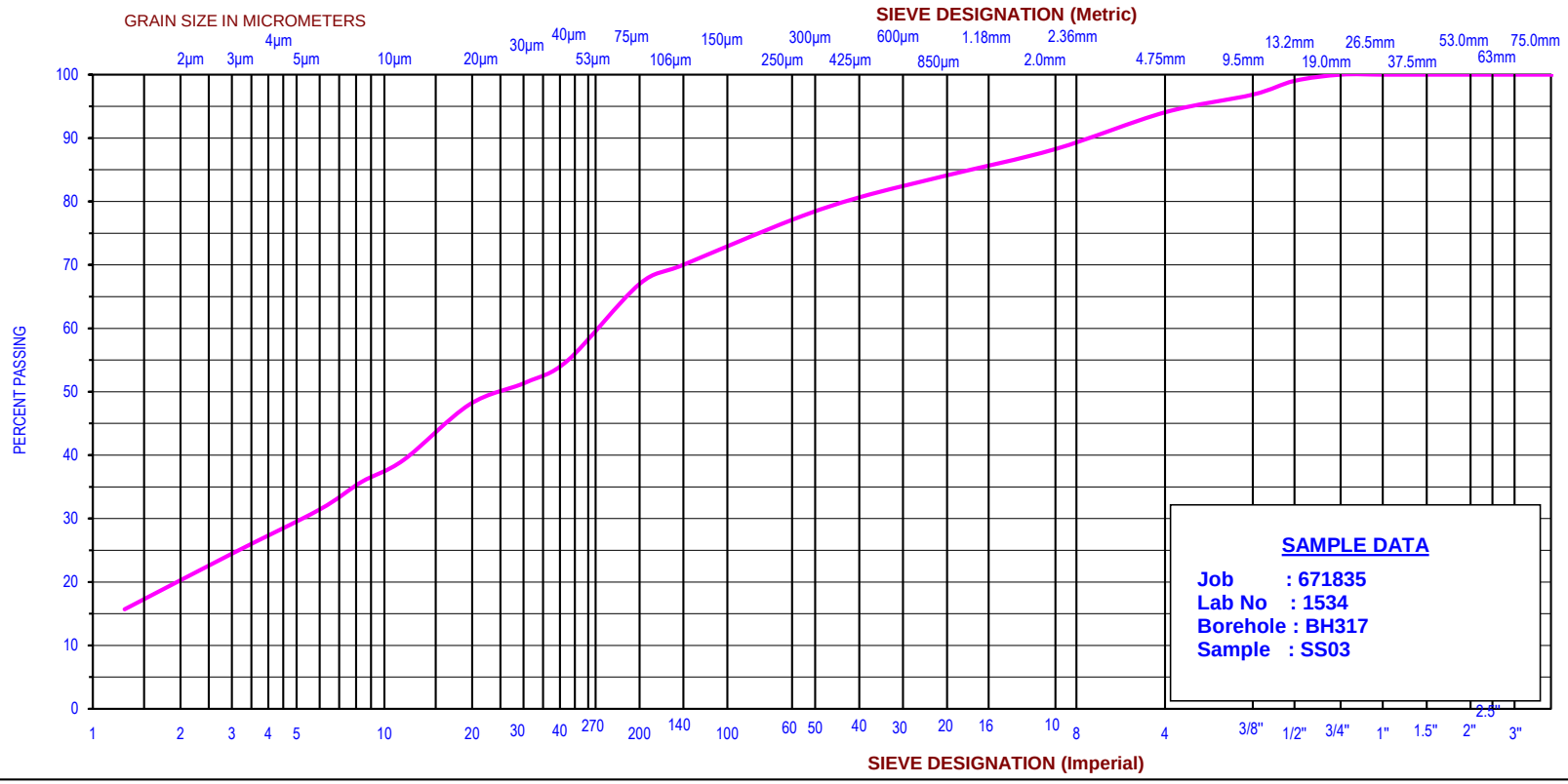
Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	6	6	7	14	47	20

SNC-Lavalin GEM Ontario Inc.
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905.851.0090 905.851.0091

GRAIN SIZE DISTRIBUTION

SANDY / CLAYEY SILT

trace gravel

Client: City of Brampton

Project: Rutherford Rd South Brampton Geotechnical

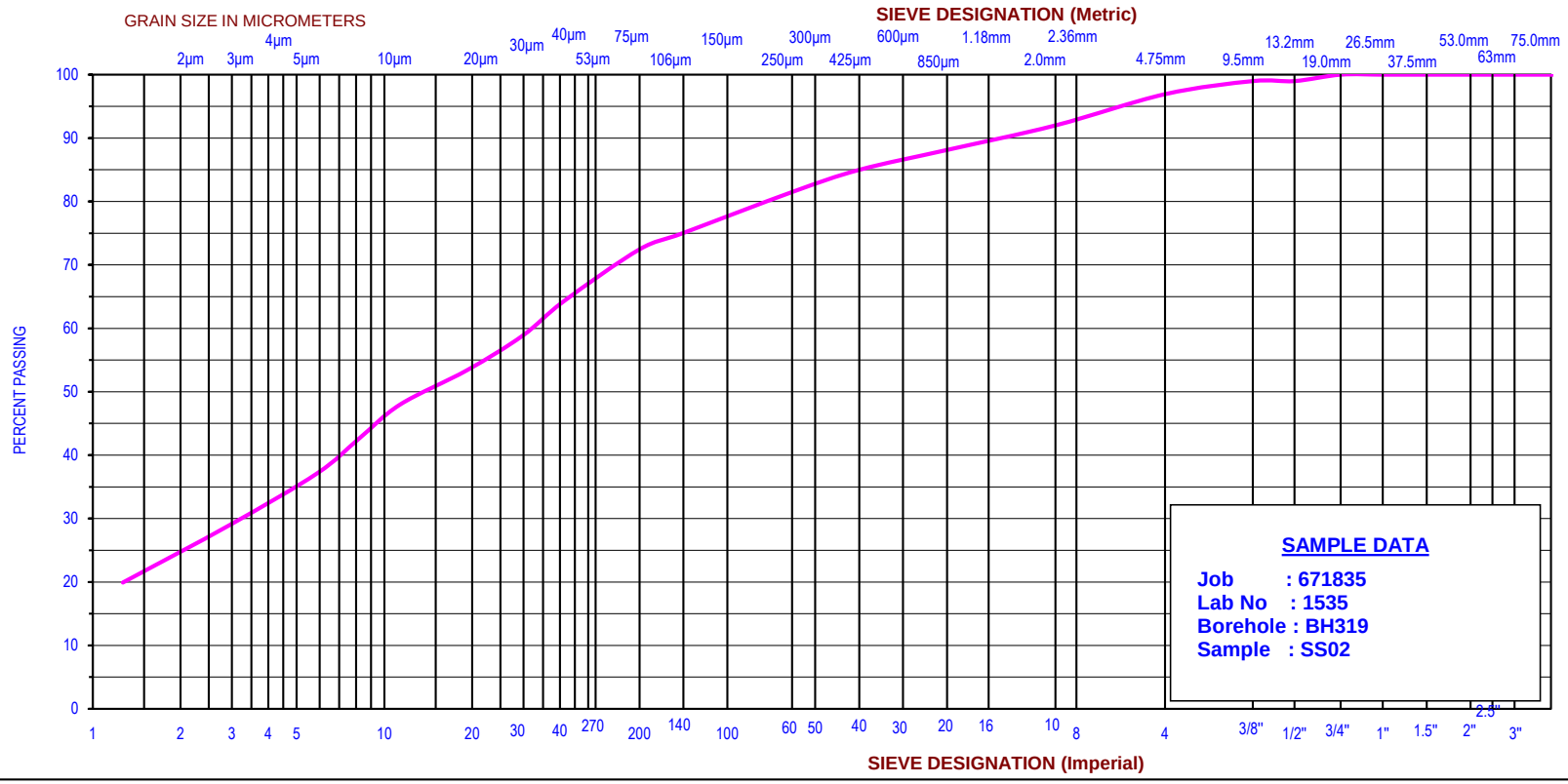
Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	3	5	7	12	48	25

SNC-Lavalin GEM Ontario Inc.
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GRAIN SIZE DISTRIBUTION

CLAYEY / SANDY SILT

trace gravel

Client: City of Brampton

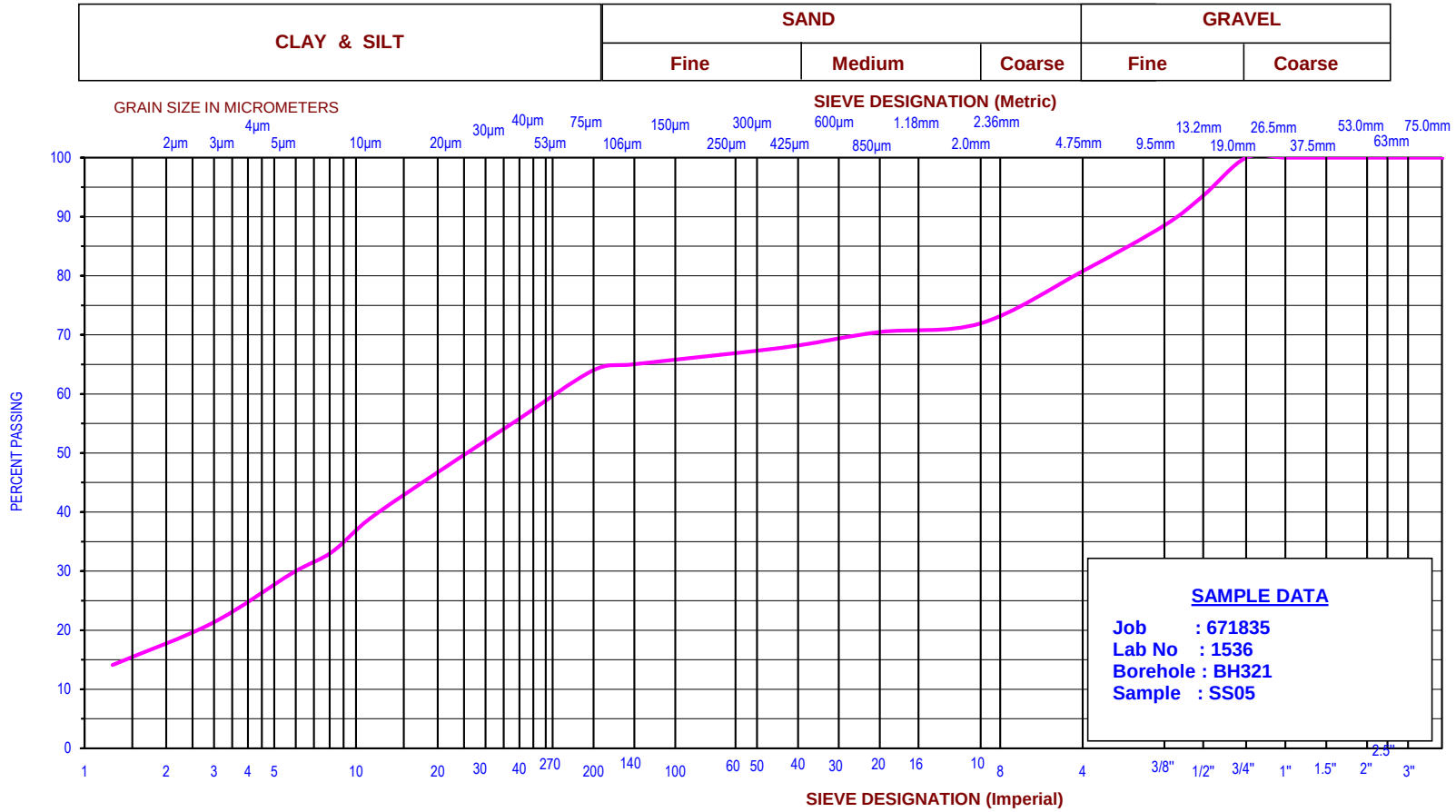
Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	19	9	4	4	47	17

SNC-Lavalin GEM Ontario Inc.
401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

GRAIN SIZE DISTRIBUTION

SILT

some gravel, some sand, some clay

Client: City of Brampton

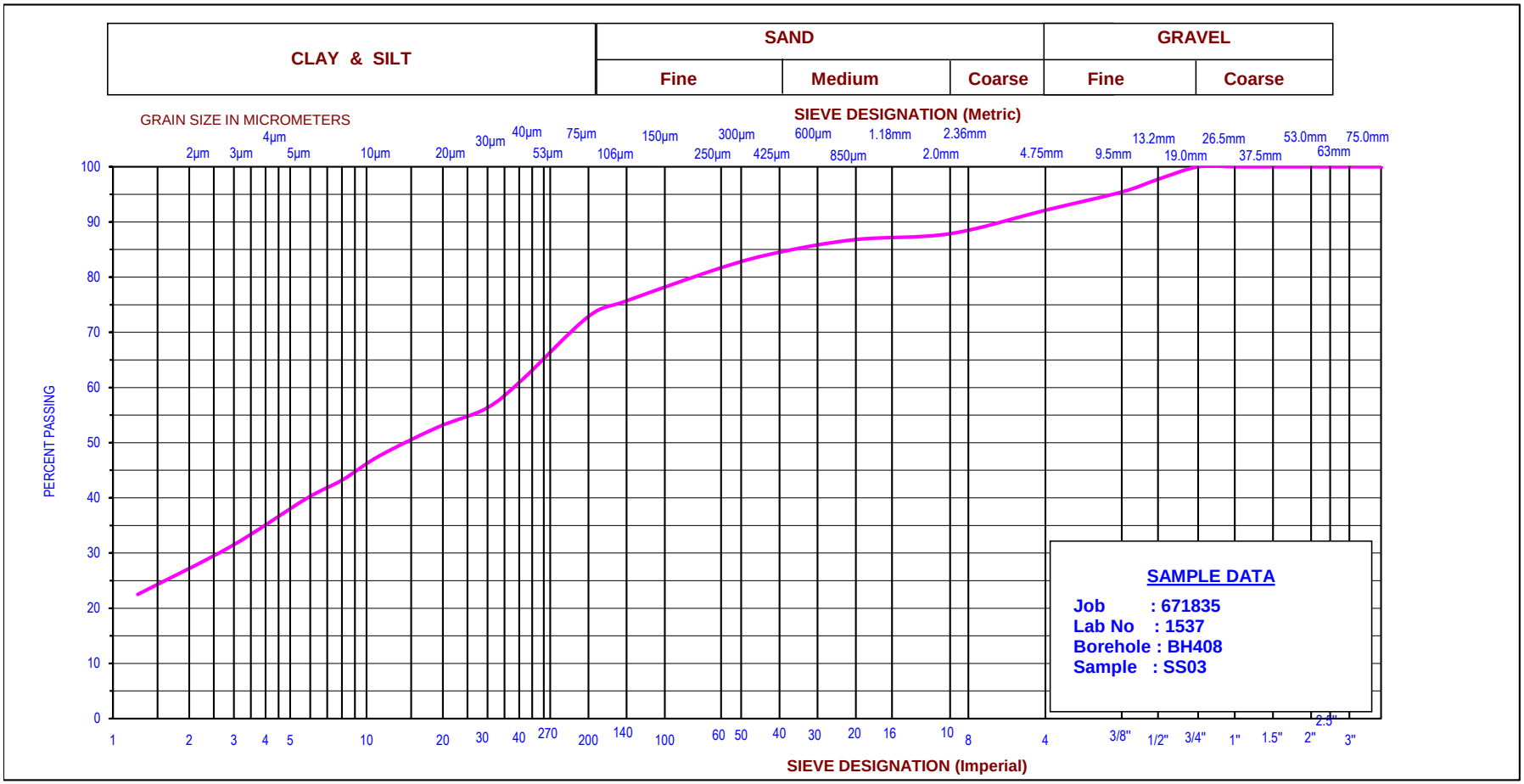
Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	8	4	3	12	46	27

SNC-Lavalin GEM Ontario Inc.
401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

GRAIN SIZE DISTRIBUTION

CLAYEY SILT

some sand, trace gravel

Client: City of Brampton

Project: Rutherford Rd South Brampton Geotechnical

Location: 25 Rutherford South Brampton, ON

Date: April 2020

SNC·LAVALIN

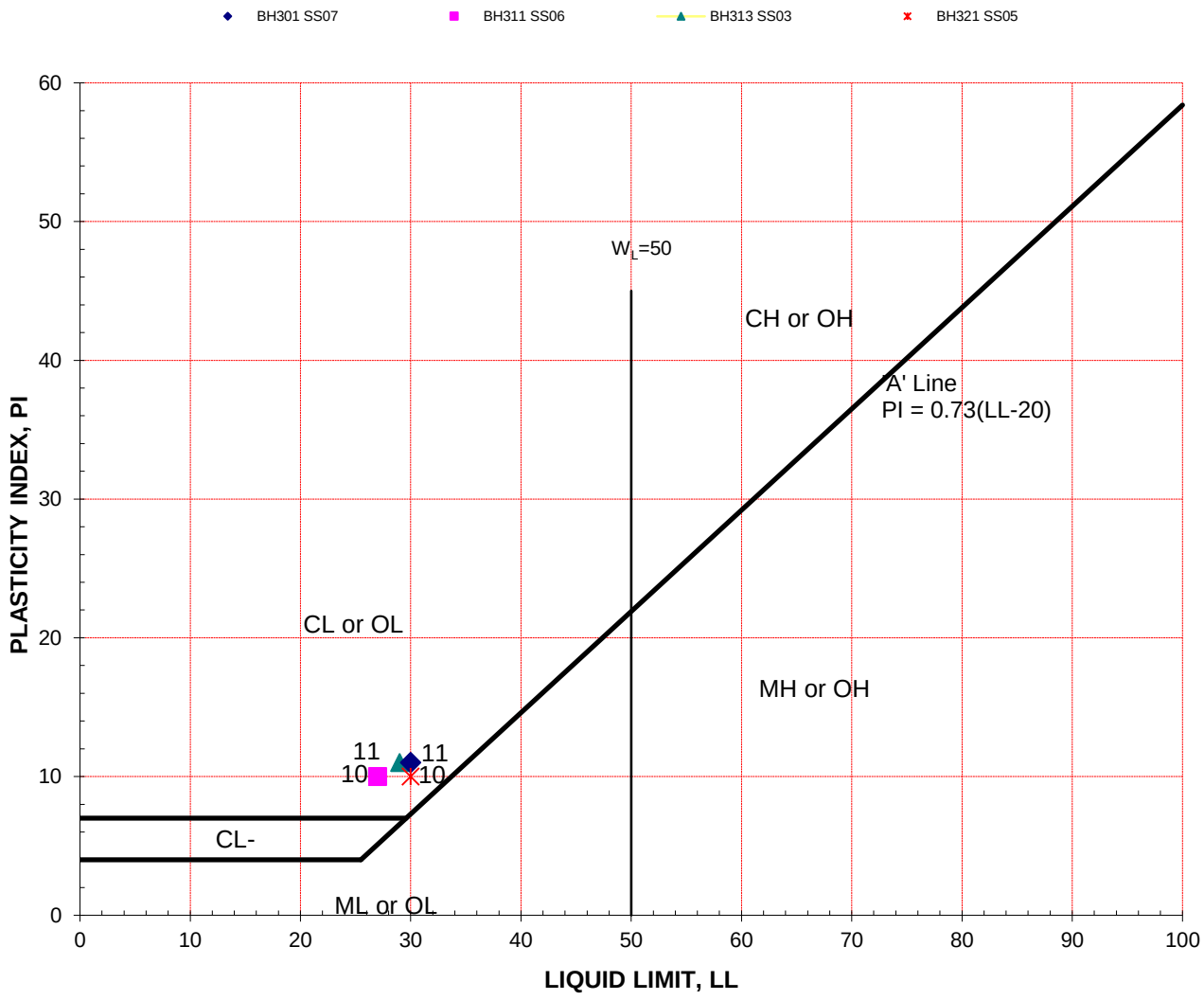
SNC-Lavalin GEM Ontario Inc.
401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

PLASTICITY CHART

Job # :	671835		
Project Client:	City of Brampton	**Technician** :	UC
Project :	Rutherford Rd South Brampton Geotechnical	**Supervisor** :	KL
Location :	25 Rutherford South, Brampton, ON	**Date** :	04-21-20

TEST RESULTS

Specimen #	Sample #	Depth	LL%	PL%	PI	Fines	W%	Classification	Remarks
BH301	SS07		30	19	11		12	CL	Lab # 1527
BH311	SS06		27	17	10		10	CL	Lab # 1531
BH313	SS03		29	18	11		15	CL	Lab # 1533
BH321	SS05		30	20	10		7	CL	Lab # 1536



SNC·LAVALIN

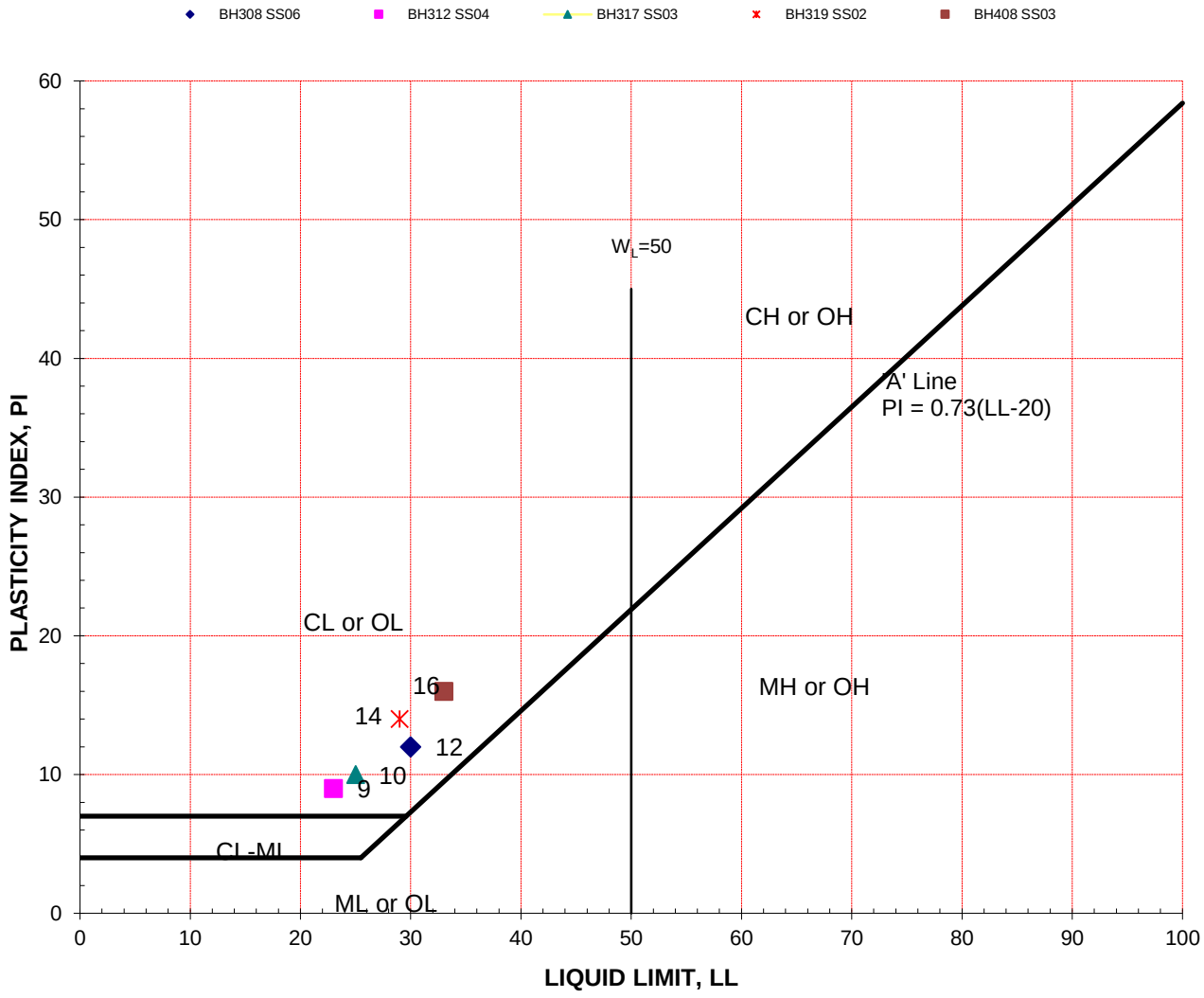
SNC-Lavalin GEM Ontario Inc.
401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 905.851.0091

PLASTICITY CHART

Job # :	671835		
Project Client:	City of Brampton	**Technician** :	AL
Project :	Rutherford Rd South Brampton Geotechnical	**Supervisor** :	KL
Location :	25 Rutherford South, Brampton, ON	**Date** :	04-20-20

TEST RESULTS

Specimen #	Sample #	Depth	LL%	PL%	PI	Fines	W%	Classification	Remarks
BH308	SS06		30	18	12		12	CL	Lab # 1530
BH312	SS04		23	14	9		14	CL	Lab # 1532
BH317	SS03		25	15	10		12	CL	Lab # 1534
BH319	SS02		29	15	14		15	CL	Lab # 1535
BH408	SS03		33	17	16		19	CL	Lab # 1537



Appendix D

Analytical Laboratory Results (12 pages)

SNC-Lavalin Inc.
ATTN: Mavara Turab
401 Hanlan Road
Vaughan ON L4L 3T1

Date Received: 10-MAR-20
Report Date: 12-MAR-20 13:59 (MT)
Version: FINAL

Client Phone: 905-851-0090

Certificate of Analysis

Lab Work Order #: L2426098

Project P.O. #: NOT SUBMITTED
Job Reference: 671835
C of C Numbers: 17-795682
Legal Site Desc:

Gayle Braun
Senior Account Manager

ANALYTICAL REPORT

Summary of Guideline Exceedances

ALS ID	Client ID	Grouping	Analyte	Result	Guideline Limit	Unit
Guideline						
Ontario Regulation 153/04 - April 15, 2011 Standards - T1-Soil-Res/Park/Inst/Ind/Com/Commu Property Use						
L2426098-4	BH319 SS1	Physical Tests	Conductivity	0.690	0.57	mS/cm

ANALYTICAL REPORT

Physical Tests - SOIL

			Lab ID	L2426098-1	L2426098-2	L2426098-3	L2426098-4
			Sample Date	03-MAR-20	04-MAR-20	04-MAR-20	03-MAR-20
			Sample ID	BH301 SS2	BH315 SS4	BH317 SS2	BH319 SS1
Analyte	Unit	Guide Limits #1	#2				
Conductivity	mS/cm	0.57	-	0.360	0.225	0.270	0.690
% Moisture	%	-	-	17.6	10.9	12.2	12.3
pH	pH units	-	-	7.56	7.93	7.85	7.72
Redox Potential	mV	-	-	175	174	181	193
Resistivity	ohm*cm	-	-	2780	4440	3700	1450

Guide Limit #1: T1-Soil-Res/Park/Inst/Ind/Com/Commu Property Use

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

Leachable Anions & Nutrients - SOIL

			Lab ID	L2426098-1	L2426098-2	L2426098-3	L2426098-4
			Sample Date	03-MAR-20	04-MAR-20	04-MAR-20	03-MAR-20
			Sample ID	BH301 SS2	BH315 SS4	BH317 SS2	BH319 SS1
Analyte	Unit	Guide Limits #1	#2				
Chloride	ug/g	-	-	74.1	47.2	54.0	374

Guide Limit #1: T1-Soil-Res/Park/Inst/Ind/Com/Commu Property Use

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Anions and Nutrients - SOIL

			Lab ID	L2426098-1	L2426098-2	L2426098-3	L2426098-4
			Sample Date	03-MAR-20	04-MAR-20	04-MAR-20	03-MAR-20
			Sample ID	BH301 SS2	BH315 SS4	BH317 SS2	BH319 SS1
Analyte	Unit	Guide Limits #1	#2				
Sulphate	mg/kg	-	-	21	81	46	<20

Guide Limit #1: T1-Soil-Res/Park/Inst/Ind/Com/Commu Property Use

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Inorganic Parameters - SOIL

		Guide Limits					
			Lab ID	L2426098-1	L2426098-2	L2426098-3	L2426098-4
			Sample Date	03-MAR-20	04-MAR-20	04-MAR-20	03-MAR-20
			Sample ID	BH301 SS2	BH315 SS4	BH317 SS2	BH319 SS1
Analyte	Unit	#1	#2				
Acid Volatile Sulphides	mg/kg	-	-	<0.20	<0.20	<0.20	<0.20

Guide Limit #1: T1-Soil-Res/Park/Inst/Ind/Com/Commu Property Use

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MOISTURE-WT	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

The reported Resistivity value is calculated as the inverse of the conductivity of a 2:1 water:soil leachate. This method does not use direct measurement of Soil Resistivity using a resistivity meter.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	MOECC E3138

The reported Resistivity value is calculated as the inverse of the conductivity of a 2:1 water:soil leachate. This method does not use direct measurement of Soil Resistivity using a resistivity meter.

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J

This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.

**ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody Numbers:

17-795682

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information. Guideline limits are not adjusted for the hardness, pH or temperature of the sample (the most conservative values are used). Measurement uncertainty is not applied to test results prior to comparison with specified criteria values.

Quality Control Report

Workorder: L2426098 Report Date: 12-MAR-20

Client: SNC-Lavalin Inc.
401 Hanlan Road
Vaughan ON L4L 3T1
Contact: Mavara Turab

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-R511-WT	**Soil**							
Batch R5022208								
WG3290070-3 CRM		**AN-CRM-WT**						
Chloride			93.8		%		70-130	11-MAR-20
WG3290070-4 DUP		**L2426098-3**						
Chloride		54.0	53.9		ug/g	0.2	30	11-MAR-20
WG3290070-2 LCS								
Chloride			103.8		%		80-120	11-MAR-20
WG3290070-1 MB								
Chloride			<5.0		ug/g		5	11-MAR-20
EC-WT	**Soil**							
Batch R5021393								
WG3290066-4 DUP		**WG3290066-3**						
Conductivity		0.197	0.231		mS/cm	16	20	11-MAR-20
WG3290066-2 IRM		**WT SAR3**						
Conductivity			98.1		%		70-130	11-MAR-20
WG3290355-1 LCS								
Conductivity			99.5		%		90-110	11-MAR-20
WG3290066-1 MB								
Conductivity			<0.0040		mS/cm		0.004	11-MAR-20
MOISTURE-WT	**Soil**							
Batch R5020867								
WG3289728-3 DUP		**L2426245-1**						
% Moisture		18.6	19.5		%	4.2	20	11-MAR-20
WG3289728-2 LCS								
% Moisture			100.3		%		90-110	11-MAR-20
WG3289728-1 MB								
% Moisture			<0.25		%		0.25	11-MAR-20
PH-WT	**Soil**							
Batch R5021296								
WG3289558-1 DUP		**L2424783-2**						
pH		7.46	7.46	J	pH units	0.00	0.3	11-MAR-20
WG3290339-1 LCS								
pH			7.01		pH units		6.9-7.1	11-MAR-20
REDOX-POTENTIAL-WT	**Soil**							
Batch R5021379								
WG3290338-1 CRM		**WT-REDOX**						
Redox Potential			100.6		%		80-120	11-MAR-20
WG3289526-1 DUP		**L2425859-3**						

Quality Control Report

Client: SNC-Lavalin Inc.
401 Hanlan Road
Vaughan ON L4L 3T1
Contact: Mavara Turab

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
REDOX-POTENTIAL-WT	**Soil**							
Batch R5021379								
WG3289526-1 DUP		**L2425859-3**						
Redox Potential		217	213		mV	1.9	25	11-MAR-20
SO4-WT	**Soil**							
Batch R5022208								
WG3289492-4 CRM		**AN-CRM-WT**						
Sulphate			110.3		%		60-140	11-MAR-20
WG3289492-3 DUP		**L2425859-3**						
Sulphate		62	61		mg/kg	0.3	30	11-MAR-20
WG3289492-2 LCS								
Sulphate			104.8		%		80-120	11-MAR-20
WG3289492-1 MB								
Sulphate			<20		mg/kg		20	11-MAR-20
SULPHIDE-WT	**Soil**							
Batch R5021250								
WG3290225-3 DUP		**L2426098-2**						
Acid Volatile Sulphides		<0.20	<0.20	RPD-NA	mg/kg	N/A	45	11-MAR-20
WG3290225-2 LCS								
Acid Volatile Sulphides			102.7		%		70-130	11-MAR-20
WG3290225-1 MB								
Acid Volatile Sulphides			<0.20		mg/kg		0.2	11-MAR-20

Quality Control Report

Workorder: L2426098 Report Date: 12-MAR-20

Client: SNC-Lavalin Inc.
401 Hanlan Road
Vaughan ON L4L 3T1
Contact: Mavara Turab

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytic Request Form

Canada Toll Free: 1 800 668 9878

L2426098-COFC

COC Number: 17 - 795682

Page of

MH

Report To	Contact and company name below will appear on the final report	Report Format / Distribution		Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)	
Company:	SNC	Select Report Format:	✓ PDF ☐ EXCEL ☐ EDD (DIGITAL)	Regular [R]	✓ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Navara Turab	Quality Control (QC) Report with Report	✓ YES ☐ NO	PRIORITY (Business Days) 4 day [P4-20%]	☐ EMERGENCY 1 Business day [E - 100%] ☐
Phone:	905-851-0090	☐ Compare Results to Criteria on Report - provide details below if box checked		3 day [P3-25%] ☐	Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
	Company address below will appear on the final report	Select Distribution:	✓ EMAIL ☐ MAIL ☐ FAX	2 day [P2-50%] ☐	
Street:	401 Hanlon Rd	Email 1 or Fax	Navaraturab@snclavalin.com	Date and Time Required for all E&P TATs:	dd-mmm-yy hh:mm
City/Province:	Woodbridge	Email 2	Nawaz.Fall@snclavalin.com	For tests that can not be performed according to the service level selected, you will be contacted.	
Postal Code:	L4L 3T9	Email 3			

Invoice To		Invoice Distribution	
	Same as Report To ✓ YES ☐ NO	Select Invoice Distribution:	✓ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ✓ YES ☐ NO	Email 1 or Fax	
Company:		Email 2	
Contact:			

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:	671835	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	

ALS Lab Work Order # (lab use only): L2426098 CFC

ALS Contact: GB

Sampler: M.F

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS (Radioactivity Test)	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	BH301 SS2	03-03-20	09:15	SS	X		
	BH315 SS4	04-03-20	15:10	SS	X		
	BH317 SS2	04-03-20	9:10	SS	X		
	BH319 SS1	03-03-20	11:50	SS	X		

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO	
Are samples for human consumption/ use? ☐ YES ☐ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☒ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
9.9				1.1			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
Nawaz Fall	March 05, 2020	14:30		10/3/20	8:40		10-MAR-20	14:01

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Appendix E

MASW Test Results (8 pages)

GEOPHYSICS GPR INTERNATIONAL INC.

6741 Columbus Road
Unit 14
Mississauga, Ontario
Canada, L5T 2G9

Tel.: 905-696-0656
Fax: 905-696-0570
info@geophysicsgpr.com
www.geophysicsgpr.com

February 26, 2020 GPR file: T202021

Mavara Turab, PMP
Geotechnical Project Manager
SNC-Lavalin
401 Hanlan Road
Woodbridge, Ontario
L4L 3T1

RE: Shear-wave velocity sounding for seismic site classification, 25 Rutherford Road South, Brampton, Ontario

Dear Ms Turab,

Geophysics GPR International Inc. has been requested by SNC-Lavalin to carry out a shear-wave velocity sounding at the above site in Brampton. Figure 1 shows the location of the test profile.

The survey was performed on February 18th, 2020.

The investigation included the multi-channel analysis of surface waves (MASW) and the refraction methods to generate shear-wave velocity model (Figure 4).

The following paragraphs describe the survey design, the principles of the test method, the methodology for interpreting the data, and provide a culmination of the results in table format.

Figure 1: Approximate location of the shear-wave velocity sounding.

MASW and MAM Surveys

Basic Theory

The Multi-channel Analysis of Surface Waves (MASW) and the Micro-tremor Array Measurements (MAM) are seismic methods used to evaluate the shear-wave velocities of subsurface materials through the analysis of the dispersion properties of Rayleigh surface waves ("ground roll"). The dispersion properties are measured as a change in phase velocity with frequency. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves. Inversion of the Rayleigh wave dispersion curve yields a shear-wave (V_S) velocity depth profile (sounding). Figure 2 outlines the basic operating procedure for the MASW method. Figure 3 is an example image of a typical MASW record and resulting 1D V_S model. A more detailed description of the method can be found in the paper *Multi-channel Analysis of Surface Waves,*

Park, C.B., Miller, R.D. and Xia, J. Geophysics, Vol. 64, No. 3 (May-June 1999); P. 800–808.

Survey Design

The geometry of an MASW survey is similar to that of a seismic refraction investigation (i.e. 12 to 24 geophones in a linear array). The fundamental principle involves intentionally generating an acoustic wave at the surface and digitally recording the surface waves from the moment of source impact with a linear series of geophones on the surface. This is referred to as an "active source" method. A sledgehammer was used as the primary energy source with traces being recorded at 6 locations: approximately 6 m off both ends, 15 to 20 m off both ends, and in the middle of the spread. Data were collected with geophones spacing of 3 m and 1 m for a total of 10 shot records per sounding.

Unlike the refraction method, which produces a data point beneath each geophone, the shear-wave depth profile is the average of the bulk area within the middle third of the geophone spread.

The theoretical maximum depth of penetration (34.5 m) is half of the maximum seismic array length (69 m), in practice the maximum depth of penetration is often influenced by the geology.

The MAM/passive survey used the same geophone array set up as for the MASW survey. Unlike the MASW survey, the MAM method is considered a "passive source" method in that there is no time break and the motions recorded are from ambient energy generated by cultural noise such as traffic, wind, wave motion, etc. Data collection for the passive method involves recording approximately 10 minutes of background "noise". The records generated by the MAM method contain lower frequency data, thus increasing the data resolution at greater depths of investigation. Typically the MAM results aid in clarifying the MASW results for depths greater than 20 m; however, the direction of noise propagation relative to the spread orientation can influence the results.

Interpretation Method and Accuracy of Results

The main processing sequence involved plotting, picking, and 1-D inversion of the MASW/MAM shot records using the SeisimagerSW™ software package. In theory, all MASW shot records should produce a similar shear-wave velocity profile. In practice, however, differences can arise due to energy dissipation and localized surface variations. The results of the inversion process are inherently non-unique and the final model must be judged to be geologically realistic. The inversion modelling also assumes that all layering is flat/horizontal and laterally uniform.

Seismic refraction processing was also realized for the main geological layers and rock depth evaluation, as well as for compressional wave velocity. These results were used to guide the initial geophysical model, prior to the mathematical

inversions, for optimized and more accurate V_S results.

The results of the MASW/MAM test are presented in chart format as Figure 4. The chart presents the 1-D shear wave velocity values from the inversion models of the passive and active seismic records.

The V_S30 values for the sounding are presented in Table 1. The V_S30 values are based on the harmonic mean of the shear wave velocities over the upper 30 m. The V_S30 value is calculated by dividing the total depth of interest (e.g. 30 m) by the sum of the time spent in each velocity layer up to that depth. This harmonic mean value reflects the equivalent single layer response.

The estimated error in the average V_S30 value determined through MASW tests is typically +/-10 to 15% for overburden sites. The shear-wave velocities modelled through the MASW method within bedrock have a higher estimated error.

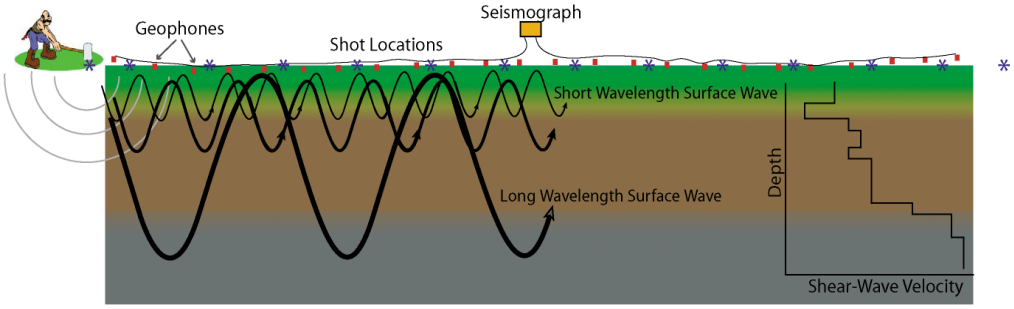
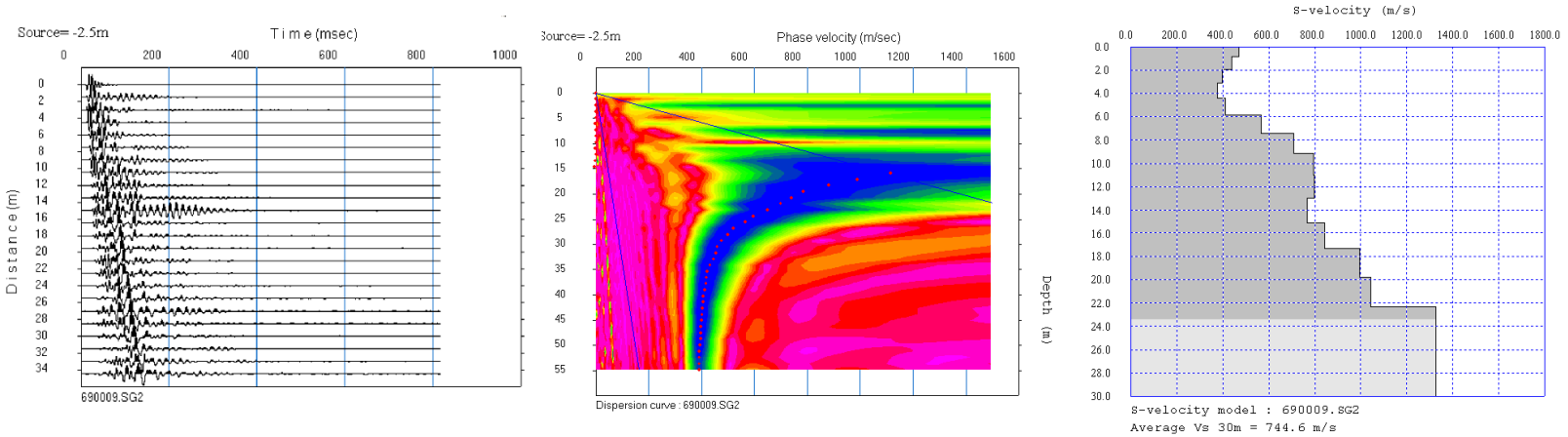


Figure 2: MASW operating principle



Raw Seismic Shot Record

Phase Velocity-Frequency Transformation indicating Dispersion Curve

1D Shear-Wave Velocity Profile from Inversion of Dispersion Curve

Figure 3: Example of a typical MASW shot record, phase velocity/frequency curve and resulting 1D shear-wave velocity model

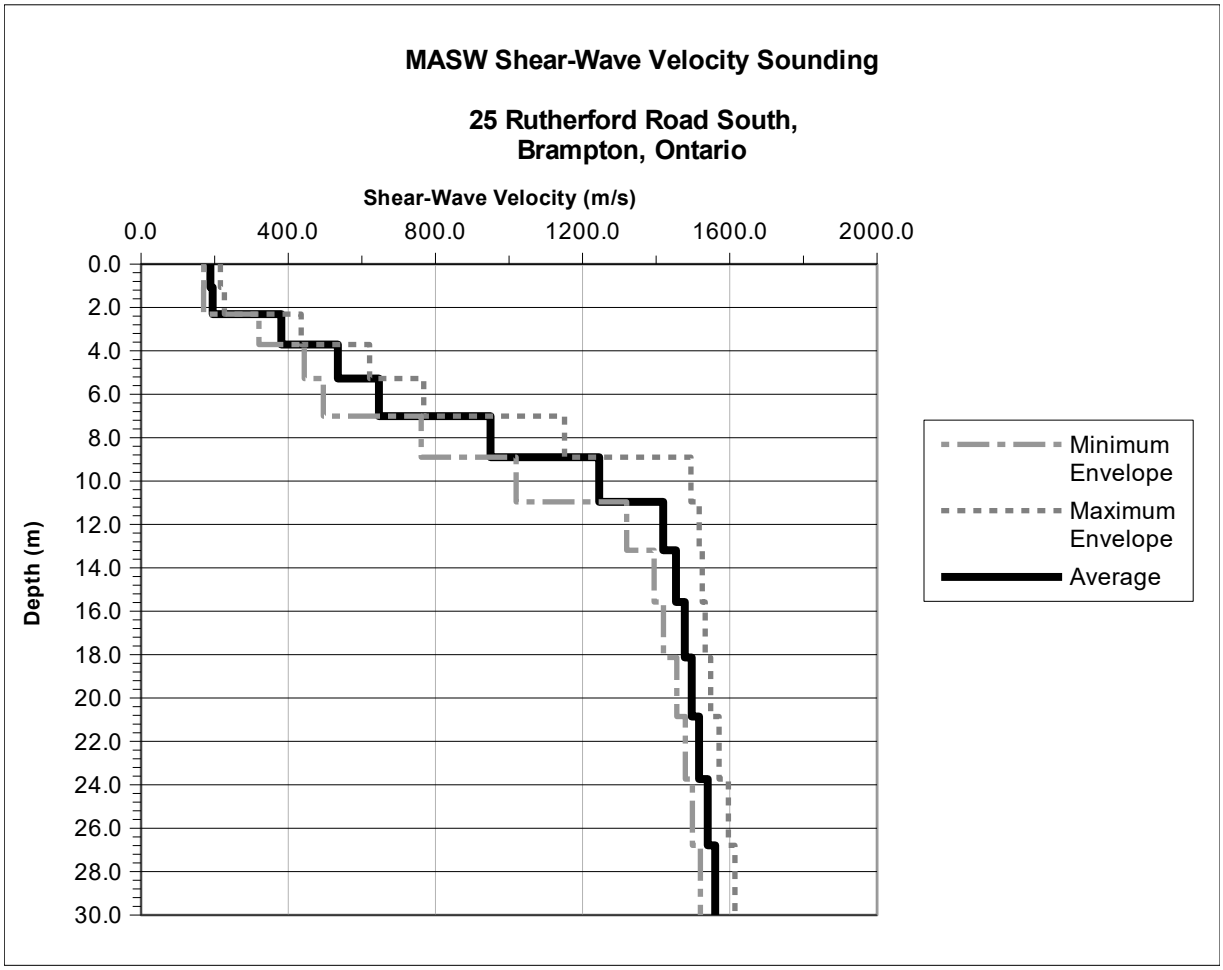


Figure 4: MASW shear-wave velocity model.

CONCLUSIONS

The approximate location of the shear-wave sounding is indicated in Figure 1.

The MASW shear-wave model is presented in Figure 4. The results are summarized in Table 1. The background seismic noise levels at this site were low. The quality of the seismic records was excellent and the resulting dispersion curves were well defined.

Simple critical distance calculations from the refracted wave arrivals show that the bedrock could be approximately 7.5 meters deep. The seismic refraction results showed a 3500 m/s bedrock compressional wave velocity (V_P), which is typical for very competent shale or moderately weathered to competent limestone. Considering a conservative Poisson ratio estimate of 0.4, the corresponding V_S value could be approximately 1500 m/s. These parameters were used to set the initial geophysical models prior to the mathematical inversions.

Table 1: Calculated V_S30 values (m/s) from the MASW data (0 to 30 m)

Sounding	Minimum	Average	Maximum	Site Class
1	704	**796**	892	**C***

* Given the estimated error in the MASW method (+/-10 to 15%).

The calculated average V_S30 value from the 1D MASW sounding was 796 m/s +/-10% to 15%. The V_S30 values calculated for the minimum and the maximum envelopes ranged from 704 to 892 m/s.

Based on the average V_S30 values (taking into account the estimated error in the MASW method of +/-10% to 15%) and table 4.1.8.4.A of the National Building Code of Canada, 2010 Edition, the investigated area is site class "C" ($360 < V_S30 \leq 760$ m/s).

It must be noted that the site classifications provided in this report are based solely on the V_S30 value as derived from the MASW method and that it can be superseded by other geotechnical information. This geotechnical information includes, but is not limited to, the presence of sensitive and/or liquefiable soils, more than 3 m of soft clays, high moisture content, etc. The reader is referred to section 4.1.8.4 of the National Building Code of Canada, 2010 Edition for more information on the requirements for site classification.

Processing of the seismic data was performed by Ilia Gusakov, P.Geo. This report has been written by Carolyn Boone, P.Geo.

I hope everything is to your satisfaction.

If you have any questions please do not hesitate to call.

Carolyn Boone, P.Geo.

Appendix F

Perimeter Drainage Details (1 pages)

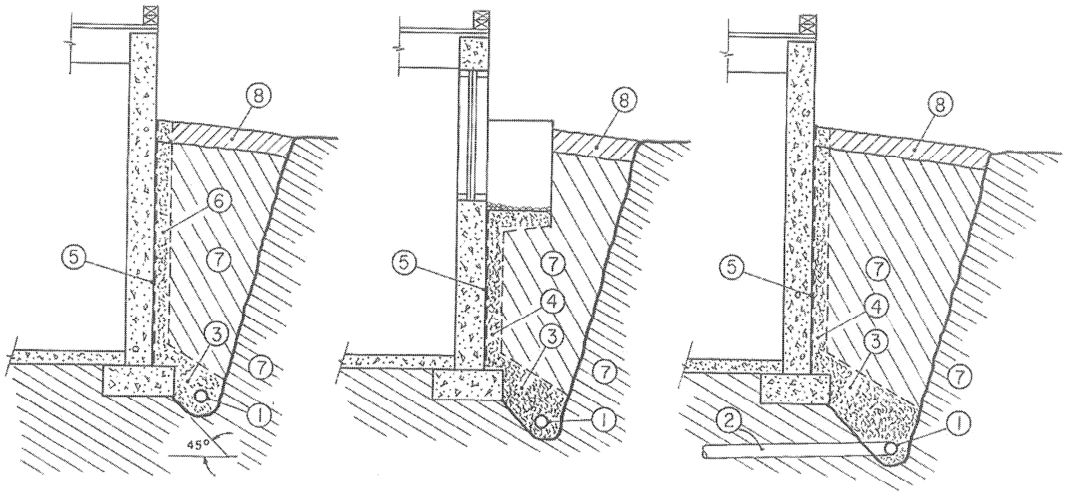


FIGURE 12.1 *Typical Sections Showing Arrangement of Subsurface Perimeter Drains around Shallow Foundations*

(1) perforated or slotted pipe placed about 300 mm below the upper level of the basement floor slab;
(2) unperforated drain pipe connected to appropriate trap and backwater valve before connecting to a sewer. The trap shall have provisions for inspection and cleaning;
(3) filter material that is compatible with the grain size characteristics of the fine-grained foundation and backfill soils, as well as with the perforations of the pipe;
(4) filter material continuously or intermittently placed next to the foundation wall to intercept water from window wells and from low areas near the building (see also 6);
(5) damp-proofing on wall - optional depending on the quality of the concrete wall;
(6) optional use of sheet drain, or synthetic filter blanket, next to the foundation wall to replace the soil filter according to (4);
(7) foundation and backfill soils, which may contain fine-grained and erodible materials; and
(8) "topping-off" material sloping outward to lead off the surface water. It is usually desirable to use low permeability soil to reduce the risk of overloading the pipe.

Refer to : Canadian Foundation Engineering Manual (2006), 4th Edition, Canadian Geotechnical Society, p. 184

SNC·LAVALIN

401 Hanlan Road
Vaughan, Ontario, Canada, L4L 3T1
905.851.0090 - 905.851.0091

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment and services necessary to supply, erect, and strip all formwork and falsework for poured-in-place concrete shown or indicated on the contract drawings and specifications.

.2 Install all anchor bolts, embedded metal, inserts, hangers, reglets, dovetail anchors etc. supplied by applicable trades for casting into concrete and assume responsibility for correct positioning within the agreed tolerance and in accordance to drawings supplied by the trade.

.3 Install all openings, sleeves, blockouts, etc. required by other trades and assume responsibility for correct positioning within the agreed tolerance and in accordance to drawings supplied by the trade.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 032000 - Concrete Reinforcement

.2 Section 033100 - Structural Cast-in-Place Concrete

1.4 REFERENCE STANDARDS

.1 Concrete formwork shall conform to the requirements of the following Standards unless otherwise required by this specification:

.1 Ontario Building Code - 2006.

.2 CSA-A23.1-04 - Concrete Materials and Methods of Concrete Construction.

.3 CSA-A23.3-04 - Code for the Design of Concrete Structures for Buildings.

.4 CSA-S269.3 – Concrete Formwork

.2 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.

.3 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.

1.5 DEFINITIONS - FOR THIS SECTION

.1 “Owner”, “Contractor”, “Consultant” as per the General Conditions and Definitions.

.2 “Specialty Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.3 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

2. Products

2.1 GENERAL

.1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.2 MATERIALS

.1 Form Material

.1 Exposed surfaces - metal, plywood or plywood lined. Plywood to conform to the Standard.

.2 Unexposed surfaces - metal, plywood, or wood lumber to conform to the Standard.

.3 Plywood and wood formwork materials shall, conform to the Standard, be free from warp and sawn straight so that lines and shapes will be accurately retained.

.4 Un-lined forms for unexposed surfaces shall be made with a good grade of lumber_or plywood and fitted so that there will be no leakage of mortar.

.5 Use metal forms, plywood lined forms or plywood forms of sufficient structural strength for exposed surfaces. Plywood for lining shall be GIS exterior grade fir plywood with waterproof glue.

.6 Proprietary and/or modular forming systems shall be designed such that they do not interfere with the specified placement of reinforcement or other embedded hardware and must be pre-approved by the Consultant.

.2 Ties And Spreaders

.1 Use metal form ties that are adjustable in length to permit tightening of forms. Use only the snap-off type of form ties which will permit no metal within 25mm (1”) of the concrete surface after removal. Twisted wire form ties will not be accepted.

.2 Wood spreaders inside wall forms will not be permitted.

.3 Form Release Agent

.1 Use a non-staining form release agent that is compatible with any finishes specified elsewhere in the contract documents.

.4 Void Form

.1 Void form shall be of a deteriorating material.

.5 At exposed concrete:

.1 Form release agents shall be non-staining.

.6 At exposed concrete slab and beam soffits

.1 Plywood shall be peri plastic coated forms, or approved equivalent.

.2 Provide a mock-up of exposed concrete slab. Location of the mock-up within the structure to be determined by the architect. Mock-up shall use the same materials and procedures as will be used for the actual exposed concrete slabs. Assume a minimum mock-up size of 9m x 9m.

3. Execution

3.1 GENERAL

.1 All phases of concrete formwork construction shall be in accordance with the Standard unless otherwise specified herein or on the drawings. Only workers who are skilled and experienced in their trade shall do the work.

3.2 LINES AND LEVELS

.1 Verify lines, levels and column centres before proceeding with work and ensure that dimensions agree with drawings.

.2 Co-ordinate and co-operate with all other trades in forming and setting of recesses, chases, sleeves, inserts, bolts, and hangers.

3.3 DESIGN OF FORMWORK, FALSEWORK AND RESHORING

.1 Conform to the Standard.

.2 The Contractor shall assume full responsibility for the structural adequacy of the forms to withstand all concrete, environmental, and construction loads.

.3 As a minimum, the work shall conform to CSA-A23.1, Section 6.5 for regular work and Section 8.3.4 for architectural concrete.

.4 Where concrete is exposed to view, forms are to be laid out so that joints are kept to a minimum and located in an orderly and symmetrical arrangement wherever possible. Form ties shall be evenly spaced and located in straight horizontal and vertical lines. Spacing and location of form tie holes shall be detailed by the Contractor and approved by the Consultant. See also the architectural drawings and specifications for any special requirements for architectural concrete.

.5 The strength and rigidity of forms shall be such that they will not leak mortar or result in visible irregularities in the finished concrete. In addition the deflection of facing materials between studs, as well as the deflection of studs and whalers, shall not exceed 0.0025 times the span.

.6 Forms shall be so constructed that the finished concrete will conform to the shape, dimensions and tolerances as specified in the Standard or on the structural drawing, whichever is most rigorous. They shall also incorporate the cambers specified on the structural drawings. Movement resulting from form support deflection, closure of form joints, and elastic shortening of forms and shoring, must be calculated and added to the cambers indicated on the drawings.

.7 Construct forms so that they may be dismantled and removed without damaging the concrete.

.8 The Contractor shall submit details of the sequence and extent of formwork removal and re-shoring to the Consultant for review. Such details shall include magnitude of loads and location of all reshores at each level. Forms shall not be removed or adjusted until the review is complete. Such review does not relieve the Contractor of responsibility for formwork and safety during construction.

.9 Set shores on wedges or use adjustable shores so they may be removed without causing undue strains in the concrete.

.10 Do not exceed the safe capacity of the structure with any construction or shoring loads. The safe capacity of the structure may be taken as the design live load, as indicated on the structural drawings, multiplied by the ratio of the concrete strength at the time of loading to the specified concrete strength, but not greater than 1.0.

3.4 ERECTION

.1 Sleeves and openings shown on the structural drawings must be confirmed with mechanical, electrical and architectural drawings. Any discrepancies are to be reported to the Consultant.

.2 Sleeves and openings not shown on the structural drawings must be approved by the Consultant.

.3 Keep all untreated forms moist to prevent shrinkage prior to placing of concrete and wet the surface at time of placing.

.4 Treated formwork surfaces shall have the approved form coating applied in accordance with the manufacturer's recommendations, prior to placing reinforcing steel. Remove any excess form coating.

3.5 TOLERANCES

.1 The tolerances for all concrete work shall conform to the requirements of the Standard and Drawings.

3.6 PRODUCT HANDLING

.1 Protect formwork materials before, during and after installation and protect installed work and materials of other trades.

.2 In the event of damage, immediately make required repairs or replacements necessary to the approval of the Consultant at no extra cost to the Owners.

3.7 REMOVAL OF FORMWORK

.1 Forms shall not be removed until concrete has attained sufficient strength that no damage to strength or continuity of concrete will occur when forms are removed. Time for formwork removal of suspended concrete shall be approved by the Consultant. See also the requirements of Section 3.3.

.2 Prying against face of concrete to remove forms is not allowed, only wooden wedges shall be used.

.3 Removal of form ties shall be done carefully to avoid marking concrete and to allow for patching. Grout bottom of form tie hole to prevent rust staining.

End of Section 031100

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment and services necessary to supply and install reinforcing steel work shown or indicated in all the contract drawings and specifications including accessories such as hanger bars, spirals, wire ties, support bars, chairs, spacers supports or other devices required to position reinforcing properly.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 030050 - Testing of Concrete and Reinforcement

.2 Section 031100 - Concrete Formwork

.3 Section 033100 - Structural Cast-in-Place Concrete

.4 Section 051200 - Structural Steel Framing

1.4 REFERENCE STANDARDS

.1 Concrete reinforcing shall conform to the requirements of the following Standards unless otherwise required by this specification:

.1 Ontario Building Code - 2006.

.2 CSA-A23.1-04 - Concrete Materials and Methods of Concrete Construction.

.3 CSA-A23.2-04 - Methods of Test and Standard Practices for Concrete.

.4 CSA-A23.3-04 - Code for the Design of Concrete Structures for Buildings.

.5 CSA G30.5M - Welded Steel Wire Fabric for Concrete Reinforcement.

.6 CSA G30.15M - Welded Deformed Steel Wire for concrete reinforcement.

.7 CAN/CSA G30.18 - Billet Steel Bars for Concrete Reinforcement

.8 CSA-W47.1 - Certification Of Companies For Fusion Welding Of Steel Structures

.9 CSA-W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.2 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.

.3 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor", "Consultant" as per the General Conditions and Definitions.

.2 "Specialty Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.3 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 TESTING

.1 As per Section 030050 - Testing of Concrete and Reinforcement.

2. Products

2.1 GENERAL

.1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.2 MATERIALS

.1 Reinforcing bars shall conform to the Standard unless otherwise specified herein or on the drawings.

.2 Reinforcing bars to be welded shall conform to the Standard, G30.18W.

.3 Welded wire fabric shall conform to the Standard, size and gauges as shown on the drawings.

.4 Welded wire fabric for slabs shall be delivered in flat sheets.

.5 In suspended parking slabs, bar support chairs shall be plastic or plastic coated.

3. Execution

3.1 GENERAL

.1 All phases of concrete reinforcement work shall be in accordance with the Standards unless otherwise specified herein or on the drawings. The Contractor shall ensure that the work is executed only by workers skilled and experienced in their trade.

.2 The Contractor shall notify the Consultant at least 24 hours before any concrete is placed in order that the Consultant may review the work.

3.2 SHOP DRAWINGS

.1 Submit shop drawings for concrete reinforcement, bar support and accessories for review by the Consultant at least 14 days prior to the placement of rebar.

.2 Clearly indicate bar sizes, grades, spacing, location and quantities of reinforcing mesh, bar supports and accessories and identifying code marks to permit correct placement without reference to structural drawings.

.3 Placing drawings and bar lists will be reviewed for number and size of bars only and this review shall in no way relieve the Contractor of his responsibility for carrying for carrying out the Work in accordance with the drawings.

.4 Substitution of imperial reinforcing sizes and grades will only be accepted if placing drawings showing imperial sizes are submitted to the Consultant for review. Approval must be obtained before any work is commenced.

3.3 FABRICATION

.1 Fabricate all reinforcing to the Standard and contract documents.

.2 Reinforcing bars shall be cold bent. Bars shall not be straightened or re-bent.

.3 Splices in reinforcing bars at locations not shown on the drawings must be submitted for review by the Consultant. Such splices shall conform to the Standards.

.4 Color code each bar to correspond with code mark appearing on bar list.

3.4 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Store reinforcement in a manner to prevent excessive rusting and fouling with dirt, grease, form-oil and other bond-breaking coatings

.2 Reinforcement at the time concrete is placed shall be free from excessive rusting, mud, oil or other coatings that adversely affect its bonding capacity

3.5 PLACING

.1 Reinforcing of size and shapes shown on the structural drawings shall be accurately placed in accordance with the drawings and the requirements of the Standard.

.2 Reinforcement shall be adequately supported by chairs, spacers, support bars, hangers or other accessories, and secured against displacement within the tolerances permitted in the Standard. Support devices contacting surfaces exposed to the exterior shall be non-corroding.

.3 Bars that are not part of the structural design or drawings, and whose only function is supporting other reinforcing in lieu of other support accessories, shall be considered as accessories.

.4 In suspended parking slabs, uncoated metal ties shall not extend more than 5.0 mm (3/16") into the concrete cover.

.5 All rebar shall be adequately tied and chaired to maintain it in the specified location during pouring. Lifting of reinforcing or welded wire mesh into specified position during the concrete pour will not be allowed.

.6 Tolerances for bar placement shall be as per the Standard. Tolerances shall not be used to justify the use of chair, bolsters, or chair/support combinations which result in improper cover.

.7 At exposed concrete:

1. Rebar chairs shall be plastic coated to prevent rust stains.

2. Provide a mock-up of exposed concrete slab. Location of the mock-up within the structure to be determined by the architect. Mock-up shall use the same materials and procedures as will be used for the actual exposed concrete slabs. Assume a minimum mock-up size of 9m x 9m.

3.6 WELDING

.1 Any welding of reinforcing steel shall be in accordance with the Standard.

.2 Welding of concrete reinforcement shall be performed by workmen who are approved by the Canadian Welding Bureau in accordance with the Standard. Copies of the Canadian Welding Bureau approved welding procedure and certificate of current operator qualification shall be submitted to the Consultant prior to commencement of welding.

3.7 CONSTRUCTION REVIEW

.1 No concrete shall be placed until the Consultant has completed a review of reinforcing in place. The Contractor shall provide a minimum of 24 hours notice of the time when the reinforcement will be substantially in place and ready for the Consultants review. A minimum of 6 hours is to be provided for review and any required remedial work prior to concrete placement.

End of Section 032000

1 General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment and services necessary to supply and install cast-in-place concrete work shown or indicated in all the contract drawings and specifications including concrete toppings, bases, sumps, curbs, posts, manholes, pits, paving, sidewalks, equipment bases or curbs, grouting of baseplates, etc.

.2 Coordinate concrete placement fully with other trades. Ensure other related work such as inserts, dowels, sleeves, reinforcement, etc. is complete before placing concrete.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 030050 - Testing of Concrete and Reinforcement

.2 Section 031100 - Concrete Forming

.3 Section 032000 - Concrete Reinforcement

.4 Section 051200 - Structural Steel Framing

.5 Section 053100 - Steel Decking

1.4 REFERENCE STANDARDS

.1 Concrete work shall conform to the requirements of the following Standards unless otherwise required by this specification:

.1 Ontario Building Code – 2005.

.2 CSA-A23.1-04 - Concrete Materials and Methods of Concrete Construction.

.3 CSA-A23.2-04 - Methods of Test for Concrete.

.4 CSA-A23.3-04 - Code for the Design of Concrete Structures for Buildings.

.2 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.

.3 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.

1.5 DEFINITIONS FOR THIS SECTION

.1 “Owner”, “Contractor”, “Consultant” as per the General Conditions and Definitions.

.2 “Specialty Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.3 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 SUBMITTALS

.1 Keep a record at the job site showing time and place of each pour of concrete, together with a transit-mix delivery slip certifying contents of pour. Make the record available to the Owner for his inspection upon request. Upon completion of this portion of work, submit placing records and delivery slips to the Owner.

.2 Submit details of proposed methods of concrete curing and provisions for weather protection to the Consultant for review

.3 Submit plan locations and details of construction joints for the Consultants review

2 Products

2.1 GENERAL

.1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

.2 Provide samples of materials on request

2.2 MATERIALS

.1 Cement for S-1, S-2, and S-3 concrete shall be as per Table 3 A23.1 and conform to the Standard.

.2 Mixing water shall conform to the Standard.

.3 Air entraining admixtures to the Standard.

.4 Calcium chloride, either as a raw material or as a constituent in other admixtures, shall not be used unless approved in writing by the Consultant.

.5 Curing compounds shall conform to the specification and shall also be compatible with specified floor hardeners, covering adhesives and waterproofing compounds.

.6 Grout shall be preapproved, premixed, non-shrink conforming to the Standard. Exposed grout shall be non-staining cement grey in colour.

3 Execution

3.1 GENERAL

.1 All phases of concrete work shall be in accordance with the Standard unless otherwise specified herein or on the drawings. The work shall be executed only by experienced and skilled workers.

.2 The Contractor shall notify the Consultant at least 30 hours before any concrete is placed to allow the Consultant to review the work.

3.2 MIX DESIGNS

.1 Concrete mixes shall be proportioned by the supplier to meet the compressive strength, exposure class, and other performance specifications noted in the contract documents. In addition, concrete mix design shall satisfy the transport, placing, and finishing requirements of the Contractor. All concrete shall be normal weight unless noted otherwise. Concrete types are specified in accordance with CSA-A23.1 Table 5, Alternate 1.

.2 Concrete mix design is the responsibility of the supplier, including the use of admixtures, alone or in combination. The supplier is also responsible for ensuring the plastic and hardened properties of the concrete meet the construction and specified requirements. This includes the long term performance of the hardened mix.

.3 Pump mix slumps shall also conform to the above.

.4 Water/Cement ratios and air contents for exposure class shall be as per the Standard.

.5 The proposed mixes shall be submitted to the Consultant and Testing Agency for review.

.6 The mix designs shall note the constituents by weight, the properties required by the structural drawings, and the structural elements for which the mix is to be used.

.7 At exposed concrete:

1. Concrete shall not include fly ash.
2. Concrete shall include blast furnace slag and/or white Portland cement.
3. Provide a mock-up of exposed concrete slab. Location of the mock-up within the structure to be determined by the architect. Mock-up shall use the same materials and procedures as will be used for the actual exposed concrete slabs. Assume a minimum mock-up size of 9m x 9m.

3.3 PRODUCTION

.1 Production shall conform to the Standard.

3.4 TESTING

.1 As per Section 030050 - Testing of Concrete and Reinforcement

3.5 PLACING OF CONCRETE

.1 Conveying and placing of concrete is to conform to the Standard.

.2 All concrete shall be consolidated by means of vibrators of appropriate size operated by experienced workers.

.3 The use of vibrators to transport concrete shall not be permitted.

.4 Cement slurry used to prime concrete pumps shall be discarded and not placed in the project.

3.6 OPENINGS AND INSERTS

.1 The Contractor shall notify all trades sufficiently in advance to ensure that provision is made for openings, inserts and fasteners. The Contractor shall cooperate with all trades in the forming and setting of all slots, sleeves, bolts, dowels, hangers, inserts, conduits, clips, etc. Any embedded hardware may be subject to review by the Consultant.

.2 Openings and sleeves shown on the structural drawings must be confirmed with mechanical, electrical and architectural drawings.

.3 Openings and sleeves not shown on the structural drawings must be approved by the Consultant.

3.7 CONSTRUCTION AND CONTROL JOINTS

.1 Construction joints shall conform to the Standard except that for horizontal joints in walls it will be sufficient to place fresh concrete on a clean rough surface unless directed otherwise by the Consultant or otherwise noted on the structural drawings.

.2 Joints in slabs on grade shall be located as indicated on the structural and/or architectural drawings. Unless noted otherwise on the drawings a joint in the slab on grade may be a pour joint, trowelled joint, saw cut, or other pre-approved method. The depth of joints shall be a minimum of ¼ of the thickness of the slab. Saw cut joints are to be completed within 12 hr. of placing. Alternative joint details are to be submitted in writing to the Consultant.

.3 For vertical joints in walls below grade, see standard detail on structural drawings. For locations, see architectural and structural drawings.

.4 Construction joints in walls and columns shall occur at the top of slab and at the underside of slab/beam systems unless noted otherwise on the structural drawings.

.5 Construction joints not shown in the drawings or specifications shall be subject to the approval of the Consultant. The Consultant may require keys, or extra reinforcing to be provided at the Consultant's discretion with associated costs borne by the Contractor.

.6 The existing concrete surface at construction joints shall be wetted thoroughly immediately prior to placement of concrete.

.7 Construction joints exposed to view may be subject to non-structural review by Consultant.

.8 Unless noted otherwise on the drawings, control joints in walls are to be located at a maximum spacing of 9m (30') on centre and detailed as indicated on the structural drawings.

.9 Supply and install pre-molded water-stops in construction joints where indicated on the drawings. Weld joints to make watertight. Install waterstops in accordance with manufacturer's specifications and recommendations. Water stop procedures require approval of Consultant.

3.8 CURING AND PROTECTION

.1 Curing procedures shall be in accordance with the Standard. Alternate methods with Consultants approval, may be used providing they produce concrete that meets the contract documents.

.2 Cold and hot weather protection shall comply with the Standard or the requirements on the structural drawings, whichever are more rigorous.

.3 Concrete place during extreme drying conditions shall satisfy clause 7.4.2.2 of A23.1.

.4 Suspended parking slabs shall be wet cured for seven (7) days minimum, as per S413. Curing compounds are not allowed.

3.9 PATCHING

.1 Honeycomb, exposed reinforcement and other defects shall be repaired and patched by the Contractor at the Contractor's cost using a procedure preapproved by the Consultant. Exposed patching must also be approved by the Consultant.

.2 Immediately after the removal of forms, all bolts, ties, nails or other metal not specifically required for construction purposes shall be removed or cut back to a depth of 25 mm (1") from the surface of the concrete.

3.10 TOLERANCES

.1 Tolerances shall conform to the Standard or the requirements on the structural or architectural contract documents, whichever are more rigorous.

3.11 FINISHING - FLOORS

.1 Finishing shall conform to CSA-A23.1 - Section 7.5 as a minimum. Care shall be taken during finishing to maintain the cambers specified on the structural drawings. See also the architectural drawings and specifications for additional finish requirements.

.2 Unless noted otherwise, floor finishes shall be Class A "institutional and commercial floors" and have gaps less than or equal to 8.0 mm (5/16") under a 3000 mm (10'-0") straight edge. Only a single curvature within this distance is allowed.

3.12 FINISHES - FORMED SURFACES

.1 All formed surfaces shall be treated in accordance with CSA A23.1, Section 7.7 as a minimum. See also architectural drawings and specifications for additional finish requirements.

3.13 ARCHITECTURAL CONCRETE

.1 See architectural drawings and specifications for any requirements. Conform to CSA-A23.1 - Section 8.3 as a minimum.

3.14 OPENINGS THROUGH STRUCTURAL WORK

.1 If, after any part of the structural work has been completed, it is required that additional openings be made through the structure, the Consultant shall be so informed. No opening, including cored sleeves, shall be made through completed work without authorization in writing from the Consultant.

3.15 REJECTION OF DEFECTIVE WORK

.1 In the event that concrete tests do not conform to the requirements of this specification, or when conditions are such to cause doubt about the safety of the structure, testing of the structure will be undertaken at the direction of the Consultant. This may entail further concrete tests, coring or load testing as per the Standard, or any other test the Consultant deems suitable. Such test shall be made at the expense of the Contractor and to the satisfaction of the Consultant.

.2 Where, in the opinion of the Consultant, material or workmanship fails to meet the requirements of the specification, such work may be rejected. Work rejected shall be replaced or repaired to the approval of the Consultant and at no additional cost to the Owner.

End of Section 033100

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for masonry work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A1064/A1064-M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

.2 ASTM C207, Specification for Hydrated Lime for Masonry Purposes.

.3 CAN/CSA A82, Fired Masonry Brick Made From Clay or Shale.

.4 CSA A165 Series, CSA Standards on Concrete Masonry Units.

.5 CSA A179, Mortar and Grout for Unit Masonry.

.6 CSA A370, Connectors for Masonry.

.7 CSA A371, Masonry Construction for Buildings.

.8 CAN/CSA A3001, Cementitious Materials for Use in Concrete.

.9 CSA G30.18, Carbon Steel Bars for Concrete Reinforcement.

.10 CSA S304, Design of Masonry Structures.

1.3 **DESIGN REQUIREMENTS**

.1 Design unit masonry in accordance with following Climatic Design Data for Brampton contained in the Ontario Building Code:
  .1 Design temperature: January 1%, July 2 1/2%.
  .2 Hourly wind pressures: 1 in 50 year occurrence.

1.4 **SUBMITTALS**

.1 Shop drawings:
  .1 Submit shop drawings in accordance with Section 01 30 00 indicating.
  .2 Wall sections and details, reinforcing and anchors, special detailing, patterning and locations of control joints.
  .3 Seismic anchors, supports and accessories for complete installation.

.2 Samples:
  .1 Submit samples in accordance with Section 01 30 00:
  .2 Submit samples of each type and colour of masonry unit used prior to placing order.
  .3 Submit samples of coloured mortar to match masonry samples.

.4 Submit samples of masonry anchors, and ties.
.5 Submit 250 x 200 mm samples of dampproof course and flashing.

.3 Quality control submittals: Submit manufacturer's certificates stating that materials supplied are in accordance with this Specification.

1.5 QUALITY ASSURANCE

.1 Provide plain and reinforced masonry in accordance with CSA A370, CSA A371, and CSA S304.

.2 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for unit masonry work:
.1 Design of unit masonry work.
.2 Design of brick ties and anchors, including requirements necessary to meet seismic requirements.
.3 Review, stamp and sign shop drawings.
.4 Conduct shop and field inspections and prepare and submit inspection reports.

.3 Cold Weather Protection:
.1 To CAN/CSA-A371 and as follows:
.1 Maintain temperature of mortar between 5°C and 50°C until batch is used or becomes stable.
.2 Maintain ambient temperature of masonry work and it's constituent materials between 5°C and 50°C and protect site from windchill.
.3 Maintain temperature of masonry above 0°C for minimum of 3 days, after mortar is installed.
.4 Preheat unheated wall sections in enclosure for minimum 72 hours above 10°C, before applying mortar.
.5 Do not use scorched aggregate. Do not use salts or anti-freezes. Only use approved smokeless heaters.

.4 Hot Weather Requirements:
.1 To CAN/CSA-A371 and as follows:
.1 Plan in advance for hot weather construction. Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
.2 Avoid using dry masonry in hot weather conditions. Use predampened masonry unit nominally saturated, but surface dry at time of laying. Do not dip masonry unit in bucket of water.
.3 Spread only enough mortar to permit soft setting of masonry units; do not over mix mortar materials; do not retemper mortar after 2 hours of use; do not retemper pigment coloured mortar; do not spread more than 900 mm (3') of mortar for placement of masonry unit.

.5 Mock-up:
.1 Construct one mock-up panel of unit masonry construction, 1200 mm wide x 1200 mm high in a location accepted by Consultant.

.2 Demonstrate use of reinforcement, ties, through-wall flashing, weep holes, jointing, coursing, and sills, mortar, bonding, control joints, and workmanship.

.3 Mock-up may form part of Work if accepted by Consultant. Mock-ups which do not form part of Work are to be removed from Site during final cleanup, or when directed by Consultant.

.4 Rejected mock-ups: Correct rejected mock-ups and requested re-review by Consultant.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver, store and handle Products in accordance with the Conditions of the Contract and as specified herein.

.2 Remove unacceptable materials from Site and replace to acceptance of Consultant. Store materials off ground protected from wetting by rain, snow or ground water, or inter-mixture with earth or other materials. Store metal ties and reinforcement to prevent corrosion.

.3 Do not concentrate storage of materials on any part of structure beyond design load, take particular care not to overload unsupported portions of structure which may have not attained their full design strength.

.4 Comply with CSA A371. Do not use salt or calcium-chloride to remove ice from masonry surfaces.

.5 Deliver mortar materials in original unbroken and undamaged packages with the maker's name and brand distinctly marked thereon. Prevent damage to units.

.6 Keep masonry materials free from ice and frost. Keep units protected from concrete, mortar and other materials which could cause staining.

2 Products

2.1 **MASONRY UNITS**

.1 Brick cladding: CAN/CSA A82,Type X, Grade EG, metric jumbo, size to be selected by Consultant. ‘Cream Bricks’ by Belden Brick or approved alternative. Colour to be Acadia Velour.

.2 Concrete block units: Lightweight units for use at all fire rated applications and block exposed to view, CSA A165 Series, 200 mm thick unless otherwise indicated on Contract Drawing, classifications as follows:

.1 H/15/D/M.

.2 SS/15/D/M.

.3 SF/15/D/M.

.3 Concrete block units: Normalweight units for all non-fire rated applications and where concealed, CSA A165 Series, 250 mm thick unless otherwise indicated on Contract Drawing, classifications as follows:
- .1 H/15/A/M.
- .2 SS/15/A/M.
- .3 SF/15/A/M.

.4 Precast concrete sills and shapes: Reinforced and constructed of 27.5 MPa concrete with slopes in direction indicated. Provide drips. Dowel and hook anchors to be stainless steel. Finish: Smooth unless otherwise indicated.

.5 Special shapes:
- .1 Unless indicated otherwise, supply and install corner returns, bull-nosed or double bull-nosed units for exposed and external corners, bond beams, sash blocks for control joints, concrete block lintels over openings in concrete block walls and any additional special shapes as indicated.
- .2 Provide solid masonry units where required for mechanically fastening of blocking, furring, mechanically applied finishes or where noted.

.6 Obtain each masonry unit type from same manufacturer. Supply and install units of uniform texture and colour for each kind required.

.7 Supply masonry units with exposed surfaces free of cracks, chips, blemishes, and broken corners.

2.2 ACCESSORIES

.1 Reinforcement: CSA A370, CSA A371, and ASTM A1064/A1064-M, all components to be hot dip galvanized unless otherwise specified:
- .1 This specification is based on products manufactured by Blok-Lok Limited. Products by Dur-O-Wal Ltd. and Fero Corporation are approved alternatives.
- .2 Type 1 (single wythe): Truss type; ‘Blok-Trus BL30'.
- .3 Type 2 (double wythe): Truss type; ‘Blok-Trus BL32'.
- .4 Type 3 (cavity wall block back-up): Adjustable, bayonet-tie type, 1.6 mm steel plate with 4.76 mm diameter steel wire tie. ‘Adjustable Veneer Anchors BL507'.
- .5 Type 4 (cavity wall stud back-up): Anchors fabricated from 1.5 mm plate with 4.76 mm wire, complete with screws; ‘Adjustable Veneer Anchors BL607' with ‘Flex-O-Lok tie’.
- .6 Connectors: CSA A370 and CSA S304.1.
- .7 Reinforcing steel: CSA G30.18, Grade 400, refer to Contract Drawings for number, size, and location.
- .8 Corner reinforcing: Provide pre-manufactured ‘L’ and ‘T’ reinforcing at all corner units. Crimped metal strap ties are not acceptable for connecting intersecting walls.
- .9 Design of anchors, supports and accessories to meet seismic requirements.

.2 Cavity wall insulation: In accordance with Section 07 21 00 .

.3 Loose steel lintels and lateral support angles: Supplied as part of work of Section 05 50 00.

.4 Precast concrete shapes: Fabricate to shapes and sizes shown on drawings, 35 MPa concrete in accordance with CSA A23.4, galvanized steel reinforced. Dowel and hook anchors to be stainless steel.

.5 Dampproof course:
- .1 Metal flashing: Prefinished metal angle flashing in accordance with Section 07 62 00, continuous strips with a 19 mm folded drip edge.
- .2 Rubberized underlay: Adhered reinforced SBS rubberized asphalt damproof flashing over prefinished metal flashing and cut off flush with wall face as detailed on drawings; 'Blueskin TWF' by Henry or 'Airshield Thru Wall Flashing' by W.R. Meadows or approved alternative, complete with primer and adhesive recommended by flashing manufacturer.

.6 Control joint bond breaker: CSA A123.3; 15 lb, asphalt impregnated, non-perforated felt paper as manufactured by IKO Manufacturing Inc. or approved alternative.

.7 Mortar mesh: 250 mm high x thickness to suit cavity, 90% open HDPE mesh; 'Mortar Trap' by Blok-Lok Limited or 'Mortar Net' by Hohmann & Barnard, Inc.

.8 Weep hole vents:
- .1 Flexible ultra-violet resistant polypropylene-copolymer plastic, 'Cell-Vent' by Blok-Lok, 'Mortar Maze Cell Vents' by Advanced Building Products Inc. or approved alternative.
- .2 Provide manufacturer recommended clear silicone adhesive for suspended applications.
- .3 Colour: To be selected by the Consultant.

2.3 MORTAR MATERIALS

.1 Loadbearing masonry: CSA A179, Type S, proportion method.

.2 Interior non-loadbearing masonry: CSA A179, Type N, proportion method.

.3 Exterior non-loadbearing masonry: CSA A179, Premixed 1-1-6 Type N, portland cement/lime, proportion method.

.4 Cement: CAN/CSA A3001, normal Portland, Type GU. Provide white cement where required for white or light coloured mortars.

.5 Masonry aggregate: CSA A179. Provide white aggregate where required for white or light coloured mortars.

.6 Hydrated lime: ASTM C207, Type S.

.7 Water: Clean potable, free from deleterious elements and free from salts that can cause efflorescence.

.8 Concrete fill and grout: Minimum 12.5 Mpa concrete in accordance with CSA A179.

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 of this Section means acceptance of existing conditions.

3.2 **PROTECTION**

.1 Supply and install temporary waterproof, non-staining coverings, secured against displacement, to extend over walls and down sides to protect masonry Work from snow and wind driven rain, and from drying too quickly, until masonry work is completed and protected by flashings or other permanent construction.

.2 Supply and install non-staining, protective coverings on horizontal and vertical surfaces to protect work of this Section from damage, staining, marking, and mortar droppings.

3.3 **WORKMANSHIP**

.1 Perform masonry work in accordance with CSA A371 and as indicated .

.2 Supply and install masonry work plumb, level and true to line, with vertical joints in alignment and horizontal courses level, uniform, and straight.

3.4 **MASONRY - GENERAL INSTALLATION**

.1 Construct masonry work as required by jurisdictional authorities.

.2 Before commencing masonry work, verify required limitations for wall heights, wall thicknesses, openings, bond, anchorage, lateral support, and compressive strengths of masonry units and mortars.

.3 Construct masonry fire protection and fire separations of the thickness indicated on Drawings for the fire resistant ratings as noted on Drawings, and conforming to the Fire-Performance Ratings, Appendix ‘D’ to the National Building Code of Canada.

.4 Fire Separations and Fire Separations with Fire Resistance Ratings: Construct walls tightly to construction above and at perimeter, and without openings or voids. Do not reduce the thickness of walls to less than the thickness indicated on the Drawings or for the required fire resistance rating where required.

.5 Do not butter corner units, throw mortar droppings into joints, or excessively furrow bed joints. Do not shift or tap units after mortar has taken initial set. If adjustment is necessary after mortar has started to set, remove and replace with fresh mortar.

.6 Do not use admixtures without Consultant's written acceptance.

.7 Tool mortar joints slightly concave with non-staining tools unless indicated otherwise. Strike joints flush in non exposed areas or where shown on Contract Drawings. Use sufficient force to press mortar tight against masonry units on both sides of joints. Remove excess, remaining mortar material and burrs.

.8 Install masonry walls 25 mm clear of underside of steel building frames, roof or floor deck. Install masonry with a 19 mm space beneath shelf angles and install compressible filler.

.9 Cut masonry units with a wet saw to obtain straight, clean, even, unchipped edges. Cut units as required to fit adjoining work neatly or for flush mounted electrical outlets, grilles, pipes, conduit, leaving 3 mm maximum clearance. Use full-size units without cutting wherever possible.

.10 Reinforce veneer walls with adjustable wall reinforcing at maximum 400 mm o.c. vertically and 600 mm o.c. horizontally. Install reinforcing in accordance with manufacturer’s instructions. In veneer walls extend reinforcement from support wall, spanning cavity into exterior wythe. Place at maximum 75 mm o.c. each way around perimeter of openings, within 300 mm of openings.

.11 Reinforce block walls with continuous wire reinforcement in every second block course. Supply and install prefabricated L and T sections. Cut, bend and lap reinforcing units as per manufacturer's printed directions for continuity at returns, offsets, pipe enclosures, and other special conditions. Bending of masonry reinforcement is not permitted.

.12 Reinforce masonry walls with reinforcing steel as indicated on Drawings. Vertical reinforcing shall be fully grouted in masonry cores with grout.

.13 At openings in block walls install extra reinforcement, so that first and second courses above and below openings are reinforced. Extend extra reinforcement 600 mm beyond opening in each direction.

.14 Reinforce joint corners and intersections with strap anchors 400 mm o.c.

.15 Do not place reinforcement across masonry wythes at control joints.

.16 Install masonry with 10 mm thick joints unless indicated otherwise. Make vertical and horizontal joints equal and of uniform thickness.

.17 Build control joints in masonry walls at intervals and in locations shown. Form joints for block walls using sash block units in accordance with details shown. Form joints for veneer walls by leaving head joints between stacked units void of mortar. Provide chase and joint with joint bond breaker full height of control joints and fill with mortar. Leave a depth of 13 mm for sealing unless otherwise shown.

.18 Install control joints in masonry walls where indicated on drawings and at projections and changes in direction. Where control joints have not been indicated provide joints at 6100 mm o.c. for exterior walls and 9150 mm o.c. for interior walls.

.19 If required, provide movement joints, similar to building control joints, installed between areas with different support conditions.

.20 Supply and install solid block or metal lath under block, and fill block cells solid for lintel bearing and as required to secure built-in anchor bolts and/or anchors shown.

.21 Do not tooth intersections of walls except as otherwise indicated.

.22 Install weep hole vents in accordance with manufacturer's directions, in exterior wythe of masonry above dampproof courses and flashings and at tops of walls using adhesive. Space weep hole vents maximum 600 mm o.c. horizontally. Prevent weep hole vents from becoming plugged with mortar or debris.

.23 Coordinate installation of masonry with installation of air barrier and vapour retarder to ensure continuity of these systems.

.24 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.

3.5 DAMPPROOF COURSES AND FLASHING

.1 Install dampproof courses beneath first masonry bearing course on slabs-on-grade. Trim dampproofing to conceal it.

.2 Install flashings in masonry in accordance with CSA A371.

.3 Install flashings under exterior masonry bearing on foundation walls, slabs, shelf angles, and steel angles over openings and elsewhere as indicated. Where flashings occur over openings in walls extend them past openings a minimum of 200 mm and turn up minimum 150 mm at each end to create a waterproof dam to prevent water draining into cavity.

.4 In veneer walls install flashings continuously from front edge of masonry, under outer wythe, turn up backing minimum 200 mm and provide watertight seal against support wall.

.5 Lap dampproofing and flashing 150 mm and seal in accordance with manufacturer's instructions.

.6 At bottom of cavity install mortar mesh to manufacturer's instructions. Apply additional mortar mesh layer as required to fill cavity thickness. Place mesh in continuous layer.

.7 Before masonry work begins, place specified dampproofing under first course of masonry. Install continuous dampproofing with ends lapped and cut flush with exterior face of wall. Place similar dampproofing over top course.

3.6 **MORTAR MIXING**

.1 Thoroughly mix mortar ingredients in proper quantities needed for immediate use to requirements of CSA A179.

.2 Measure and batch mortar materials either by volume or weight, to accurately control and maintain proportions. Do not measure materials by shovel.

.3 Mix mortar with maximum amount of water consistent with workability for maximum tensile bond strength within capacity of mortar.

.4 Do not use mortar which has begun to set. Use mortar within 2 hours after initial mixing. Re-temper mortar during 2 hour period only as required to restore workability.

3.7 **BLOCK**

.1 Lay blocks in running bond except as indicated otherwise. Align block webs vertically and install thicker ends of face shells up.

.2 Install a full bed of mortar for first courses of masonry, for masonry units 100 mm thick and less, and between solid units. For remaining courses bed face shells, including vertical end joints, fully in mortar.

.3 Install special shaped and sized concrete block units as indicated and as required for a complete and coordinated assembly and to minimize cut units.

.4 Supply and install two courses of solid block beneath lintel bearing.

.5 Stagger end joints in every course. Align joints plumb over each other in every other course.

.6 Bond intersecting block walls in alternate courses. Where block work abuts concrete, anchor each block course to concrete.

3.8 **MASONRY VENEER**

.1 Prior to installation of masonry veneer, coordinate installation of air and vapour retarder with Section 07 26 00.

.2 Prior to installation of cavity insulation, examine air and vapour retarder and make good damage. Install cavity wall insulation in accordance with Section 07 21 00 .

.3 Lay masonry veneer in running bond, unless indicated otherwise, and in a full bed of mortar.

.4 Form angle corners with special shaped units; cutting of units is not permitted.

.5 Erect exterior cavity wall construction as shown on Contract Drawings.

.6 Install masonry veneer to prevent mortar droppings and protrusions from impeding drainage and pressure equalization of rainscreen cavities and drained walls.

.7 Apply sufficient mortar on end of stretchers to ensure end joints are compressed full when masonry unit is pressed into place.

3.9 PRECAST SHAPES

.1 Install dampproofing or flashings continuous under full length of precast shapes.

.2 Install precast shapes in full mortar bed and secure units to each other with stainless steel dowels and to masonry units with stainless steel hook anchors, fully grouted.

3.10 LINTELS

.1 Install concrete block lintels over openings in masonry except where steel lintels are indicated.

.2 Set lintels with minimum of 200 mm uniformly distributed bearing at each end. Provide bond breaker under bearing ends.

.3 Install reinforcing steel and concrete fill in block lintels.

.4 Install loose steel lintels, as indicated in Contract Drawings. Centre over opening width.

3.11 LATERAL SUPPORT ANGLES

.1 Where non load bearing unit masonry partitions meet structural elements at top of partitions, install supplied lateral supports as required by the Ontario Building Code and in accordance with Structural details. In areas where ceilings are scheduled, use 150 mm lengths of steel angle located each side of partition at 1200 mm and staggered.

3.12 BUILT-IN ITEMS

.1 Coordinate and locate build-in items required to be built into masonry or supplied under work of other Sections including hollow metal doors, windows, lintels, sleeves, inserts, etc. Build-in items to present a neat, rigid, true and plumb installation.

.2 Build wall openings, slots, and recesses required for ducts, grilles, pipes and other items.

.3 Coordinate installation of conduit, outlet boxes and other mechanical and electrical built-ins with work of Divisions 21, 22, 23 and 26.

.4 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as Work progresses.

.5 Brace door jambs to maintain plumbness. Set anchors between metal frames and masonry and fill voids between hollow metal frames and masonry walls with mortar.

3.13 INSTALLATION TOLERANCES

.1 Install masonry work to a plane flatness and exposed end tolerance of 3 mm in 3000 mm.

.2 Variation in Alignment from Unit to Adjacent Unit: 1.5 mm maximum.

.3 Plumb within 6 mm in 3 m, or in 6 mm in 6 m at external corners, expansion joints, or other conspicuous lines.

.4 Level within 6 mm in any bay or 6 m maximum distance, and 12 mm in 12 m or more.

.5 Located from position shown, and from related position of columns, walls, and partitions within 12 mm in any bay or 6 m maximum distance, and 19 mm in 12 m or more.

.6 Opening sizes within 6 mm of designated dimension.

.7 Column and wall cross-section dimensions within minus 6 mm and plus 12 mm.

.8 Joint widths to dimensions indicated or specified herein, but in no case greater than 12 mm. Variation of Mortar Joint Thickness: 1 mm every metre.

3.14 REPAIR AND POINTING

.1 Remove and replace masonry units which are loose, chipped, broken, cracked, marked, stained, discoloured, or otherwise damaged. Supply and install new units to match adjoining units and install in fresh mortar, and point to eliminate evidence of replacement.

.2 During tooling of joints, enlarge any cracks, holes, or other defects, point and completely fill with mortar.

.3 Point-up joints including corners, openings and adjacent Work for a neat, uniform appearance, properly prepared for application of sealant compounds.

3.15 CLEANING

.1 Obtain and follow unit masonry manufacturer's written instructions for cleaning of masonry.

.2 Clean exposed, masonry surfaces, removing excess mortar as work progresses. Allow mortar droppings to partially dry then dry brush with a stiff fibre brush.

.3 Cleaning of stone work:

.1 Protect adjacent surfaces and other work from damage.

.2 Remove large particles with stiff fibre brushes without damaging surface. Saturate masonry with clean water and flush off loose mortar and dirt.

.3 Scrub with solution of 25 mL trisodium phosphate and 25 mL household detergent dissolved in 1 L of clean water using stiff fibre brushes, then clean off immediately with clean water using hose.

.4 Repeat cleaning process as often as necessary to remove mortar and other stains.

END OF SECTION

1 General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment, access, cooperation, coordination and services to allow the testing of structural steel, open web steel joists, structural steel deck and welds to be carried out by a Testing Agency responsible to the Owner.

.2 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and allow the Contractor to make appropriate allowances. The testing describe in this section is not the responsibility of the Contractor. It will be paid for by the Owner.

.3 Testing required by the Contractor for his own quality control will be paid for by the Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 051200 - Structural Steel Framing.

.2 Section 053100 - Steel Decking.

1.4 REFERENCE STANDARDS

.1 Testing of Structural Steel shall conform to the requirements of the following Standards unless otherwise required by the specification:

.1 Ontario Building Code –2005.

.2 CSA S16-01 - Limits States Design of Steel Structures.

.3 CSA S136-07 - North American Specification for the Design of Cold-Formed Steel Structural Members

.4 CSA W47.1-03 - Certification of Companies for Fusion Welding of Steel Structures.

.5 CSA W59-03 - Welded Steel Construction (Metal Arc Welding) (Metric version).

.6 CSA W178.1-08 - Certification of Welding Inspection Organizations.

.7 CSA G40.20-04 - General Requirements for Rolled or Welded Structural Quality Steel.

.8 CSA G40.21-04 - Structural Quality Steel.

.9 ASTM A653-07 - Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.10 CSSBI 10M-06 - Standard for Steel Roof Deck.

.11 CSSBI 12M-06 - Standard for Composite Steel Deck.

.12 ASTM A123-02 - Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products.

.13 ASTM A143-07 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

.14 ASTM A153-05 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.15 ASTM A384-07 - Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies.

.16 ASTM A780-01(2006) - Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

.2 Where the Standard is referred to in this specification it shall mean the documents specified in this clause, and their referenced Standards.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor" and "Consultant" as per the General Conditions and Definitions.

.2 "Structural Engineer" shall mean a representative of Read Jones Christoffersen Ltd.

.3 "Testing Agency" shall mean the testing agency responsible to the Owner.

.4 "Non-destructive Testing" shall mean magnetic particle, ultrasonic, or radiographic testing as determined appropriate by the Testing Agency.

.5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 APPOINTMENT OF TESTING AGENCY

.1 The Owner will appoint a Testing Agency approved under W178.1 (Building Category).

.2 Testing paid for by the Owner is outlined in Section 3.0.

.3 Testing paid for by the Contractor.

.1 Testing of pre-approved connections not on the structural drawings and required by the Contractor for ease of fabrication, transportation or erection.

.2 Any additional costs due to overtime, shift work, holiday or weekend work required to meet the schedule.

.3 Costs for retesting or additional testing due to work having failed to meet the specified requirements.

.4 For the purpose of bidding, assume all welds will be examined by a nondestructive testing method. Non-destructive testing will be performed on samples of the work at the discretion of the Structural Engineer as well as outlined in this specification. Any repair and retesting costs shall be borne by the Contractor.

2 Duties

2.1 RESPONSIBILITY OF THE CONTRACTOR

.1 The Contractor shall cooperate fully with the Testing Agency. Allow free access to all parts of the work for the purpose of testing and review at all times.

.2 Notify the Testing Agency and Structural Engineer when work is ready for review.

.3 Prior to commencement of work, provide a schedule of shop fabrication and erection to the Testing Agency and Structural Engineer.

.4 Provide mill certificates in accordance with the Standard, properly correlated to the elements being fabricated.

.5 The Contractor is solely responsible to provide a finished product that meets the specifications and contract documents. Testing is not carried out for the Contractor's benefit, nor does it make the Structural Engineer or Testing Agency guarantors of the Contractor's work.

2.2 RESPONSIBILITY AND DUTIES OF THE TESTING AGENCY

.1 The Testing Agency is responsible to the Owner and has the authority to, and is expected to, reject any work not meeting the specifications.

.2 Review the structural drawings and specifications prior to carrying out the work.

.3 Provide testing as per the Standards and as per this specification.

.4 Provide timely test reports to the Structural Engineer, Consultant and Contractor.

3 Testing - Structural Steel, And Deck

3.1 GENERAL

.1 The Structural Engineer may reject at any time during the progress of the work a piece of material or any member which the Structural Engineer may find defective or not in accordance with the detailed drawings. This material may be rejected notwithstanding any previous acceptance and components so rejected shall be replaced at no expense to the Owner. In case of dispute, the decision of the Structural Engineer shall be final

.2 Testing in general shall conform to CSA S16 and W59. Acceptance criteria for welding to be for statically loaded structures as per W59.

.3 If initial tests indicate that the work failed to meet specification, the Structural Engineer shall decide if any additional testing is necessary. This testing shall be done by the Owner's agency. The proposed additional testing shall have prior approval of the Structural Engineer.

.4 Confirm that the fabricator and erector are certified to CSA-W47.1 and that all welders are properly qualified.

.5 Review welding procedures.

.6 Confirm welding consumables are properly stored in shop and field.

.7 Review mill certificates for the material used and forward to the Structural Engineer.

.8 Non-destructive testing operators to have Level II qualifications as a minimum.

3.2 TESTING OF STRUCTURAL STEEL

.1 Randomly check and record structural steel member sizes - 10% ± of columns and 5% ± total of beams and girders.

.2 Check grade markings on structural steel in fabricator's plant prior to fabrication.

.3 Provide a visual review of 100% of all types of welds and 100% of workmanship.

.4 Randomly select shop welds for nondestructive testing - 5% to 10% of connections.

.5 Randomly select field welds for nondestructive testing - 5% to 10% of connections.

.6 Review all snug tight bolted connections to determine that plates are in contact. Check 10% ± of bolts for snugness, including anchor bolts.

.7 For pre-tensioned bolted connections check 10% ± of bolts, minimum two (2) per connection. Pre-tensioned connections are :

.1 Seismic and wind brace connections and drag strut connections.

.2 Crane rail connections.

.3 Connections subject to repeated loads.

.4 Bolted trusses.

.5 Slotted holes with loads perpendicular to the slot or oversized holes.

.6 Connections noted as pre-tensioned on the structural drawings or the shop drawings.

.2 For the following critical welds, observe 20% ± being welded and provide suitable nondestructive testing to:

.1 Tension chord splices in trusses - 100%.

.2 Moment frame beam - column welds - 100%.

.3 Base welds at cantilever columns - 100%.

.4 Full strength beam flange and web connections - 100%.

3.3 TESTING OF HEADED STUDS AND DEFORMED BAR ANCHORS

.1 Visually inspect 100% of welds.

.2 Reinforcing bars butt welded to plates shall be tested as per this section, and shall be weldable grade (W) reinforcing.

.3 1%± of randomly selected studs will be tested by bending to an angle of 30%. Minimum of four (4) studs to be tested. Studs on composite beams shall be bent towards the nearest column.

.4 0.33% (1 in 300)± of randomly selected studs will be tested to destruction. Minimum of four (4) studs to be tested.

.5 Failure of the weld of any studs will be cause for rejection of the stud welding and cause for further testing at the Structural Engineer’s discretion and at the Contractor's expense.

.6 A 10% or greater failure rate at the welds of the tested studs will be cause for rejection of all studs.

.7 Studs tested to destruction shall be replaced by the Contractor and retested.

.8 Replacement of failed or rejected studs shall be at the Contractor’s expense.

3.4 TESTING OF STEEL DECK

.1 Visual review of 100% of deck welds and button punching.

.2 Verify galvanizing as per specification.

.3 Random review of 10%± of deck for required thickness.

End of Section 050050

1 General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment and services to supply, design, and erect structural steel required and/or indicated on the drawings or specified herein, including the supply of plates and/or angles for support of masonry, embedded steel parts, headed stud and deformed bar anchors, wedge anchors, and epoxy anchors which will form the connection between the structural steel, open web steel joists and masonry or concrete; and reinforcement of steel deck openings larger than 400 mm (16"). Report any discrepancies between structural, mechanical, electrical and architectural drawings to the Consultant and Structural Engineer immediately.

.2 Co-ordinate with Section 053100 (Steel Deck) for the design, supply, and installation of headed stud shear connectors for composite beams and girders, and where required on other beams, girders, and drag struts.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 033100 – Structural Cast-in-Place Concrete

.2 Section 050050 - Testing of Structural Steel, and Deck

.3 Section 053100 - Steel Decking

1.4 REFERENCE STANDARDS

.1 Structural steel shall conform to the requirements of the following Standards unless otherwise required by the specification:

.1 Ontario Building Code –2005.

.2 CSA S16-01 - Limits States Design of Steel Structures.

.3 CSA S136-07 - North American Specification for the Design of Cold-Formed Steel Structural Members

.4 CSA W47.1-03 - Certification of Companies for Fusion Welding of Steel Structures.

.5 CSA W59-03 - Welded Steel Construction (Metal Arc Welding) (Metric version).

.6 CSA G40.20-04 - General Requirements for Rolled or Welded Structural Quality Steel.

.7 CSA G40.21-04 - Structural Quality Steel.

.8 CSA G30.18-M92 (R2007) - Billet Steel Bars for Concrete Reinforcement.

.9 CSA W186-M1990 (R2007) - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.10 ASTM F1554-07a Standard Specification for 36, 55 and 105 ksi yield strength Steel Anchor Bolts.

.11 ASTM A193-08a – Standard Specification for Alloy-Steel Bolting Materials for Special Purpose Applications.

.12 ASTM A325-07a - Standard Specification for Structural Bolts, Steel, Heat Treated 120 / 105 ksi Minimum Tensile Strength.

.13 ASTM A490-08a - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated 150 ksi Minimum Tensile Strength.

.14 ASTM A496-07 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.

.15 CISC / CPMA Standard 1-73a - A Quick-Drying One-Coat Paint for Use on Structural Steel.

.16 SSPC SP-6-2000 - Commercial Blast Cleaning

.17 ASTM A123-02 - Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products.

.18 ASTM A143-07 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

.19 ASTM A153-05 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.20 ASTM A384-07 - Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies.

.21 ASTM A780-01(2006) - Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

.2 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.

1.5 DEFINITIONS FOR THIS SECTION

.1 “Owner”, “Contractor” and “Consultant” as per the General Conditions and Definitions.

.2 “Structural Engineer” shall mean a representative of Read Jones Christoffersen Ltd.

.3 “Specialty Structural Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.4 “Testing Agency” shall mean the testing agency responsible to the Owner.

.5 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 QUALIFICATIONS

.1 Structural steel fabricator shall have not less than five (5) years experience in the fabrication of structural steel.

.2 Erector shall not have less than five (5) years experience in the erection of structural steel.

.3 Steel fabricators and erectors must be certified under requirements of CSA W47.1 as required by CSA S16.

.4 Welding procedures, welders and welding operations shall be qualified in accordance with Canadian Welding Bureau Standards.

1.7 EXAMINATIONS

.1 All dimensions shall be taken from the drawings and verified by field measurement. Be responsible for the correctness of such measurements and report to the Consultant and Structural Engineer in writing all discrepancies between measurements in the field and those shown on drawings prior to commencing work. Verify location of anchor bolts and embedded steel and ensure that work prepared by other trades is at a proper elevation, on line, level and true.

1.8 SUBMITTALS

.1 The Contractor shall submit, before starting work, written evidence of qualification of the steel fabricators and erectors for welding under Canadian Welding Bureau requirements.

.2 The Contractor shall submit, before starting work written evidence of ability to weld reinforcing steel to structural steel in accordance with CSA W186.

.3 When requested, submit copies of mill test reports properly correlated to the materials used on the project.

.4 Provide a schedule of fabrication to the Consultant, Structural Engineer and Testing Agency prior to the commencement of the fabrication.

1.9 SHOP DRAWINGS

.1 The Contractor shall notify the Consultant and Structural Engineer, in writing and before the submission of shop drawings, of the name of the Specialty Structural Engineer who will be designing and providing field review for the connections and components designed by the Contractor.

.2 Submit "design" drawings for review summarizing the proposed connection details to be used on the project. These drawings to be prepared by, or under supervision of, the Specialty Structural Engineer and submitted for review before start of shop drawing production. These design drawings shall show the complete connection and:

.1 How the connection assembly fits with the connected members.

.2 Sizes of plates, bolts, welds, etc.

.3 Capacities of the connection.

.4 Assumed eccentricities, lines of action of forces, etc.

.3 Submit shop drawings prepared under direction of the Specialty Structural Engineer. Drawings of components and connections designed by the Contractor shall be sealed and signed by this Specialty Structural Engineer or a letter shall be submitted at the end of the project signed and sealed by this Specialty Structural Engineer. The letter shall identify what was designed by the Specialty Structural Engineer and list the final shop drawings by number with dates and revision numbers.

.4 Shop drawings shall show complete shop and erection details necessary for fabrication and erection of the component parts of the structure, including cuts, copes, connections, holes, threaded fasteners, splices and location, type, size and extent of all welds. Splices not shown on the shop drawings will be rejected. All welds, both shop and field, shall be indicated by AWS Welding Symbols as specified in the CSA W59 Appendix D and E.

.5 Provide a shop drawing clearly locating all anchor bolts, embedded plates, baseplates, etc.

.6 Provide setting drawings, templates and directions for the installation of anchor bolts, plates and other devices.

.7 Prior to starting erection work, submit a description of the methods, sequence of erection and type of equipment proposed for use in erecting structural steel for review of the effects of construction loads on the remainder of the structure.

.8 Review of the shop drawings by the Structural Engineer is intended as an assistance to the Contractor and does not relieve the Contractor of his responsibility for the completeness or accuracy of his work and its conformance with the contract documents.

.9 Fabrication that commences prior to shop drawing review by the Structural Engineer is at the risk of the Contractor.

.10 Clearly identify on the shop drawing all revisions, changes, or modifications.

.11 Resubmit reviewed shop drawings where noted in the Read Jones Christoffersen Ltd.'s review stamp, or when the Contractor makes revisions for his own purposes.

.12 Allow at least two (2) weeks for shop drawing review by the Structural Engineer.

.13 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias may be used by the Contractor under the following conditions:

.1 Copyright remains with Read Jones Christoffersen Ltd.

.2 The drawings will only be used for shop drawings for this project and not be put to any other use.

.3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in the drawings. The Contractor assumes all risk and expenses associated with the use of structural drawings in the production of his work.

.4 References to Read Jones Christoffersen Ltd. must be deleted from the title block.

.5 The Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.

1.10 SUPPLY OF ALTERNATE PRODUCTS

.1 Should the rolled sections shown on the drawings not be procurable, or should substitution for those sections be desired, sections of equivalent strength, may be substituted if approved by the Consultant. In such cases full particulars, thereof must be submitted after contract award. Material substitutions after the closing of Bid, if accepted, will be at the Contractor's cost.

1.11 TESTING AND FIELD REVIEW

.1 See Section 050050 - Testing of Structural Steel, Steel Joists Framing and Steel Decking.

.2 The Specialty Structural Engineer responsible for shop drawings, or the Specialty Structural Engineer's representative, shall visit the site to review in place the connections and components designed by that Specialty Structural Engineer. The Specialty Structural Engineer shall be satisfied or take steps to ensure that these connections and components substantially comply with the Specialty Structural Engineer's design. The Specialty Structural Engineer shall then provide a sealed and signed letter to the Consultant and Structural Engineer to this effect.

.3 Prior to the commencement of work provide a schedule of shop fabrication to the Testing Agency.

.4 If requested, submit certified mill tests in accordance with the Standards.

.5 The Contractor shall advise the Testing Agency of the scheduling of all shop and field work pertaining to this Project. The Contractor shall permit the testing agency full access to the fabrication shop and the site, for the purpose of carrying out his work and he shall provide assistance required to aid in the performance of the inspection and testing.

1.12 STORAGE AND HANDLING

.1 The Contractor shall be responsible for the protection of all steelwork during fabrication, shipping, storage and construction. All small bends and damage shall be reported to the Structural Engineer for instructions. Steel work which is bent, broken or otherwise damaged, shall be repaired or replaced by the Contractor prior to erection to the satisfaction of the Structural Engineer at no cost to the Owner.

.2 The Contractor shall be responsible for proper scheduling of delivery and erection for the structural steel in accordance with the construction schedule.

.3 Store structural steel members at the site above ground on platforms, skids or other devices so that ground dampness will not affect the bottom members of the stacks.

.4 Steel, which is stored outdoors after fabrication, shall be protected from accumulations of standing water.

.5 Other materials shall be stored in a weather tight and dry place until ready for use in the Work.

.6 Packaged materials shall be stored in their original unbroken packages or containers.

1.13 COORDINATION WITH OTHER TRADES

.1 Supply all necessary instructions and drawings to other trades for setting bearing plates, anchor bolts, and other members that are built in with the work of other trades. Provide punched holes for the convenience of other trades in attaching wood blocking or other materials. Coordinate with drawings of other disciplines for locations and details. Supply the necessary material in accordance to the construction schedule.

2 Products

2.1 MATERIALS

.1 All steel shall be new unless otherwise indicated and be of sizes and shapes listed in the current CISC Handbook or AISC Handbook and as indicated on the drawings.

.2 Rolled shapes, except wide flanges, and rolled plate shall be to CSA G40.21 - grade 300W or equal.

.3 Wide flange rolled shapes and welded wide flange sections shall be to CSA G40.21 - grade 350W or equal.

.4 Hollow structural sections shall be to CSA G40.21 - grade 350W, Class H or C.

.5 High strength bolts shall be to ASTM A325 or A490, as required by the drawings.

.6 Standard anchor rods shall be to ASTM F1554, 36ksi. High strength anchor rods shall be to ASTM A193, grade B7, see drawings for locations, if required.

.7 Bolts and nuts shall be to ASTM A307.

.8 Primer for interior exposure not to receive a shop or field paint finish shall be to CISC / CPMA Standard 1-73a or other pre-approved, unless noted otherwise.

.9 Primer used in a multi-coat system where a final shop or field paint finish is to be applied shall conform to Section 09900 - Painting and shall be selected and preapproved by the Architect based on surface preparation, exposure conditions and compatibility with subsequent coatings, unless noted otherwise.

.10 Brick support angles and related framing materials exposed to weather, shall be galvanized to CSA G164.

.11 Headed shear stud connectors shall be Nelson anchors with fluxed ends or other pre-approved equal conforming to ASTM A108. Studs to be automatically end welded with suitable stud welding equipment or shop fillet welded to develop full strength of the stud. Field fillet welded studs will be rejected.

.12 Bar anchors shall be Nelson deformed bar anchors or pre-approved equal conforming to ASTM A496.

.13 Welding consumables for all processes shall be fully approved by the Canadian Welding Bureau and certified by the manufacturers as complying with the requirements of this specification. Such certificates shall be not more than two (2) years old.

.14 Electrode strengths to be equal to E49XX (E70XX) or better.

.15 Grout for column bases shall be non-metallic, non-expanding and non-shrink type with a minimum strength of 35 MPa at 28 days, unless noted otherwise. Grout may be place in a dry pack or flowable consistency.

2.2 DESIGN

.1 Unless otherwise noted connections and trusses shall be designed by the Contractor to the reference Standards by the Specialty Structural Engineer.

.2 Where connections are detailed, use connection of the type and detail shown on the drawings. Modifications to the specified connection types and details will not be permitted without prior approval from the Structural Engineer.

.3 The following connections, and any connections so noted on the structural drawings, shall be designed as slip critical and shall be pre-tensioned:

.1 Trusses.

.2 Elements resisting crane loads.

.3 Connections for supports of running machines or other live loads that produce impact or cyclic loads.

.4 Connections where bolts are subject to repeated tensile loads.

.5 Connections using slotted holes in the direction of the load or oversize holes unless specifically designed to accommodate movement.

.4 Connections for wind or seismic lateral load-resisting elements, such as bracing and drag struts, and others so noted on the structural drawings may be designed as bearing connections but shall be pre-tensioned.

.5 Other bolted connections may be snug tight.

.6 Use standard connection types where connections are not detailed on the structural drawings.

.7 Design shall be for the forces and loads shown on the drawings and shall allow for the effects of beam deflections. Provide a minimum of two (2) 19 mm (3/4") A325 bolts or an equivalent weld for all beam to girder and beam to column connections. If forces or loads are not given, the connection shall be designed for the maximum uniform distributed load that the member can carry for the span shown.

.8 Structural steel members spliced for ease of fabrication or transportation shall have splices designed to develop the full strength and stiffness of the member. Splices shall be subject to non-destructive testing as directed by the Structural Engineer. The cost for such testing shall be borne by the Contractor.

.9 Provide stiffeners in beam webs at all locations where beams pass over supports. Unless noted otherwise in the structural drawings, web stiffeners shall be 10 mm minimum.

.10 Provide separators for all double members in accordance with CSA S16.

3 Execution

3.1 FABRICATION

.1 Fabrication shall be to CSA S16 and reviewed shop drawings.

.2 Welding shall be to CSA W59.

.3 Structural steel work shall be executed by skilled and experienced workmen.

.4 Fabricated units shall be straight and true and without sharp kinks or bends, accurate to sizes shown.

.5 Fabricate rolled steel sections so that any camber and/or sweep resulting from manufacturing is positioned to create a hump up between the ends, not a sag down.

.6 Flame cut steel columns shall have their ends milled. Steel base plates supporting columns shall be flat.

.7 Unless noted otherwise, all hollow structural sections shall be dry inside and closed airtight with end plates sealed with welds.

.8 Visually inspect all plates and shapes for laminations. Replace plates or shapes that contain laminations.

.9 Headed shear stud connectors and deformed bar anchors shall be applied in strict accordance with the manufacturer's instructions and the Standards or shop fillet welded as per the Standards. Procedural control to be in accordance with W59 as a minimum. Field fillet welds will be rejected.

.10 Obtain Structural Engineer's approval for holes required through structural steel that are not shown on the drawings.

.11 Refer to Architectural drawings for extent and location of Architecturally exposed steel elements.

.12 Remove and replace any work which is not acceptable to the Consultant, when and as directed. Such operation shall not become an extra charge to the Owner.

.13 Steel members spliced for ease of fabrication shall develop the full strength and stiffness of the member.

.14 Where roof slopes exceed 5% and do not permit flush bearing of the steel deck on the beams, provide continuous 3mm bent plates to the pitch and necessary to ensure full bearing of the steel deck. Co-ordinate with the deck supplier the locations that will require these bent plates.

3.2 CLEANING AND PRIMING

.1 All steel shall be thoroughly cleaned of all loose mill scale, loose rust, oil or dirt.

.2 Architecturally exposed steel members, related framing and exterior steel shall be primed.

.3 Steel, which will be encased in concrete, fireproofed, zinc coated or galvanized, welded, receive shear studs, faying surfaces of slip resistant connections and the underside of base plates and bearing plates steel shall not be primed.

.4 Steel girder, beams, trusses, columns, bracing and connections plates on the perimeter of the building shall be primed.

.5 Other steel for interior exposure shall not be primed.

.6 Structural steel which will not receive a finish paint coat and is required to be primed for interior exposure shall be cleaned in accordance with CISC / CPMA Standard 1-73 (minimum).

.7 Structural steel to be primed for exterior exposure shall be cleaned in accordance with SSPC SP6 "Commercial Blast Cleaning" as a minimum.

.8 Structural steel to receive a shop or field paint finish shall be cleaned in accordance with Section 099100 - Painting or SSPC SP6 "Commercial Blast Cleaning", whichever produces a surface which has less rust and mill scale.

.9 Apply primers in accordance with the manufacturer's instructions.

.10 Use paint prepared by manufacturer without thinning or adding admixtures. Execute painting on dry surfaces, free from rust, scale, or grease. Do not paint in temperatures lower than 8°C.

.11 Where finish painting to parts inaccessible for finish painting after final assembly is required, apply two coats of paint during fabrication. Apply paint of 2 different colours so that missed areas can be detected.

.12 Provide the following touchup for steel in an exterior exposure or which has a finish paint coat. After erection and after connections are completed, provide a field touchup coat of primer to all surfaces that had no paint shop coat and have been chipped or scraped. Touch up with primer and paint all shop coat painted areas that have been chipped or scraped.

.13 Provide the following touchup for galvanized steel. After erection and after connections are completed, provide a field touchup coat of zinc rich paint to all surfaces that have been chipped or scraped.

3.3 ERECTION

.1 The erector is fully responsible for erection methods, equipment, workmanship and safety precautions.

.2 Confirm the setting of anchor bolts and bearing plates and make an instrument survey to verify the setting prior to erection of steel members.

.3 Cutting or burning of baseplates to accommodate anchor bolts shall be cause for rejection of baseplates.

.4 Install all temporary bracing that is required to stabilize the work against wind, earthquake and construction loads. Keep structure true and plumb until completion of the building. Assume complete responsibility for the extent and timing of the removal of such bracing. The bracing members indicated on the drawings are required for the finished structure and shall not be considered as adequate for temporary bracing. Any failure to make proper and adequate provision for stresses occurring during the erection from any causes whatsoever shall be entirely the responsibility of the Contractor.

.5 As erection progresses, the work shall be securely bolted up to take care of all loads including wind and seismic during erection. Any failure to make proper and adequate provisions for loads during erection shall be solely the responsibility of the Contractor.

.6 The Contractor shall be responsible for the design of all hooks, erection connections and handling gear.

.7 Whenever piles of materials, erection equipment, or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from same. All construction loads shall be adequately distributed so as not to exceed the capacity of any member.

.8 Structural steel shall be assembled and erected in accordance with the approved erection drawings and specified reference Standards.

.9 Structural steel work on concrete shall be carefully located at the proper grade and rigidly secured in place, using steel shims. Spaces under the steel shall then be filled with nonshrink premix grout as soon as possible, and before placing any concrete toppings or precast concrete units.

.10 Plumb, level and align individual members of steel work as specified in CSA S16.

.11 The various members forming parts of complete frame or structure after being assembled shall be aligned and adjusted accurately before being fastened.

.12 Bearing surfaces and surfaces which will be in permanent contact shall be cleaned before the members are assembled.

.13 Temporary bolts, clips and angles etc. used to facilitate erection shall be removed unless noted otherwise on the drawings.

3.4 TEMPORARY FLOORING

.1 Provide all temporary flooring, planking and scaffolding necessary in connection with erection of structural steel, or support of erection machinery in accordance with governing regulations and by-laws.

3.5 WELDING

.1 Welding shall be done by the shielded metal-arc method in accordance with the requirements CSA W59. The welding operators shall be currently certified under CSA W47.1 for the work they are performing.

.2 Submit, when requested, welding procedures prepared and sealed by a Specialty Structural Engineer for review.

.3 Surfaces to be welded shall be free from loose scale, rust, paint, or other foreign matter. Where weld material is deposited in two (2) or more layers, each layer shall be cleaned before the next layer is deposited. Care shall be taken to minimize stresses due to heat expansion, contraction and distortion by using proper sequence in welding and by approved methods.

.4 Appearance, quality of welds made, methods of correcting defective work shall be in accordance with CSA W59.

.5 Welding of reinforcing bars to structural steel as per CSA W186.

3.6 COMPLETION

.1 The Specialty Structural Engineer responsible for the sealed shop drawings, or his representative shall visit the site to review in place connections and components designed by that Specialty Structural Engineer to ensure substantial compliance with his sealed shop drawings. He shall then submit a sealed and signed letter of substantial compliance to the Consultant and Structural Engineer.

.2 On completion of the work of this section, all protection erected in conjunction with the structural steel work shall be removed, all damage to this work and adjoining work shall be made good and all surplus materials and debris and all tools, plant and equipment shall be removed from the site.

End of Section 051200

1 GENERAL

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment and services to supply, design, and erect open web steel joists required and/or indicated on the drawings or specified herein. Report any discrepancies between structural, mechanical, electrical and architectural drawings to the Consultant and Structural Engineer immediately.

.2 Co-ordinate with Section 051200 (Structural Steel Framing) for the design, fabrication, supply, installation and erection of structural steel and accessories.

.3 Co-ordinate with Section 053100 (Steel Decking) for the design, supply, and installation of headed stud shear connectors for composite joists, and where required on other joists and drag struts.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 033000 - Structural Cast-in-Place Concrete

.2 Section 050050 - Testing of Structural Steel, Steel Joist Framing and Steel Decking

.3 Section 051200 - Structural Steel Framing

.4 Section 053100 - Steel Decking

1.4 REFERENCE STANDARDS

.1 Open web steel joists shall conform to the requirements of the following Standards unless otherwise required by the specification:

.1 Ontario Building Code – 2012.

.2 CSA S16 - Limits States Design of Steel Structures.

.3 CSA S136 - North American Specification for the Design of Cold-Formed Steel Structural Members.

.4 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.

.5 CSA W59 - Welded Steel Construction (Metal Arc Welding) (Metric version).

.6 CSA G40.20 - General Requirements for Rolled or Welded Structural Quality Steel.

.7 CSA G40.21 - Structural Quality Steel.

.8 CISC / CPMA Standard 1-73a - A Quick-Drying One-Coat Paint for Use on Structural Steel.

.9 SSPC SP-6 - Commercial Blast Cleaning

.10 ASTM A123 - Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products.

.11 ASTM A143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

.12 ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.13 ASTM A384 - Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies.

.14 ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

.15 LEED ® Canada-NC Green Building Rating.

.2 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.

.3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor" and "Consultant" as per the General Conditions and Definitions.

.2 "Structural Engineer" shall mean a representative of Read Jones Christoffersen Ltd.

.3 "Specialty Structural Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.4 "Testing Agency" shall mean the testing agency responsible to the Owner.

.5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 QUALIFICATIONS

.1 Open web steel joist fabricator shall have not less than five (5) years experience in the fabrication of open web steel joists.

.2 Erector shall not have less than five (5) years experience in the erection of open web steel joists.

.3 Steel fabricators and erectors must be certified under requirements of CSA W47.1 as required by CSA S16.

.4 Welding procedures, welders and welding operations shall be qualified in accordance with Canadian Welding Bureau Standards.

1.7 EXAMINATIONS

.1 All dimensions shall be taken from the drawings and verified by field measurement. Be responsible for the correctness of such measurements and report to the Consultant and Structural Engineer in writing all discrepancies between measurements in the field and those shown on drawings prior to commencing work. Verify location of embedded steel and ensure that work prepared by other trades is at a proper elevation, on line, level and true.

1.8 SUBMITTALS

.1 The Contractor shall submit, before starting work, written evidence of qualification of the steel fabricators and erectors for welding under Canadian Welding Bureau requirements.

.2 The Contractor shall submit, before starting work, written evidence of ability to weld reinforcing steel to structural steel in accordance with CSA W186.

.3 When requested, submit copies of mill test reports properly correlated to the materials used on the project.

.4 Provide a schedule of fabrication to the Consultant, Structural Engineer and Testing Agency prior to the commencement of the fabrication.

1.9 SHOP DRAWINGS

.1 Shop drawings shall show complete shop and erection details necessary for fabrication and erection of the joists, including connections, splices and location, type, size and extent of all welds. Splices not shown on the shop drawings will be rejected. All welds, both shop and field, shall be indicated by AWS Welding Symbols as specified in the CSA W59 Appendix D and E.

.2 Review of the shop drawings by the Structural Engineer is intended as an assistance to the Contractor and does not relieve the Contractor of his responsibility for the completeness or accuracy of his work and its conformance to the with the contract documents.

.3 Fabrication that commences prior to shop drawing review by the Structural Engineer is at the risk of the Contractor.

.4 Clearly identify on the shop drawing all revisions, changes, or modifications.

.5 Resubmit reviewed shop drawings where noted in the Read Jones Christoffersen Ltd.'s review stamp, or when the Contractor makes revisions for his own purposes.

.6 Allow at least two (2) weeks for shop drawing review by the Structural Engineer.

.7 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias can be used by the Contractor under the following conditions:

.1 Copyright remains with Read Jones Christoffersen Ltd..

.2 The drawings will only be used for shop drawings for this project and not be put to any other use.

.3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in the drawings. The Contractor assumes all risk and expenses associated with the use of structural drawings in the production of his work.

.4 References to Read Jones Christoffersen Ltd. must be deleted from the title block.

.5 The Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.

1.10 TESTING AND FIELD REVIEW

.1 See Section 050050 - Testing of Structural Steel, Steel Joist Framing and Steel Decking.

.2 Prior to the commencement of work provide a schedule of shop fabrication to the Testing Agency.

.3 If requested, submit certified mill tests in accordance with the Standards.

.4 The Contractor shall advise the Testing Agency of the scheduling of all shop and field work pertaining to this Project. The Contractor shall permit the testing agency full access to the fabrication shop and the site, for the purpose of carrying out his work and he shall provide assistance required to aid in the performance of the inspection and testing.

1.11 STORAGE AND HANDLING

.1 The Contractor shall be responsible for the protection of all joists during fabrication, shipping, storage and construction. Steel joists shall be handled at the job site in such a manner as to prevent bending or

damage of the joist. All small bends and damage shall be reported to the Structural Engineer for instructions. Damaged joists shall not be used. Joists which is bent, broken or otherwise damaged, shall be repaired or replaced by the Contractor prior to erection to the satisfaction of the Structural Engineer at no cost to the Owner.

.2 The Contractor shall be responsible for proper scheduling of delivery and erection for the joists, all in accordance with the construction schedule.

.3 Joists shall be stored at the site above ground on platforms, skids or other devices so that ground dampness will not affect the bottom members of the stacks. Stacks of joists shall not be of such height as to cause bending in members near the bottom.

.4 Joists, which are stored outdoors after fabrication, shall be protected from accumulations of standing water.

.5 Other materials shall be stored in a weather tight and dry place until ready for use in the Work.

.6 Packaged materials shall be stored in their original unbroken packages or containers.

1.12 COORDINATION WITH OTHER TRADES

.1 Provide punched holes for the convenience of other trades in attaching wood blocking or other materials. Coordinate with drawings of other disciplines for locations and details. Supply the necessary material in accordance to the construction schedule.

2 PRODUCTS

2.1 MATERIALS

.1 Steel shall be new unless otherwise indicated and be of sizes and shapes listed in the current CISC Handbook or AISC Handbook and as indicated on the drawings.

.2 Steel shall be to CSA G40.21.

.3 Primer for interior exposure not to receive a shop or field paint finish shall be to CISC / CPMA Standard 1-73a or other pre-approved, unless noted otherwise.

.4 Primer used in a multi-coat system where a final shop or field paint finish is to be applied shall conform to Section 099100 - Painting and shall be selected and preapproved based on surface preparation, exposure conditions and compatibility with subsequent coatings, unless noted otherwise.

.5 Welding consumables for all processes shall be fully approved by the Canadian Welding Bureau and certified by the manufacturers as complying with the requirements of this specification. Such certificates shall be not more than two (2) years old.

.6 Electrode strengths to be equal to E49XX or better.

2.2 DESIGN

.1 Unless otherwise noted all open web steel joists shall be designed by the Contractor to the reference Standards by the Specialty Structural Engineer.

.2 Open web steel joists spliced for ease of fabrication or transportation shall have splices designed to develop the full strength and stiffness of the member. Splices shall be subject to non-destructive testing as directed by the Structural Engineer. The cost for such testing shall be borne by the Contractor.

.3 Provide separators for all double members in accordance with CSA S16.

.4 Design of bridging for steel joists shall conform to the requirements of the CSA S16, unless otherwise indicated on the drawings. Refer to the drawings for areas of non-typical joist bridging and bracing.

.5 Design joists of the depth and spacing shown on drawings to carry the loads shown on the drawings in accordance with CSA S16.

.6 Joists shall have a live load deflection of less than 1/360 of the span unless noted otherwise.

.7 Line up openings and webs in adjacent to allow for the passage of pipe, ducts, conduits, etc. Make allowance in joist design for support of pipes, ducts, conduits, etc.

.8 Upon request by the Consultant or Authority Having Jurisdiction, submit calculations and such further proof as may be necessary to show that the steel joist construction conforms to the requirements set forth herein, as well as the municipal building bylaws.

.9 The joist manufacturer may be required, at the Structural Engineer's and Consultant's option, to demonstrate by testing or analysis, which includes the effects of actual joint eccentricities, that the joists provided have the capacity to resist the loads specified.

.10 In addition to the point loads called for in the governing building code, design joists for a 1.8 kN (0.4 kip) factored additional point load at any location on top chord and bottom chord (including the effects of local bending) concurrent with other design loads. Over mechanical areas the additional point loads shall be 4.5 kN (1.0 kip) factored. The additional point loads noted above on each chord need not be applied concurrently with each other.

.11 Where joists frame into both sides of a support, extend the top chord of the joists to the center of the support, unless shown otherwise.

.12 Where joists frame into one side of a support, extend the top chord of the joists to the far side of the support, unless shown otherwise.

.13 Provide extended ends of the joists as required to support edges of roofs and floors and walls and where shown.

.14 Extended ends of joists shall have a load carrying capacity at least equal to the loads shown on the drawings.

.15 Provide bracing as required for lateral stability of bottom chords in compression due to wind uplift, bottom chord extensions and other effects causing compression in the bottom chord.

3 EXECUTION

3.1 FABRICATION

.1 Fabrication shall be to CSA S16 and reviewed shop drawings.

.2 Welding shall be to CSA W59.

.3 Joist work shall be executed by skilled and experienced workmen.

.4 Fabricated units shall be straight and true and without sharp kinks or bends, accurate to sizes shown.

.5 Refer to Architectural drawings for extent and location of Architecturally exposed joist elements.

.6 Provide bridging for steel joists conforming to the requirements of the CSA S16, unless otherwise indicated on the drawings. Refer to the drawings for areas of non-typical joist bridging and bracing.

.7 Remove and replace any work which is not acceptable to the Consultant, when and as directed. Such operation shall not become an extra charge to the Owner.

.8 Joist and other steel members spliced for ease of fabrication shall develop the full strength and stiffness of the member.

.9 Where roof slopes exceed 5% and do not permit flush bearing of the steel deck on the joist top chords, provide continuous 3mm bent plates to the pitch and necessary to ensure full bearing of the steel deck. Co-ordinate with the deck supplier the locations that will require these bent plates.

3.2 CLEANING AND PRIMING

.1 Steel shall be thoroughly cleaned of all loose mill scale, loose rust, oil or dirt.

.2 Architecturally exposed joists and related framing and bridging and exterior steel shall be primed.

.3 All joists which will be encased in concrete, fireproofed, zinc coated or galvanized or welded shall not be primed.

.4 All other steel joists shall be shop primed.

.5 Joists which will not receive a finish paint coat and are required to be primed for interior exposure shall be cleaned in accordance with CISC / CPMA Standard 1-73 (minimum).

.6 Joists to receive a shop or field paint finish shall be cleaned in accordance with Section 099100 - Painting or SSPC SP6 “Commercial Blast Cleaning”, whichever produces a surface which has less rust and mill scale.

.7 Apply primers in accordance with the manufacturer’s instructions.

.8 Use paint prepared by manufacturer without thinning or adding admixtures. Execute painting on dry surfaces, free from rust, scale, or grease. Do not paint in temperatures lower than 8°C.

.9 Where finish painting to parts inaccessible for finish painting after final assembly is required, apply two coats of paint during fabrication. Apply paint of 2 different colours so that missed areas can be detected.

.10 Provide the following touchup for steel in an exterior exposure or which has a finish paint coat. After erection and after connections are completed, provide a field touchup coat of primer to all surfaces that had no paint shop coat and have been chipped or scraped. Touch up with primer and paint all shop coat painted areas that have been chipped or scraped.

.11 Primer for steel to receive Intumescent fireproofing: Determined to be acceptable based on adhesion and compatibility characteristics under laboratory conditions in accordance with ASTM D3359-09e2, Method A and/or ASTM D4541-09e1, and approved by manufacturer of Intumescent fireproofing to be applied.

.12 Surfaces to receive intumescent fireproofing shall be clean and free of dust, grease or other foreign matter. Existing coatings (except compatible coating manufacturer approved primer), mill scale or surface contaminants shall be removed.

.13 Coating manufacturers recommend Commercial Blast Cleaning (SSPC-SP6/NACE No.3). The quality of finish will depend on the quality of the surface to which the coating is applied. The coating will not hide substrate defects.

3.3 ERECTION

.1 The erector is fully responsible for erection methods, equipment, workmanship and safety precautions.

.2 Install all temporary bracing that is required to stabilize the work against wind, earthquake and construction loads. Assume complete responsibility for the extent and timing of the removal of such

bracing. The bracing members indicated on the drawings are required for the finished structure and shall not be considered as adequate for temporary bracing. Any failure to make proper and adequate provision for stresses occurring during the erection from any causes whatsoever shall be entirely the responsibility of the Contractor.

.3 As erection progresses, the work shall be securely connected to take care of all loads including wind and seismic during erection. Any failure to make proper and adequate provisions for loads during erection shall be solely the responsibility of the Contractor.

.4 The Contractor shall be responsible for the design of all hooks, erection connections and handling gear.

.5 Whenever piles of materials, erection equipment, or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from same. All construction loads shall be adequately distributed so as not to exceed the capacity of any joist or joists.

.6 Joists and bridging shall be assembled and erected in accordance with the approved erection drawings and specified reference Standards.

.7 Co-ordinate with mechanical and electrical trades prior to erection of steel joists to ensure that the joists and bridging will not interfere with the installation of mechanical and electrical equipment.

.8 Support joists at 2 or more points during handling and erection.

.9 Steel joists shall bear on beams as per section 2.2, but in no case shall be less than 65mm on supporting steel members. Connect to supporting steel with a 5mm x 30mm long fillet weld at each side. Secure to bearing plates on masonry walls in the same manner, bearing 100mm minimum.

.10 Plumb, level and align individual joists as specified in CSA S16.

.11 Temporary bolts, clips and angles etc. used to facilitate erection shall be removed unless noted otherwise on the drawings.

3.4 JOIST BRIDGING

.1 Install bridging for steel joists conforming to the requirements of the CSA S16, unless otherwise indicated on the drawings. Refer to the drawings for areas of non-typical joist bridging and bracing.

.2 Where required for stability of bottom chord, additional bridging shall be provided. Such stability requirement shall be designed by the supplier using the loads provided on the drawings.

.3 Architecturally exposed joist bridging and bracing shall be butt spliced and splices shall be ground smooth to receive finish painting as specified in Architectural Finishes. Lap splices in architecturally exposed bridging will not be permitted.

3.5 WELDING

.1 Welding shall be done by the shielded metal-arc method in accordance with the requirements CSA W59. The welding operators shall be currently certified under CSA W47.1 for the work they are performing.

.2 Submit, when requested, welding procedures prepared and sealed by a Specialty Structural Engineer for review.

.3 Surfaces to be welded shall be free from loose scale, rust, paint, or other foreign matter. Where weld material is deposited in two (2) or more layers, each layer shall be cleaned before the next layer is deposited. Care shall be taken to minimize stresses due to heat expansion, contraction and distortion by using proper sequence in welding and by approved methods.

.4 Appearance, quality of welds made, methods of correcting defective work shall be in accordance with CSA W59.

END OF SECTION

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, closures, equipment and services necessary to design, supply, fabricate, erect and install the steel deck and field welded shear connectors to structural steel as indicated on the drawings and as hereinafter specified. Provide gauge metal formwork at all deck edges for composite deck or concrete-filled deck and reinforcement for deck openings as required herein.

.2 Coordinate with Section 051000 - Structural Steel for the design, supply and installation of headed stud shear connections for composite beams and girders and where required on other beams, girders and drag struts.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 031000 - Concrete Forming

.2 Section 032000 - Concrete Reinforcing

.3 Section 033000 – Structural Cast-in-Place Concrete

.4 Section 050050 - Testing of Structural Steel, and Steel Decking

.5 Section 051200 - Structural Steel Framing

1.4 REFERENCE STANDARDS

.1 Structural Steel Deck shall conform to the requirements of the following Standards unless otherwise required by the specification:

.1 Ontario Building Code – 2005.

.2 CSA W47.1-03 - Certification of Companies for Fusion Welding of Steel Structures.

.3 CSA W59-03 - Welded Steel Construction (Metal Arc Welding)

.4 CSA S136-07 - Cold Formed Steel Structural Members

.5 ASTM A653M-09a - Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

.6 CSSBI 10M-06 - Standard for Steel Roof Deck.

.7 CSSBI 12M-06 - Standard for Composite Steel Deck.

.2 Where the Standard is referred to in this specification it shall mean the documents specified in this clause and their referenced documents.

1.5 DEFINITIONS FOR THIS SECTION

.1 “Owner”, “Contractor” and “Consultant” as per the General Conditions and Definitions.

.2 “Structural Engineer” shall mean a representative of Read Jones Christoffersen Ltd.

.3 “Specialty Structural Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.4 "Testing Agency" shall mean the testing agency responsible to the Owner.

.5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 QUALIFICATIONS

.1 Steel deck fabricator shall have not less than five (5) years experience in the fabrication of steel deck.

.2 Erector shall not have less than five (5) years experience in the erection of steel deck.

.3 Steel deck welders must possess current Canadian Welding Bureau Certificates of Qualification for light gauge structural welding.

.4 The deck erectors must be certified under the requirements of CSA W47.1

1.7 EXAMINATION

.1 Examine and verify all necessary measurements and dimensions of previously executed work which may affect the work of this contract.

.2 Examine surfaces which work is to be placed on or against to ensure that they are square, true, level, plumb, of correct slope or shape and of proper surface to receive such work.

.3 Report any discrepancies to the Consultant and Structural Engineer immediately so that instructions may be given for the necessary remedial work.

.4 Commencement of work shall be construed as acceptance of all conditions and surfaces.

1.8 SHOP DRAWINGS

.1 Submit shop drawings prepared under the supervision of a Specialty Structural Engineer. Drawings of components designed by the Contractor shall be sealed and signed by this Specialty Structural Engineer.

.2 Shop drawings shall show the position, extent, type and arrangement of the units, their relationship to other materials, depth, core thickness, coating thickness, connections, openings, accessories, closures, light gauge formwork and reinforcement for openings, and complete stud shear connector details for composite beams.

.3 Calculations and/or test data may be requested with the shop drawings to justify deck design and shear connector design.

.4 Show deck load capacities, including point load capacities, and for composite deck confirm that these load capacities are compatible with the zinc coating.

1.9 TESTING AND FIELD REVIEW

.1 As per Section 050050 - Testing of Structural Steel and Deck.

1.10 STORAGE AND HANDLING

.1 Bundles of decking shall be stacked on wood blocking clear of the ground and tilted to ensure that no water lies on the material.

2. Products

2.1 GENERAL

.1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.2 MATERIALS

.1 Steel deck units shall be formed of zinc-coated sheet steel minimum CSSBI 10M Grade A with a base steel nominal thickness of 0.76 mm or greater. Unless noted otherwise, zinc coatings shall be:

.1 Interior Exposure Floors ZF75 Galvanneal; Roofs - ZF75 - Galvanneal

.2 Exterior ExposureZ275.

.2 Touchup paint for welds shall conform to CGSB –1.181 Ready-Mixed Organic Zinc Rich Coating.

.3 Cover plates, cell closures, etc. shall be of the same material as the deck with a minimum nominal thickness of 0.76 mm.

.4 Deck shall conform to the depths shown on the drawings. Deck receiving composite shear studs shall have an average bottom flute width equal to twice the deck depth.

.5 Shear stud connectors shall be Nelson headed anchors or other preapproved. Studs to be automatically end welded with suitable stud welding equipment in the field. Fillet welded studs will be rejected.

.6 Steel deck to receive concrete topping shall be composite deck unless noted otherwise.

.7 Steel deck that is indicated to be painted on the underside shall have factory applied, baked-on series 5000 paint finish. Painted steel deck shall be connected with alternate fasteners that do not damage the paint finish. Painted steel deck shall not be connected with welds.

.8 Alternate Fasteners – Note that any alternates must be reviewed by RJC:

.1 The following alternate fasteners are acceptable in lieu of welding to structural supports:

.1 Hilti X-ENP-19 L15, X-EDN19 THQ12 or X-EDNK22 THQ12 as recommended by the manufacturer for the application.

.2 6mm x 25mm HHA weather-guard screws at 300mm maximum centers at all bearing points (min. of 4 screws per sheet) for use on wood trusses.

.2 In lieu of button-punching, clinching or welding sidelaps, Hilti S-SLC01 M HWH or S-SLC02 M HWH, as recommended by the manufacturer for the application, are acceptable.

2.3 FABRICATION

.1 Composite steel deck shall be formed with integral locking lugs to provide mechanical lock between concrete and steel.

.2 Steel deck shall span over three (3) or more supports unless prevented by the structural steel layout.

.3 Steel deck shall have interlocking male and female side laps.

.4 Provide cell closures where required by architectural drawings and specifications at open ends of all cell runs at columns, openings, walls, etc., and where cells change direction.

.5 For deck with concrete topping provide necessary metal gauge formwork at the deck edges for full deck and concrete depth to prevent leaking of concrete topping. This includes, but is not limited to, edges formed by building edges, openings framed by structural steel, elevator shafts, stairwells, and around webs and flanges of columns.

2.4 DESIGN

.1 Steel deck shall be designed by the Contractor to the reference Standards and the loads on the drawings unless otherwise noted.

.2 Deck thickness, spacing of puddle welds and type and extent of side connections shall be proportioned to resist forces and loads shown on drawings, or as designated on drawings.

.3 Deck material thickness may be greater than the minimum thickness shown on the drawings.

.4 Design floor deck to support loads without temporary shoring and with deflection not exceeding 1/180th of the span under construction loading.

.5 Unless noted otherwise, the deflection under live load alone shall be limited to span/360 for floors, and for roof deck the deflection shall be limited to span/360.

.6 Where the diaphragm loads are not shown on the drawings or where shear requirements are not shown on the drawings, the design of the decking and its fastenings shall meet a minimum diaphragm shear requirement of 3.5 kN/m.

.7 Decking to be used as formwork shall conform to WCB formwork requirements.

.8 Shear stud connectors shall be designed for the forces indicated on the drawings. If the capacities of the individual studs are reduced because of the geometry of the particular deck profile used, provide additional studs so that the total shear transfer capacity provided is at least that indicated on the drawings.

.9 At splice locations, steel decking shall be installed with laps sufficient to ensure that both pieces of deck are properly fastened to the supporting member. As a minimum, over supporting members with uninterrupted top surfaces, such a W-beams and channels, the lap shall be 100mm and the welds or deck fasteners shall be at or near the centerline of the supporting members. Over supporting members with interrupted top surfaces, such as OWSJ's with double angle or hat-shaped top chords, each sheet shall extend a minimum of 25mm past the opposite edge of the joist chord, and the sheets shall not lap less than 100mm total. In this case the welds or deck fasteners shall be centered on the supporting surface nearer the end of the top deck sheet. See General Notes and Typical Details for clarification.

3. Execution

3.1 ERECTION

.1 The erection of the steel deck shall be carried out by personnel experienced in the installation of steel deck.

.2 Obtain and verify all dimensions at project site or from approved shop drawings.

.3 The Contractor shall be solely responsible for the accuracy of such measurements and precise fitting and assembly of the finished product.

.4 Use special care in unloading, handling and erecting the deck to avoid bending, twisting or otherwise distorting the panels.

.5 The steel deck units shall be laid in accordance with the approved shop drawings.

.6 At splice locations, steel decking shall be installed with laps sufficient to ensure that both pieces of deck are properly fastened to the supporting member. As a minimum, over supporting members with uninterrupted top surfaces, such a W-beams and channels, the lap shall be 100mm and the welds or deck fasteners shall be at or near the centerline of the supporting members. Over supporting members with interrupted top surfaces, such as OWSJ's with double angle or hat-shaped top chords, each sheet shall extend a minimum of 25mm past the opposite edge of the joist chord, and the sheets shall not lap less than 100mm total. In this case the welds or deck fasteners shall be centered on the supporting surface nearer the end of the top deck sheet. See General Notes and Typical Details for clarification.

.7 Metal closures and flashing shall be fastened in place by welding, sheet metal screws, or structural adhesive as recommended by the decking manufacturer.

.8 Unless noted otherwise the decking shall be welded to the supporting steel by means of 19mm

diameter fusion welds in every second flute and at 300mm maximum centers at all bearing points (minimum of 4 welds per sheet).

.9 Side laps shall be mechanically fastened (clinched) or welded together at not more than 600mm on center.

.10 At perimeter parallel to flutes deck edges shall be fastened to supporting steel at 300mm on center unless noted otherwise on the drawings.

.11 Alternate Fasteners – Note that any alternates must be reviewed by RJC:

.1 The following alternate fasteners are acceptable in lieu of welding to structural supports:

.1 Hilti X-ENP-19 L15, X-EDN19 THQ12 or X-EDNK22 THQ12 as recommended by the manufacturer for the application.

.2 6mm x 25mm HHA weather-guard screws at 300mm maximum centers at all bearing points (min. of 4 screws per sheet) for use on wood trusses.

.2 In lieu of button-punching, clinching or welding sidelaps, Hilti S-SLC01 M HWH or S-SLC02 M HWH, as recommended by the manufacturer for the application, are acceptable.

.12 Steel deck shall be placed on the supporting steel framework and adjusted to final position before being permanently fastened. Each section shall be brought to proper bearing. If the supporting framework is not in proper alignment or at the proper level, the Contractor shall so advise the Consultant and Structural Engineer of such irregularities and shall not make final placement until corrections are made.

.13 For steel deck that will not receive a concrete topping, immediately after the steel deck is welded in place, the steel deck surface shall be inspected, and all areas where zinc coating has been burned by welding shall be covered by a suitable zinc enriched paint, applied to the paint manufacturer's instructions.

.14 Cut openings in metal decking at locations shown on the project drawings. These openings shall be located and dimensioned in cooperation with the various trades at the time of erecting the steel deck. Unless noted otherwise, openings up to 150 mm (6") need not be reinforced. Openings between 150 mm (6") to 400 mm (16") in size shall be reinforced by this trade, using 75 mm x 75 mm x 5.0 mm x 1200 mm (48") steel angles welded to the flutes on either side of those cut.

.15 The Contractor shall accommodate the erection and welding sequence of the structural steel as required.

.16 Shear stud connectors to be applied in strict accordance with manufacturer's instructions and Standards. Procedural control to be in accordance with W59 as a minimum.

.17 Studs shall be placed in bottom flutes of steel deck on the side closest to the nearest end of the beam.

.18 After welding studs, the ceramic ferrule shall be removed and the stud fillet visually inspected by the operator. If the fillet is less than 360° around the base of the stud, then the stud is to be hammer tested by the operator by bending the stud 30° from the vertical away from the side of no fillet. If the weld fails, the stud is to be replaced. Bent studs may be left bent.

.19 If studs are welded to steel plates or members with temperature below 0°C, one (1) stud in each 100 is to be tested by the operator by bending 30° from the vertical.

.20 No stud welding is to be done when the base metal temperature is below -15°C or when the deck surface is wet or the structural steel surface below the deck is wet.

3.2 COVER PLATES AND CLOSURES

.1 Furnish, install and weld in position, sheet metal cover plates to close openings between deck sections and columns and to cover gaps where deck sections abut or change direction.

.2 For deck with concrete topping install all light gauge metal closures and edge strips necessary as formwork for the concrete.

.3 Install all closures as required by the architectural drawings and specifications.

3.3 CLEAN-UP

.1 Steel deck cuttings, strappings, packaging material and other debris pertaining to steel deck units shall be cleaned up.

.2 Remove all debris and excess material at completion of erection of steel deck and leave work ready for other trades.

.3 Touchup welds and other areas of damaged galvanizing with zinc rich paint.

.4 Repair any defects. Leave steel deck free of all oil, grease, paint and dirt.

End of Section 053100

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for load-bearing metal studs work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.

.2 ASTM A653/A653 M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.3 ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

.4 ASTM C1280, Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.

.5 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.

.6 CSA W47.1, Certification of Companies for Fusion Welding of Steel.

.7 CSA W55.3, Certification of companies for resistance welding of steel and aluminum.

.8 CSA W59, Welded Steel Construction (Metal Arc Welding).

.9 CSA S136, North American Specification for the Design of Cold Formed Steel Structural Members.

.10 Canadian Sheet Steel Building Institute CSSBI 52M, Lightweight Steel Framing Binder.

1.3 **DESIGN REQUIREMENTS**

.1 Design load-bearing metal studs to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads.

.2 Design load-bearing metal studs based on Limit States Design principles using factored loads and resistances. Loads and load factors to be in accordance with the National Building Code (NBC). Resistance factors to be determined in accordance with the NBC and CAN/CSA-S136-M.

.3 Design 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.

.4 Design load-bearing metal studs in accordance with following Climatic Design Data for Brampton contained in the Ontario Building Code:
- .1 Design temperature: January 1%, July 2 ½%.
- .2 Wind (Hourly wind pressures): 1 in 50 year occurrence.

.5 Design load-bearing metal studs for the full specified design wind load with the following deflection limits:
- .1 Brick and stone veneer: L/720.
- .2 Metal siding and panels: L/360.

.6 Design load-bearing metal studs without relying on sheathing or gypsum board to resist torsion and weak axis buckling.

1.4 SUBMITTALS

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and system limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Wall construction, load-bearing metal stud wall system, design loads, member sizes, materials, component details, depth and gauge designation exclusive of coatings, location and spacings of framing members, connection and bracing details, bearing, anchorage, loadings, temporary bracing, welds, types and locations of mechanical fasteners, splices, permanent bracing, and strapping.
  - .2 Indicate locations, dimensions, openings and requirements of related work.
  - .3 Indicate welds by welding symbols as defined in CSA W59.
  - .4 Complete engineering design data to confirm that load-bearing metal studs meet design requirements specified.

.3 Certificates: Prior to commencement of work, submit 2 certified copies of load-bearing metal stud mill reports covering material properties.

1.5 QUALITY ASSURANCE

.1 Retain a Professional Engineer, licensed in Province of Ontario, with experience in work of comparable complexity and scope, to perform following services as part of work of this Section:
- .1 Design of load-bearing metal studs.
- .2 Review, stamp, date and sign shop drawings and design calculations.

.3 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed shop drawings.

.2 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Bailey Metal Products.

.2 Sanders Steel Inc.

.3 Steelform (West)/Fusion (East) Divisions of Imperial Building Products Ltd.

2.2 **MATERIALS**

.1 General: All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.

.2 Steel: to CSA S136, Grade A to D steel with Z275 zinc coating designation in accordance with ASTM A653/A653M.

.3 Welding materials: to CSA W59 and certified by Canadian Welding Bureau.

.4 Screws: pan head, self-drilling, self-tapping sheet metal screws, corrosion protected to minimum requirements of CSSBI, length to suit intended end use.

.5 Anchors: concrete expansion anchors or other suitable drilled type fasteners.

.6 Bolts, nuts, washers: hot dipped galvanized to ASTM A123, 600 g/m² zinc coating.

.7 Primer paint: CAN/CGSB-1.40-M or CPMA 1.73a.

.8 Insulation: In accordance with Section 07 21 00.

.9 Sill Plate Gasket: Polyethylene foam, moisture resistant, 4.8 mm thick; ‘FoamSealR’ by Owens Corning or approved alternative.

.10 Isolation coating: Black bituminous coating, acid and alkali resistant material.

.11 Exterior sheathing: 12.7 mm,’GlasRoc Brand Sheathing’ with EGRG by CertainTeed Gypsum Canada, ‘Securock Glass-Mat Sheathing’ by CGC Inc. or ‘Dens-Glass Gold’ by Georgia-Pacific Canada LP.

.12 Sheathing screws: to ASTM C1002, Type S, corrosion resistant, 12.7 mm penetration into steel, complete with 38 mm diameter washers.

2.3 **METAL FRAMING**

.1 Metal studs: to CAN/CSA S136, fabricated from zinc coated steel, depth as indicated. Minimum steel thickness to be 0.91 mm.

.2 Stud tracks: fabricated from same material and finish as metal studs, depth to suit.
- .1 Bottom track: single piece.
- .2 Top track: two piece telescoping or single piece as required by design.

.3 Bridging: fabricated from same material and finish as studs, 38 x 12 x 1.22 mm minimum thickness.

.4 Angle clips: fabricated from same material and finish as studs, 38 x 38 mm x depth of metal stud, 1.22 mm minimum thickness.

.5 Tension straps and accessories: In accordance with reviewed shop drawings and as recommended by manufacturer.

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 of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Verify substrate surfaces are solid, free from surface water, frozen matter, and other foreign matter detrimental to performance. Ensure environmental and site conditions are suitable for installation of system.

3.3 **INSTALLATION**

.1 Install load-bearing metal studs in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Install sill plate gasket under bottom track at foundation wall locations and in locations indicated in accordance with manufacturer’s written instructions. Butt all end and perpendicular joints tightly.

.3 Perform work in accordance with CSSBI 52M. Perform welding in accordance with CSA W59.

.4 Erect studs plumb, aligned and securely attached with 2 screws minimum at each point of attachment, or welded in accordance with manufacturer's recommendations. Anchor tracks securely to structure at 800 mm o.c. maximum, unless lesser spacing prescribed on shop drawings.

.5 For telescoping tracks install 50 mm minimum telescoping track at top of walls where required to accommodate vertical deflection. Nest top track into deflection channel a minimum of 30 mm and a maximum of 40 mm. Do not fasten tracks together. Stagger joints.

.6 Seat studs into bottom tracks and top track. Install studs at not more than 50 mm from abutting walls, openings, and each side of corners and terminations with dissimilar materials.

.7 Brace metal studs with horizontal internal bridging at spacing shown on reviewed shop drawings. Fasten bridging to steel clips fastened to metal 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 Cutouts: Limit distance from centerline of last unreinforced cutout to end of member to less than 300 mm.

.10 Touch up welds with coat of zinc rich primer.

.11 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 mm from design spacing.
- .4 Gap between end of stud and track web: not more than 4 mm.

.12 Install insulation in accordance with Section 07 21 00.

.13 Apply isolation coating over entire contact surfaces of all dissimilar materials to prevent electrolytic action for protection from galvanic corrosion.

3.4 SHEATHING INSTALLATION

.1 Install sheathing materials in accordance with ASTM C1280, reviewed shop drawings, and manufacturer’s written instructions.

.2 Install sheathing with long dimension perpendicular to metal studs, offset joints and butt tight, centre edges of sheathing over metal studs, mechanically fasten with specified fasteners and washers in accordance with manufacturer’s instructions.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for the miscellaneous and metal fabrication work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.

.3 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.4 ASTM A480/A480M-15, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.5 ASTM A276, Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

.6 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

.7 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.8 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.

.9 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.

.10 CAN/CSA S16.1-M, Limit States Design of Steel Structures.

.11 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

.12 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.

.13 CSA W48, Filler Metal and Allied Materials for Metal Arc Welding.

.14 CSA W59-M, Welded Steel Construction (Metal Arc Welding).

.15 CAN/CSA W117.2-M, Safety in Welding, Cutting and Allied Processes.

.16 CAN/CGSB 1.40-M, Primer, Structural Steel, Oil Alkyd Type.

.17 CGSB 85-GP-16M, Painting Galvanized Steel.

.18 NAAMM, The National Association of Architectural Metal Manufacturers.

.19 Steel Structures Painting Council (SSPC), Steel Structures Painting Manual, Vol. 2.

1.3 **DESIGN REQUIREMENTS**

.1 Design details and connections, where not shown on Drawings, in accordance with CAN/CSA-S16.1 and CSA S136.1.

1.4 **SUBMITTALS**

.1 Shop drawings:
- .1 Submit shop drawings for fabrication and erection of miscellaneous and metal items in accordance with Section 01 30 00 indicating:
  - .1 Materials, core thicknesses, class of finish (AMP 555), connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
  - .2 Ensure shop drawings are of one uniform size and based on field measurements.

1.5 **QUALITY ASSURANCE**

.1 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in work of comparable complexity and scope, to perform the following services as part of the work of this Section:
- .1 Design metal fabrication items that are required to resist live, dead, lateral, wind, or seismic loads.
- .2 Review, stamp, date and sign shop drawings..

.2 Workmanship: Fabricate work of this Section to meet the required class of workmanship indicated below in accordance with NAAMM's AMP 555, Section 8.
- .1 Class 1: for use on direct exposed to view fabricated items:
  - .1 Exposed surfaces are finished smooth without pitts, mill marks, nicks, burrs, sharp edges, and scratches filled or ground off. Defects should not show when painted, polished, or finished.
  - .2 Welds should be concealed where possible. Exposed welds are ground to small radius with uniform sized cove unless otherwise noted.
  - .3 Distortions should not be visible to the eye.
  - .4 Exposed joints are fitted to a hairline finish.

.3 Execute welding by firms certified in accordance with CSA W47.1 Division 1 or 2.1. Ensure welding operators are licensed per CSA W47.1 for types of welding required by Work.

.4 Perform stainless steel work in accordance with NAAMM, Code of Standard Practice for the Metal Industry, Workmanship, Class 1.

2 Products

2.1 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers and paints are to have low VOC content limits.
- .2 Unless detailed or specified herein, standard products will be acceptable if construction details and installation meet intent of Drawings and Specifications.
- .3 Include all materials, products, accessories, and supplementary parts necessary to complete assembly and installation of work of this Section.
- .4 Incorporate only metals that are free from defects which impair strength or durability, or which are visible. Install only new metals of best quality, and free from rust or waves and buckles, and that are clean, straight, and with sharp defined profiles.

.2 Structural shapes, plates, and similar items: CAN/CSA-G40.20/G40.21-M, Grade 350W. Hollow structural sections: CAN/CSA-G40.20/G40.21-M, Grade 350W, Class H.

.3 Galvanized sheet steel: ASTM A653/A653M Grade A, Z275 Commercial Quality zinc coating, size and shape as shown.

.4 Stainless steel sheet and plate: ASTM A480/A480M, Type 304, finish to AISI No. 4. Size as shown.

.5 Stainless steel shapes: ASTM A276, Type 304, finish to AISI No. 4 or X-L Blend S as indicated. Sizes and shapes as shown.

.6 Bollards (protection posts): ASTM A53/A53-M, Schedule 40 standard weight steel pipe in quantity and sizes shown.

.7 Metal grating: Galvanized steel bar grating 'Standard Tru-Weld' type 19-2 by Fisher & Ludlow.

.8 Welding materials: CSA W48 and CSA W59-M.

.9 Fasteners: Conforming to ASTM A307, Grade A, in areas not exposed to view, use unfinished bolts with hexagon heads and nuts. In areas exposed to view, use bolts, nuts, washers, rivets, lock washers, anchor bolts, machine screws and machine bolts Z275 zinc coated in accordance with ASTM A653/A653M. Supply bolts of lengths required to suit thickness of material being joined, but not projecting more than 6 mm beyond nut, without the use of washers.

.10 Primer paint: CAN/CGSB-1.40-M or CPMA 1.73a.

.11 Galvanized primer paint: Inorganic zinc rich primer. For use on galvanized fabrications where touch up is to remain unpainted in finished work; Carbozinc 11WB

by Carboline Company, Catha-Coat 305 by Devoe Coatings or Zinc Clad XI by Sherwin Williams.

.12 Drilled inserts: “HSL-3" by Hilti Inc. or “Dynabolt Sleeve Anchors” by ITW Construction Products, heavy-duty anchors, sizes as shown.

.13 Adhesive anchor system: ‘HIT HY 200 Injectable Mortar with Hilti HAS Stainless Steel Anchor Rod System’ by Hilti Ltd. or approved alternative by ITW Construction Products, complete with all components required for a complete installation.

2.2 FABRICATION

.1 Verify dimensions of existing Work before commencing fabrications and report any discrepancies to the Consultant.

.2 Fit and assemble work in shop where possible. Execute work in accordance with details and reviewed shop drawings.

.3 Use self-tapping shake-proof screws on items requiring assembly by screws or as indicated. Use screws for interior metal work. Use welded connections for exterior metal work unless otherwise found acceptable by the Consultant.

.4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush. Seal exterior steel fabrications against corrosion in accordance with CAN/CSA S16.1-M.

.5 Execute shop welding to requirements specified .

.6 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.

.7 Assemble members without twists or open joints.

.8 Correctly size holes for connecting work of other trades where such can be determined prior to fabrication. Where possible, show holes on shop drawings. Place holes not to cause appreciable reduction in strength of member.

.9 Draw mechanical joints to hairline tightness and seal countersunk screw and access holes for locking screws with metal filler where these occur on exposed surfaces.

2.3 FABRICATED ITEMS

.1 Refer to Drawings for details of metal fabrication work and related items not specifically listed in this Section.

.2 Where work is required to be built into work of other Sections supply such members to respective Sections.

.3 Provide miscellaneous and metal fabrications indicated on the drawings, listed below, and not indicated to be supplied under other Sections. Provide miscellaneous and metal fabrications including but not limited to the following:

.4 Lintels: Fabricated from CAN/CSA-G40.20/G40.21-M, Grade 350W, size and location as shown, width to be not less than 25 mm less than width of wall and extend 200 mm beyond opening at each end. Unless otherwise shown, fabricate lintels in block walls of steel sections.

5. Masonry lateral support angles:
   .1 Supply only, to Section 04 20 00 for installation, all horizontal lateral support anchors at top of non-load-bearing masonry walls.
   .2 Refer to Structural Drawings for size and spacing of required support anchors. Provide drilled holes as required for anchorage.
   .3 Galvanized for all exterior wall and unheated and high humidity locations.

6. Shelf Angles: Of size indicated on Drawings and as specified in structural steel specifications, with adjustable inserts for vertical adjustment and slotted holes for horizontal; galvanized.

.7 Wood privacy framing: Structural channel and angle framing continuously welded and securely anchored to structure. Design framing and anchorage to support assembly dead loads and live loads, and lateral loads attributable to misuse and vandalism. Finish: Prime painted.

.8 Steel ladders (interior and exterior):
   .1 Fabricate complete with steel stiffeners, rungs, angle rails, bent plate straps or angle brackets as shown.
   .2 Ladders in elevator pits shall extend 1220 mm high above finished floor.
   .3 Provide safety cages around ladders where indicated on Drawings, in accordance with Ministry of Labour requirements.
   .4 Provide safety grating at top landing of exterior ladder. Galvanized steel channel planks with serrated edges on diamond shaped openings. ‘Grip Span 9-1/2" Diamond’ by Fisher & Ludlow.
   .5 Finish: Hot dipped galvanized.

.9 Hose tower platform:
   .1 Fabricate platform complete with, but not limited to galvanized steel bar grating, guardrail and hose pegs:
      .1 Metal grating: 6 mm thick steel plate, size and pattern as indicated on drawings.
      .2 Guardrails, and posts:
         .1 Design railings to withstand minimum horizontal and vertical loads as required to meet requirements of authorities having jurisdiction. In no instance shall load design of railings be less than 3.0 kN/m horizontally and 1.5 kN/m vertically.
         .2 Close open ends of steel guardrails with 1.9 mm thick closure neatly welded. Fabricate guardrails as shown on drawings.

.3 Guardrail bracket: Fabricate as shown. After fabrication, galvanized bracket in accordance with ASTM A123.

.3 Hose pegs: Heavy duty galvanized steel.

.2 Finish: Hot dipped galvanized.

.10 Corner Guards: 100 x 100 x 3.0 mm, stainless steel 2000 mm high with adjustable masonry anchors welded to back at maximum 400 mm centres.

.11 Bollards (protection posts):

.1 Provide bollards as indicated on drawings. Posts to be 250 mm diameter with a wall thickness of 8 mm. Place posts into a 1500 mm foundation, fill with 20 Mpa concrete and round top. Project pipes 1500 mm above finished grade. Finish prime coat.

.2 Finish: Provide paint finish in accordance with Section 09 91 00, colour to be selected by Consultant.

.12 Vanity counter supports:

.1 Provide supports for vanity counters. Construct supports where indicated, conceal supports within cavity of drywall partition.

.2 Provide all drill holes required for concealed anchorage of counters and for anchoring to building structure.

.13 Bench Supports:

.1 Supply only, for installation under work of Section 06 20 00, bench supports constructed of steel plates of sizes noted. Provide supports at maximum 609 mm centres and not less than 152 mm from ends of bench run.

.2 Construct supports as detailed. Provide all drill holes required for concealed anchorage of wood bench and for anchoring to building structure.

.14 Miscellaneous steel brackets, supports and angles

.1 Supply and install or supply for installation by trades responsible, all loose steel brackets, supports and angles where indicated, except where such brackets, supports and angles are specified under work of other Sections. Drill for countersunk screws, expansion anchors and anchor bolts.

.2 Unless otherwise specified, prime paint for interior installation; galvanized finish for exterior installation.

2.4 STAINLESS STEEL WORK

.1 Take all necessary precautions to safeguard against latent surface discolouration due to disturbance of the natural protective oxide coating of the material or to contamination from other sources.

.2 Workmanship shall be the best standard practice for this type of work. Execute stainless steel work in accordance with the applicable instructions set forth in Atlas Stainless Steels' "Technical Data" handbook on stainless steel.

.3 Do all stainless steel fabrication in clean shops, located away from areas where carbon steel is burnt, ground, or cut with abrasive wheels to ensure that carbon steel dust will not be embedded into the stainless steel, and as follows:
- .1 In fabrication of stainless steel do not use tools and dies which have been used on carbon steels.
- .2 Ensure tools and dies use for forming and cutting stainless steel are free of nicks and other damage.
- .3 Do not use carbon grits and grinding wheels which will imbed foreign particles into stainless steel surfaces. Use only stainless steel wool when wool polishing is required.
- .4 Stainless steel items, on which rust stains appear, shall be replaced with new fabricated material.

2.5 ANCHORS AND FASTENING

.1 Use weld studs of size not larger than 10 mm for attaching miscellaneous materials and equipment to building steel. If weight of item requires larger fasteners use clips or brackets and secure by welding or through bolting.

.2 Use self drilling expansion type concrete anchors for attaching to masonry and concrete

.3 Do not secure items to steel deck.

.4 Use steel beam clamps of two bolt design to transmit load to beam web. Do not use C and I clamps.

2.6 WELDING

.1 Perform welding by electric arc process.

.2 Execute welding to avoid damage or distortion to Work. Execute welding in accordance with following standards:
- .1 CSA W48 - for Electrodes. If rods are used, only coated rods are allowed.
- .2 CSA W59-M and CSA W59S1-M for design of connections and workmanship.
- .3 CAN/CSA W117.2-M - for safety.

.3 Thoroughly clean welded joints and expose steel for a sufficient distance to perform welding operations. Finish welds smooth. Supply continuous and ground welds which will be exposed to view and finish paint.

.4 Test welds for conformance and remove work not meeting specified standards and replace to Consultant's acceptance.

2.7 SHOP PAINTING

.1 Clean steel to SSPC SP6 and remove loose mill scale, weld flux and splatter.

.2 Shop prime steel with one coat of primer paint to dry film thickness of 0.07 mm. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 deg C. Paint items under cover and leave under cover until primer is dry. Follow paint manufacturer's recommendations regarding application methods, equipment, temperature, and humidity conditions.

.3 Shop prime galvanized steel in accordance with CGSB 85-GP-16M.

.4 Clean but do not paint surfaces being welded in field.

.5 Do not paint surfaces embedded in concrete, but clean as if they were to be primed.

.6 Do not prime steel to be fireproofed or to receive intumescent paint coating.

.7 Do not prime machine finished surfaces, but apply an effective anti-rust compound.

.8 Take precautions to avoid damage to adjacent surfaces.

2.8 **HOT DIP GALVANIZING**

.1 After fabrication, hot dip galvanize specific miscellaneous steel items as indicated. After galvanizing, plug relief vents air tight with appropriate aluminum plugs as suitable and required for intended metal fabricated item. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with zinc rich primer in accordance with manufacturer's printed directions.

.2 Hot-dip galvanize members in accordance with requirements of the following ASTM, with minimum coating weights or thicknesses as follows:

.1 Rolled, pressed and forged steel shapes, plates, bars and strips: ASTM A123; average weight of zinc coating per square/metre of actual surface, for 4.8 mm and less thickness members 600 g/m^2 for 6 mm and heavier members 640 g/m^2.

.2 Iron and steel hardware: ASTM A153; minimum weight of zinc coating, in ounces per square foot of surface, in accordance with ASTM A153,Table 1 for the various classes of materials used in the Work.

3 Execution

3.1 **EXAMINATION**

.1 Examine previously installed Work, upon which this Section depends, verify dimensions and condition of existing Work, and coordinate repairs, alterations, and rectification if necessary. Commencement of work of this Section is deemed to signify acceptance of existing, prior conditions.

.2 Obtain Consultant's written approval prior to field cutting or altering of structural members.

3.2 **ERECTION**

.1 Install metal fabrications in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Fit joints and intersecting members accurately. Make work in true planes with adequate fastenings. Build and erect work plumb, true, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.

.3 Perform drilling of concrete and steel as required to fasten work of this Section.

3.3 **TOUCH UPS**

.1 Paint bolt heads, washers, nuts, field welds and previously unpainted items. Touch up shop primer damaged during transit and installation, with primer to match shop primer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for rough carpentry work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.2 ASTM A325, Specification for Bolts Quenched/Tempered Steel Nominal Thread Diameter M16 - M36 For Structural Steel Joints.

.3 ASTM A653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.4 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.5 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.

.6 CAN/CSA O80 Series M, Wood Preservation.

.7 CSA O121-M, Douglas Fir Plywood.

.8 CAN/CSA O141, Softwood Lumber.

.9 CSA O151-M, Canadian Softwood Plywood.

.10 CWC, Canadian Wood Council, Wood Reference Book.

.11 NLGA, Standard Grading Rules for Canadian Lumber, National Lumber Grades Authority

1.3 **QUALITY ASSURANCE**

.1 Lumber identification: Grade stamp of an agency certified by the Canadian Lumber Standards Accreditation Board.

.2 Plywood identification: Grade mark in accordance with applicable CSA standards.

.3 Lumber quality: Carefully select individual pieces so that knots and obvious defects will not interfere with placing bolts, proper nailing or making proper connections.

.4 Moisture Content of wood at time of construction shall be 19% maximum.

.5 Each piece of pressure treated lumber and fire retardant treated lumber shall be shop marked with the pressure treatment brand and ULC monogram respectively, in accordance with CAN/CSA O80-M.

6. Dimensions of lumber shall conform to dressed sizes specified in CAN/CSA-0141 unless actual dimensions are otherwise indicated or specified.

7. Dimensional references to lumber on Drawings and in Specifications are to nominal sizes unless actual dimensions are indicated. Such actual dimensions shall be dry size.

.8 Lumber defects: Discard wood with defects which will render a piece unable to serve its intended function. Lumber will be rejected by Consultant for excessive warp, twist, bow, crook, mildew, fungus, or mould, as well as for improper cutting and fitting, whether or not it has been installed.

1.4 ENVIRONMENTAL REQUIREMENTS

1. When it is required that wood maintain dimensional stability and tolerances to ensure accurate installation of later work, store and install it only in dry areas, and where no further installation of moist materials is contemplated.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Store materials in a dry area. Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural and aesthetic properties. Vent to allow air movement. Tie covering to keep in place.

2 Products

2.1 MATERIALS

.1 General: All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.

.2 Lumber: Softwood, G4S, moisture content 19% or less at time of installation, in accordance with the following:
- .1 Lumber shall be of same species and grade, equally seasoned and shall be processed and stamped at same mill.
- .2 CSA O141 and NLGA Standard Grading Rules for Canadian Lumber.
- .3 Board quality: Construction or better.
- .4 Dimension quality:
  - .1 Structural joists, planks, and framing: No. 1 Select Structural.
  - .2 Light framing: Construction.

.3 Plywood: CSA O121-M, G1S, T & G, standard construction, laminated with waterproof adhesive, exterior grade, Thickness as indicated on drawings.

4. Sheathing: Douglas Fir, CSA 0121-M or CSA O151-M; Select-Tight Face, exterior grade, T & G.

.5 Roof lumber: NLGA, Construction grade light framing, Jack Pine, S4S, pressure treated to CAN/CSA-O80 series using copper based waterborne preservative treatment, impregnated to a net retention of 4 kg/ m^3 of preservative unless otherwise specified by preservative manufacturer.

.6 Wood polymer lumber: Fabricated lumber constructed from 50% recycled wood fibre and 50% reclaimed polyethylene. Colour: To be selected by Consultant. 'Trex Wood Polymer Lumber' manufactured by Trex Company and distributed by Taiga Forest Products or approved alternative.

.7 Surface applied wood preservative: Green coloured copper napthenate or 5% pentachlorophenol solution, water repellant preservative or same copper based preservative as used for shop impregnation, in accordance with CAN/CSA O80.

.8 Fire retardant treatment of lumber and plywood (interior and protected locations): 'Dricon FRT' fire retardant treatment by Biewer Lumber or approved alternative, conforming to ASTM E84, to provide a flame spread rating of 25 or less.

.9 Rough hardware: Conforming to ASTM F1667; Nails, bolts, screws, anchors, expansion shields, and other fastenings required to frame and fix rough carpentry as follows:
- .1 Nails, spikes and staples: Spiral type.
- .2 Bolts: ASTM A325; 12.7 mm diameter minimum with nuts and washers unless noted otherwise.
- .3 Screws: Countersunk head, full thread type.
- .4 Proprietary fasteners: Toggle bolts, expansion shields, lag bolts, screws, inorganic fibre plugs, recommended for purpose by manufacturer.
- .5 Galvanize rough hardware used in fire treated wood and hardware exposed to the atmosphere.

.10 Fasteners for use in pressure treated wood: Provide hot dipped galvanized fasteners complying to ASTM A153 and connectors in accordance with ASTM A653, Class G185 for non-structural members. Provide type 304 or 316 stainless steel fasteners and connectors for use in Structural, pressure treated wood.

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 of this Section means acceptance of existing conditions.

3.2 **GENERAL**

.1 Lay out work carefully and to accommodate work of others. Cut and fit accurately: erect in position indicated by Drawings.

.2 Install rough carpentry to allow for expansion and contraction of the materials.

.3 Cut work into lengths as long as practicable and with square ends. Align, level, square, plumb, and secure work permanently in place. Brace work temporarily as required. Join work only over solid backing.

.4 Bore holes true to line and to same size as bolts. Drive bolts into place for snug fit, and use plates or washers for bolthead and nut bearings. Turn up bolts and lag screws tightly when installed, and again just before concealed by other work or at completion of Work.

.5 Provide anchors, bolts, and inserts required for attachment of the work of this Section, to those performing the work of other Sections and who are responsible for their installation.

.6 Do not attach work by wood plugs or blocking in concrete or masonry. Use lead shields, expansion shields, or similar methods only as approved by Consultant.

3.3 **MISCELLANEOUS WOODWORK**

.1 Fit and install wood furring, strapping, grounds and blocking. Adequately size, correctly place and conceal members for finishes, fitments and for work under other Sections. Do not assume that Drawings show required work exactly or completely. Anchor wood members securely in place.

.2 Install rough bucks, nailing strips and linings to rough openings as required for backing for frames and other work.

.3 Except where steel supports are specifically shown, provide wood blocking and supports in metal stud partitions for fastening of item such as casework and other wall mounted accessories. Have respective trades approve the location of such wood blocking.

.4 Bolt wood blocking or nailing strips to steel framing.

.5 Align and plumb faces of furring and blocking to tolerance of 1:600.

.6 Use fire retardant lumber for blocking/framing in ceiling\ spaces, partitions and bulkheads.

.7 Wood Privacy Screen:

.1 Use pressure treated wood with hot dipped galvanized connectors, nails and bolts. Finish wood in accordance with Section 09 91 00.

.2 Coat wood below grade with two coats of Creosote unless indicated otherwise by Consultant.

.3 Install screen in sizes shown on Contract Drawings.

3.4 POLYMER LUMBER CONSTRUCTION

.1 Construct polymer lumber where indicated on drawings.

.2 Cut and pre-drill all wood polymer boards using carbide tipped equipment.

.3 Gapping: gap polymer lumber end to end with a 1.6 mm gap for every 20°F of difference between installation temperature and the hottest temperature expected. Gap width to width with a minimum 3 mm gap.

.4 Install polymer boards as recommended by manufacturer for summer or winter installations.

3.5 ROOF WOODWORK

.1 Install roof woodwork as indicated on drawings.

.2 Fasten roof woodwork at maximum 400 mm o.c. in staggered pattern unless noted otherwise.

3.6 BACKBOARDS

.1 Install plywood backboards, primed and painted white on both sides, with fire retardant paint.

.2 Use minimum 19 mm thick plywood on 19 x 38 mm furring around perimeter and at maximum 300 mm intermediate spacing.

3.7 FASTENERS

.1 Frame, anchor, fasten, tie and brace members for required strength and rigidity.

.2 Use hot dipped galvanized fasteners for exterior work and work below grade.

.3 Countersink bolts and bolt heads as required for clearance of other work.

.4 Size fasteners to penetrate base member by half of fastener length minimum. Minimize splitting of wood members by staggering nails in direction of grain.

.5 For plywood use spiral, annular or resin coated nails and staples.

3.8 SURFACE-APPLIED WOOD PRESERVATIVE

.1 Treat raw surfaces, drilled holes and cut ends of pressure treated wood with 2 coats of wood preservative immediately after cutting.

.2 Apply preservative by dipping, by brush or by pouring into plugged holes to completely saturate surface.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products equipment and services necessary for the finish carpentry work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ANSI A208.1, Particleboard.

.2 ANSI/HPVA HP-1, Hardwood and Decorative Plywood.

.3 ANSI/NEMA LD 3, High-Pressure Decorative Laminates.

.4 APA - The Engineered Wood Association.

.5 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.

.6 Architectural Woodwork Manufacturers Association of Canada (AWMAC).

.7 North American Architectural Woodwork Standards (NAAWS).

.8 CAN/CSA O141, Softwood Lumber.

.9 CSA O151-M, Canadian Softwood Plywood.

.10 National Hardwood Lumber Association (NHLA) Rules for the Measurement and Inspection of Hardwood and Cypress.

.11 National Lumber Grades Authority (NLGA) Standard Grading Rules for Canadian Lumber.

1.3 **SUBMITTALS**

.1 Shop drawings: Submit shop drawings of finish carpentry work in accordance with Section 01 30 00 indicating:
  .1 Materials, thicknesses, sizes, finishes, wood species, grades, profiles, connection attachments, shop jointing, field jointing, reinforcing, anchorage, fastener types and sizes, location of exposed fastenings, mechanical and electrical service routes, service outlets, cutout locations, and sizes.
  .2 Include erection drawings, plans, elevations, sections, and details as applicable.

.2 Samples: Submit samples of the following in accordance with the requirements of Section 01 30 00:
- .1 Two representative pieces of each type of wood to receive a stained or natural finish.
- .2 Two representative pieces of each type of wood finished as specified.
- .3 Two of each colour, pattern, gloss, and texture of plastic laminate, in manufacturer's standard tag size.
- .4 Two samples of laminated plastic joints, edging, cutouts and postformed profiles.
- .5 Two of each solid surface, in 100 x 75 x 12 mm samples.
- .6 Two samples of melamine surfaced board, edging and postformed profiles.
- .7 One of each item of finish carpentry hardware.

.3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 QUALITY ASSURANCE

.1 Execute work of this Section by member of AWMAC, with 5 years experience in finish carpentry work of comparable complexity and scope. Submit proof of experience upon Consultant’s request.

.2 Fabricate finish carpentry work in accordance with NAAWS, Premium Quality materials and installation unless otherwise indicated. Perform work in accordance with the definition of Good Workmanship as defined in the NAAWS.

.3 Remove and replace finish carpentry work which does not conform to the NAAWS or as amended by these Specifications.

.4 Mock-up:
- .1 Shop fabricate one mock-up of a base cabinet, wall cabinet, and counter top for each type of surfacing specified, complete with hardware and shop applied finishes, installed in location acceptable to Consultant.
- .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
- .3 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle finish carpentry in accordance with the NAAWS. Control the temperature and humidity in accordance with the NAAWS recommendations, before, during, and after finish carpentry delivery, and also during storage and installation.

.2 Cover finished plastic laminated work with heavy kraft paper or put in cartons during shipment. Protect installed surfaces by approved means. Do not remove until immediately before final inspection.

1.6 **EXTENDED WARRANTY**

.1 Submit an extended warranty for plastic laminate work of this Section in accordance with General Conditions, except that warranty period is extended to 2 years from date of Substantial Performance of the Work.
- .1 Warrant against defects in material and workmanship including but not limited to opening of joints, cracking, shrinkage, warpage, and delamination of plastic laminate.
- .2 Coverage: Complete replacement including affected adjacent Work.

2 Products

2.1 **MATERIALS**

.1 General: All materials under work of this Section, including but not limited to, adhesives and mastics, are to have low VOC content limits.

.2 Concealed framing lumber: Eastern Spruce, Balsam Fir, or Jack Pine, to CAN/CSA O141, NLGA, and NAAWS Custom Grade, S4S, average moisture content 7% +/- 2% at installation.

.3 Hardwood lumber (WD-1): Plain sliced grade A to NHLA and AWS Premium Grade, S4S, average moisture content 7% +/- 2% at installation. Provide the following wood species where required:
- .1 Eastern white Cedar.
- .2 Refer to Colour and Material Schedule.

.4 Hardwood Plywood (for cabinet frames, stretchers and blocking): Graded in accordance with AWMAC/AWI; average moisture content of 6-8 percent; species and grade as follows:
- .1 Shop sanded veneer core Maple plywood, 19 mm or 25 mm thickness.

.5 Softwood plywood for drawer body construction: Maple veneer core plywood (all laminations Maple veneer), interior grade plywood, G2S, sanded
- .1 Quality Standard: GOST 3916.1 (Russian), Veneer Grade: BB/BB;
- .2 Thicknesses: 12 mm (nine laminations) and 15 mm (eleven laminations)

.6 Hardwood veneer:
- .1 Maple unless otherwise indicated, conforming to ANSI/HPVA HP-1 having finishes and meeting grades as follows:
  - .1 Transparent finish, Grade AA.
- .2 Face veneer cut: Rotary cut.
- .3 Sizes, thickness, and shapes as indicated.

.7 Shelving: 19 mm thickness for spans up to 700 mm, 25 mm thickness for longer spans, Maple hardwood core veneers, with hardwood veneer edge banding.

.8 Cabinet Backs: Particle board core.

.9 Plastic laminate (PL-#): Provide plastic laminates conforming to ANSI/NEMA LD 3 as follows:
- .1 Flatwork face sheet: 1.2 mm thick, heavy wear resistance.
- .2 Vertical interior face sheets: 0.8 mm thick.
- .3 Postformed face sheet: 0.8 mm thick.
- .4 Backing sheet: thickness to match face sheet, high pressure laminate, manufactured by same manufacturer as face sheet.
- .5 Plastic laminate: As manufactured by Arborite, Formica, Lamin-Art, and Lamitech HPL (Weston Premium Woods) and Wilsonart.
- .6 Colours: Refer to Colour and Material Schedule.

.10 Compact laminate:
- .1 Provide compact laminates conforming to NEMA LD3, Grade GCS, 12 mm thick, consisting of multiple resin-impregnated kraft paper core with colour and clear melamine surface sheets, fused at high temperature.
- .2 Size: Refer to Drawing for sizes of each panels.
- .3 Finish: Solid colour with matte finish to be later selected by Consultant.
- .4 Compact laminate manufacturer: Formica, Wilsonart or approved alternative.

11. Melamine Surfaced Particleboard: ANSI A208.1, Grade M2 particleboard with a melamine impregnated decorative paper thermofused onto the surface. Edging to be done in minimum 0.5 mm thin PVC to match melamine colour. Refer to Colour and Material Schedule for melamine type.

.12 Particle board core (for cabinet door and drawer fronts): ANSI A208.1, Grade M2 of thickness indicated. Particleboard to be bound with waterproof adhesive and meeting the following minimum criteria:
- .1 Density: minimum 705 kg/m^3.
- .2 Internal bond: 0.45 N/mm^2.
- .3 Modulus of rupture: 14.5 N/mm^2.
- .4 Modulus of elasticity: 2250 N/mm^2.
- .5 Face screw holding: 1000 N.
- .6 Edge screw holding: 900 N.

.13 Tall Storage Units: 45 mm solid core wood doors with matching stiles. Doors to be installed on 38 mm x 45 mm solid hardwood rails. Rails to be rabbeted and glued to gables.

.14 Laminating adhesive: CSA O112 Series, water resistant type, low VOC content, selected by laminate manufacturer for intended end use.

.15 Engineered quartz countertop (QTZ-1): 93% crushed quartz combined with polyester resins and pigments formed into minimum 20 mm thick dense non-porous slabs with polished finish. Refer to Colour and Material Schedule for quartz colour and type.

.16 Solid Surfacing (SPS-1):
- .1 12 mm thick sheet stock, provide with bullnose edge and all cutouts as required. 'Avonite' solid surfacing or approved alternative. Refer to Colour and Material Schedule for colour type.
- .2 Installation and seam adhesives to be as recommended by solid surfacing manufacturer, colour matched to solid surfacing.

.17 Wood benches: Refer to Colour and Material Schedule for wood type in sizes and thickness shown on drawings.

.18 Draw bolts and splines: Type as recommended by fabricator.

.19 Nails and staples: Conforming to ASTM F1667; Size and type to suit application, galvanized for exterior work, interior humid areas and for treated lumber; plain finish elsewhere.

.20 Bolts, nuts, washers, blind fasteners, lags and screws: Size and type to suit application. Stapling is not acceptable.

.21 Adhesive and bituminous mastic: Selected by the millwork fabricator with low VOC content.

.22 Miscellaneous metals: In accordance with Section 05 50 00.

.23 Finishing: In accordance with Section 09 91 00.

2.2 HARDWARE

.1 The following hardware is the minimum quality standard for the work of this Section. Alternatives may be considered provided they are approved by Consultant prior to ordering of products.

.2 19 mm Door Hinges: Blum Press–In 170 degree self close full overlay or Salice equivalent. Hinges to be provided with factory installed knock in dowels. For quantity of hinges required per door, refer to hinge manufacturer's manual. Wood screw fastening system will not be accepted.

.3 19 mm Door Hinge Plates: One piece plate with min. 3 mm height adjustment. Hinge plates to be installed using pre-mounted system screws, Euro screw in 5mm pre-drilled hole. Wood screw fastening system will not be accepted.

.4 19 mm Door Dampener: Blumotion 971A with Cruciform Base or Salice equivalent required for all 19mm doors to allow for soft closing.

.5 19 mm Bumpers: Polyurethane 3 mm high X 10 mm diameter / minimum 2 per door and drawer front.

.6 Shelf Standards and Clips: KV 255 pilaster and KV 256 clip – satin nickel finish / Note: Pilasters to be fully recessed into gables.

.7 Drawer and cabinet pulls (H-#): Refer to Colour and Material Schedule.

.8 Coat Rods and Flanges: Richelieu # 122108140 and 1225140.

.9 Coat Hooks in Occasional Staff Lockers: '307 C26D' by GSH.

.10 Elbow catches: Richelieu Heavy Duty Elbow Catch # 5540180 / nickel finish / required at all two door units.

.11 Drawer Slides: Accuride 45 kg (100 lbs) #3832EC x length to suit. Finish C - Clear Electroplating.

.12 Locks:
- .1 Cam locks/deadbolt locks complete with lock core by Hafele, type to suit application and installation.
- .2 Each room to be keyed alike.
- .3 Tall storage unit door hinges and locksets, to be supplied by Hardware Supplier, installed by cabinet manufacturer.
- .4 All cabinet doors and drawers to be lockable. Provide three keys per key code and five master keys.

.13 Castors: 50 mm, general duty rubber swivel caster with brake and 57 kg (125 lb) weight capacity, 'Model F25086' by Richelieu.

.14 Safety release coat hook: High strength polycarbonate, screw mounted; Henkelhook.

2.3 PLASTIC LAMINATE WORK

.1 Perform plastic laminate Work in accordance with AWS Quality Standards and ANSI/NEMA LD 3.

.2 Ensure adjacent parts of continuous laminate work match in colour and pattern.

.3 Laminate plastic laminates to core materials in accordance with manufacturer's instructions.

.4 Fabricate core surfaces and profiles with continuous support and bond over entire surface to receive plastic laminate.

.5 Apply plastic laminate backing sheets to balance shrinkage stresses induced by plastic laminate face sheets.

.6 Minimize joints in plastic laminate Work; do not install joints in plastic laminate Work in less than 2400 mm o.c. Locate joints minimum 610 mm from cut-outs. Offset core and plastic laminate facing joints.

.7 Form shaped profiles and bends as indicated, using postformed grade laminate to laminate manufacturer's instructions.

.8 Use straight self-edging laminate strip to match adjacent colour, finish, gloss, and pattern to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20 degrees. Do not mitre laminate edges.

.9 Apply laminated plastic liner sheet to interior of cabinetry and where indicated.

.10 Fabricate units by solid surfacing manufacturer's certified or approved fabricator/ installer. Fabricate built-up profiles as indicated.

2.4 **COMPACT LAMINATE WORK**

.1 Perform compact laminate Work in accordance with AWS Quality Standards and ANSI/NEMA LD 3.

.2 Ensure adjacent parts of continuous laminate work match in colour and pattern.

.3 Fabricate compact laminates to core materials in accordance with manufacturer's instructions. Refer to Drawings for location of panels.

.4 Fabricate bed frame and any additional items indicated on Drawings to be 12 mm thick compact laminate panels. Multiple resin-impregnated kraft and surface sheets shall be fused at high temperature and pressure with all edges finished and polished.

.5 Avoid stress cracking, do not use square-cut inside corners. All inside corners to have a minimum 3 mm radius and all edges routed smooth unless indicated otherwise by consultant.

.6 All corners shall be mitered. Both panels shall have reveal on inside corner to accommodate structural adhesive with metal spline.

.7 All fasteners shall be countersunk, complete with plug made flush with panel.

.8 Fabricate core surfaces and profiles with continuous support and bond over entire surface to receive compact laminate.

.9 Joints:
- .1 Install joints in accordance with reviewed shop drawings and manufacturer written instructions.
- .2 Jointing shall be placed at logical locations in intended millwork item and shall meet the overall aesthetic intent of the Consultant.
- .3 Minimize joints in laminate work.

.10 Form shaped profiles and bends as indicated, using postformed grade laminate to laminate manufacturer's instructions.

.11 Fabricate units by manufacturer's certified or approved fabricator/ installer. Fabricate built-up profiles as indicated.

2.5 **FABRICATION**

.1 Be responsible for methods of construction and for ensuring that materials are rigidly and securely attached and will not be loosened by the work of other sections.

.2 Coordinate locations of concealed supports and blocking with other parts of Work. Provide cutouts for outlet boxes and other fixtures.

.3 Fabricate work in a manner which will permit expansion and contraction of the materials without visible open joints. Conceal joints and connections in wherever possible.

.4 Set nails and countersink screws, apply wood filler to indentations, sand smooth and leave ready to receive finish.

.5 Mitre exposed corners, no end grain shall be visible in completed installation.

.6 Finish millwork in accordance with Section 09 91 00. Finished millwork shall be free from bruises, blemishes, mineral marks, knots, shakes and other defects and shall be selected for uniformity of colour, grain and texture.

.7 Shop assemble finish carpentry to accommodate delivery and handling and to ensure passage through building openings.

.8 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.

.9 Fabricate sills, screens, frames and moldings to profiles shown.

.10 Countertops:

- .1 Core material shall be 19 mm thick particleboard with the exception of window stools and countertops with sinks installed, these shall be plywood core.
- .2 Use draw bolts and splines in countertop joints. Maximum spacing 450 mm a.c., 76mm from edges.
- .3 Veneer laminated plastic to core material in accordance with adhesive manufacturer's instructions. Ensure core and laminate profiles coincide to provide continuous support and bond over entire surface. Use continuous lengths up to 3050 mm.
- .4 Keep laminate joints 305 mm from sink cutouts. Obtain Consultant's approval for locations of all laminate joints in counter tops prior to fabrication .
- .5 Make joints where approved to hairline width. Offset joints in plastic laminate from joints in substrate.
- .6 Provide cutouts as required for inserts, grilles, outlet boxes and other fixtures. Radius internal corners, chamfer laminate edges, and apply uncut shellac sealer to exposed edges of substrate at all cutouts.
- .7 Nosing: 32 mm x 3 mm PVC edge band.
- .8 Backsplash: square-edged, as detailed on the drawings.

2.6 CABINET FABRICATION

.1 General:
- .1 Cabinet Components: As specified in AWMAC QSI Section 400-G as amended by the following requirements;
- .2 Hardware: Supply hinges, drawer slides, products and materials as specified.
- .3 Door and Drawer Fronts: Particle board core.
- .4 Cabinet Boxes: Particle board core.
- .5 Rails, Toe Kicks and Cabinet Bases: Hardwood veneer core.
- .6 Backs: Particle board core.
- .7 Blocking: Solid lumber.
- .8 Provide Semi-Exposed surfaces in same quality and finish as Exposed parts.
- .9 Adjustable Shelf Techniques/Supports: AWMAC QSI 400B-T-9;
  - .1 Custom Grade: Adjustable shelf multiple holes (min. 5 mm diameter, single pin).
- .10 Joinery of case body members: AWMAC QSI 400B-T-10, stop-dado joints which are glued and mechanically fastened with screws.
- .11 All cabinets provided for this project shall meet or exceed the Custom requirements of AWMAC QSI 400-B-C-1 thru 6.

.2 Wood Cabinet Construction: AWMAC QSI Section 400-G-7 (A), flush overlay style, Custom Grade as amended by the following requirements;
- .1 Exposed and Semi-Exposed Parts (except countertops): Particle board core, minimum 19 mm thick with thermoset melamine.
- .2 Exposed and Semi-Exposed Parts - panel edge band: lapped joint; hardwood veneer edge banding to match exposed parts.

.3 Wall Cabinets: Finish to match base cabinets.
- .1 Provide top and bottom filler and corner panels.
- .2 Provide scribes and fillers with maximum 25 mm exposed dimension.
- .3 Underside of Cabinets: Type 'B' flush (one tight line visible).
- .4 Cabinet backs: Wall hung cabinet backs must not be relied upon to support the full weight of the cabinet and its anticipated locad for hanging/mounting purposes. Method of back joinery and hanging/mounting mechanisms should transer the load to case body members.

.4 Shelving: AWMAC QSI 400B-T-9 Premium Grade, as amended by the following:
- .1 Construction:
  - .1 Multiple hole configuration at 32 mm on centre, 'System 32'.
  - .2 Hardwood veneer on tops and bottoms and hardwood veneer edge banding on exposed edges to match exposed parts.
  - .3 Core: Particle board core, 19 mm thickness up to 700 mm spans, 25 mm thickness for spans greater than 700 mm.
- .2 Provide adjustable shelves in all cabinets.

.5 Wood doors at folding grille: 19 mm hardwood plywood with hardwood veneer, 3800 mm high x 310 wide. Provide cam lock and hinges to suit.

3 Execution

3.1 **INSTALLATION**

.1 Install Work in accordance with AWS Quality Standards and tolerances for Architectural Woodwork. Set and secure finish carpentry in place, rigid, plumb, square, and level.

.2 Scribe and cut as required, fit to abutting walls, and surfaces, fit properly into recesses and to accommodate columns, fixtures, outlets, or other projecting, intersecting or penetrating objects leaving a 0.8 mm gap maximum.

.3 Coordinate cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and other fixtures, in finish carpentry. Round internal corners of cut-outs and seal exposed cores.

.4 Form joints to conceal shrinkage.

.5 Install draw bolts and splines in laminated plastic counter top joints at maximum spacing 450 mm o.c., and 75 mm from edge. Make joints flush, hairline butt joints.

.6 Install finishing hardware accurately and securely in accordance with manufacturer's directions, adjust and clean.

.7 Install prefinished millwork at locations shown on drawings. Position accurately, level, plumb straight.

.8 Apply bituminous coating over wood framing members in contact with masonry or cementitious construction.

.9 Melamine panels: Assemble melamine millwork using dowelled/wafered-and-glue construction. Installed melamine panels shall not show any exposed fasteners on finished/exposed surfaces.

.10 Solid surfacing:
- .1 Install solid surfacing in accordance with manufacturer's instructions.
- .2 Align work plumb and level.
- .3 Seal perimeter of fabrication to adjacent construction in accordance with Section 07 92 00.

.11 Stone countertops:
- .1 Construct countertops of sizes and details as noted.
- .2 Distribute stone units of ranging colour or texture evenly over the entire installation to avoid patches or streaks, to produce a homogeneous blending of all units. If an acceptable pattern or grain direction is apparent, due to natural appearance of stone, or finishing, install units so that pattern or grain is in one direction unless otherwise directed.
- .3 Clean stone exposed surfaces by washing with stiff fibre brush and clean water. Drench dry stones with clean water just before setting.

.4 Accurately and neatly cut, drill and fit stone as required for fixtures, fittings, and other appurtenances abutting or extending through stone and repair all stone after other Sections have finished.

.5 In cutting and fitting, the edges shall be carefully cut and ground to a perfect fit and all cutting shall be done in such a manner as not to impair the strength or appearance of the material.

.6 Apply grout in accordance with grout manufacturer's directions to produce watertight, filled joints without voids, cracks and excess grout.

.7 Apply 2 coats of stone sealer to all stonework in accordance with manufacturer's written instructions.

.12 Hardwood caps:

.1 Provide 13 mm thick plywood blocking mechanically fastened and glued to masonry with hardwood trim in reveal.

.2 Install 38 x 190 mm hardwood cap with rounded exposed edges and ends, glued and mechanically fastened to wood blocking with countersunk fasteners complete with plugs.

.13 Benches/Storage cubicles:

.1 Install 400 mm deep cubicles with vertical divisions as indicated on drawings.

.2 Mechanically fasten to substrate with blocking and countersunk/plugged fasteners.

.3 Construct wood benches of sizes and details as noted.

.4 Anchor wood to supports in a concealed manner.

.5 Mitre joints at corners. Keep joints to a minimum.

.6 Round all corners, edges and ends.

.7 Install bench brackets and supports supplied under work of Section 05 50 00.

.14 Fastening:

.1 Coordinate wall securement, anchorage, and blocking for finish carpentry items.

.2 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.

.3 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.

.4 Provide heavy duty fixture attachments for wall mounted cabinets.

.5 Set finishing nails to receive filler. Where screws are used to secure members, countersink screw in round cleanly cut hole and plug with wood plug to match material being secured.

.15 Remove and replace damaged, marked, or stained finish carpentry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for the dampproofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D41/D41M, Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.

.2 ASTM D4479/D4479M, Specification for Asphalt Roof Coatings, Asbestos Free.

1.3 **SUBMITTALS**

.1 Product data:
  .1 Submit manufacturer's Product data in accordance with Section 01 30 00 for each Product indicating:
    .1 Installation details, physical properties and detailed application and installation instructions, marked as applicable to Work.

.2 Certificates:
  .1 Submit manufacturer's certification stating compliance with criteria specified and that Products are compatible.

1.4 **QUALITY ASSURANCE**

.1 Installer's qualifications: Perform work of this Section by company approved by Product manufacturer and having 5 years recent experience in work of comparable complexity and scope.

1.5 **SITE CONDITIONS**

.1 Do not proceed with work when wind chill effect causes Product to set before correct curing takes place.

.2 Supply and install temporary protection and heating to maintain air temperature and structural base temperature at dampproofing installation area above 5 °C for 24 h before, during and 24 h after installation.

.3 Do not apply dampproofing in wet weather.

.4 Supply and install forced air circulation during installation and curing periods for enclosed applications.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.

.2 Primer: Penetrating asphalt primer to ASTM D41, Type 2; ‘HE910' by Henry Company Canada Inc. or ‘600 Asphalt Primer’ by W. R. Meadows.

.3 Dampproofing: Cold applied, solvent based, asphalt dampproofing to ASTM D4479, Type 1; ‘710-11' by Henry Company Canada Inc. or ‘501 Foundation Coating’ by W. R. Meadows.

.4 Sealing compound: Polymer modified sealing compound; ‘Polybitume 570-05' by Henry Company Canada Inc. or approved alternative by W. R. Meadows.

.5 Reinforcing fabric: Open weave, glass fibre reinforcing consisting of glass fibre yarn saturated with synthetic resins; 990-06 Yellow Jacket by Henry Company Canada Inc. or approved alternative by W. R. Meadows.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Engineer. Commencement of work of this Section means acceptance of existing conditions.

.2 Ensure that surfaces of concrete are dry and in accordance with manufacturer's instructions before applying dampproofing material.

3.2 **PREPARATION**

.1 Seal exterior joints between foundation walls and footings, cracks in foundation walls, and around penetrations through dampproofing with sealing compound. Apply sealing compound in accordance with manufacturer's instructions.

.2 Prime substrates to be dampproofed in accordance with manufacturer's instructions.

3.3 **APPLICATION**

.1 Apply dampproofing in accordance with manufacturer's instructions.

.2 Seal exterior joints between foundation walls and footings with sealing compound before applying dampproofing.

.3 Apply dampproofing in continuous, uniform coating to exterior side of foundation walls enclosing rooms below finished grade. Dampproof from 50 mm below finished grade level to and including tops of foundation walls and footings. Include exterior backfilled portion of interior walls where floors in adjacent rooms are at different elevations.

.4 Brush reinforcing fabric into place overlapping fabric 50 mm at all joints with a soft bristle brush, eliminating wrinkles, air pockets or blisters and ensuring full contact.

.5 Apply two additional coats of dampproofing and two layers of reinforcing fabric to vertical corners and construction joints for minimum width of 230 mm on each side, around penetrations and along pipes passing through walls for minimum of 230 mm.

.6 Apply a seal coat of dampproofing over entire area at minimum 1 l/m^2

3.4 **CLEAN-UP**

.1 Clean, repair, or replace surfaces soiled or otherwise damaged in connection with work of this Section as directed by Engineer. Replace finishes or materials that cannot be cleaned to acceptance of Engineer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for the thermal insulation work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C665, Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

.2 CGSB 71-GP-24M, Flexible Adhesive for Bonding Cellular Polystyrene Insulation.

.3 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.4 CAN/ULC-S702, Mineral Fibre Thermal Insulation for Buildings.

1.3 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating characteristics, performance criteria, and limitations. Indicate installation requirements and techniques, storage, and handling criteria and installation procedure acceptable to manufacturer.

.2 Certification: Submit installer's certification verifying compliance with specification requirements.

1.4 **QUALITY ASSURANCE**

.1 Qualifications: Execute work of this Section by company specializing in thermal insulation work with minimum of three years, recent, documented experience, on work of comparable complexity and scope.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.

2. Batt insulation:
   .1 Batt insulation (non-rated): CAN/ULC-S702, Type 1, friction fit; ‘Unfaced Thermal and Sound Control Batts’ by Johns Manville, ‘EcoTouch Pink Fiberglas Insulation’ by Owens Corning Canada or ‘ComfortBatt’ by Rockwool.

.2 Batt insulation (fire-rated/acoustic): ASTM C665, Paperless, semi-rigid, spun stone wool fibre mats, of thickness as indicated on Contract Drawings, 'MinWool SAFB' by Johns Manville, 'SAFB Thermafiber' by Owens Corning Inc. or 'Rockwool AFB' by Rockwool.

.3 Cavity wall insulation (masonry cavity walls): Sprayed applied polyurethane, refer to Section 07 21 19.

.4 Below grade insulation: CAN/ULC-S701, Type 4; Minimum RSI of 0.87, Extruded polystyrene, ship-lapped edges. Thickness: As indicated on Drawings.
.1 'Styrofoam SM' by Dupont de Nemours Inc.
.2 'Foamular C-300' by Owens Corning Canada Inc.

.5 Above grade insulation (not in cavity wall): CAN/ULC-S701, Type 3; Extruded polystyrene, square edges. Thickness: As indicated on Drawings.

.6 Under slab insulation: Closed cell extruded polystyrene sheets in thickness as indicated on drawings. Insulation to have a compressive strength of 690 kPa. PERIMATE (XPS) by Dupont de Nemours Inc. or 'Foamular 1000' by Owens Corning Canada Inc.

.7 Adhesive for polystyrene insulation: CGSB 71-GP-24M, Type 2, Class A, and approved by air/vapour barrier manufacturer when adhesive is in direct contact with air/vapour barrier membrane.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Ensure substrate surfaces are dry, clean, suitable to receive adhesive and free from other deleterious substances.

3.2 **INSTALLATION**

.1 Install thermal insulation in longest panel sizes possible in accordance with manufacturer's instructions.

.2 Butt insulation with moderate contact and, cut and fit them tightly around other construction elements. Offset single layer vertical joints and both vertical and horizontal joints in multiple layer applications.,

.3 Make thermal insulation continuous, maintain thermal protection continuity and secure to prevent displacement. Ensure that insulation is tight to substrate without air gaps.

.4 Cut and fit thermal insulation tightly around electrical boxes, plumbing and heating pipes and ducts, exterior doors and windows, and other protrusions.

.5 Leave 75 mm separation between thermal insulation and heat emitting devices such as recessed light fixtures.

.6 Cut and trim thermal insulation neatly to fit spaces; do not compress insulation to fit. Install only thermal insulation boards which are free from chipped or broken edges.

.7 Fill miscellaneous cavities with insulation to maintain continuity of thermal barrier. Do not compress insulation to fit.

.8 Arrange for Consultant to review thermal insulation before it is enclosed.

3.3 SECUREMENT

.1 Batt insulation (non-rated, fire-rated/acoustic):
- .1 Install batt insulation in partitions, between studs, and as indicated on Contract Drawings and in accordance with the manufacturer's instructions.
- .2 Fill stud cavities to full height of partitions and carefully cut and fit required batt insulation type around services and protrusions.

.2 Below grade insulation:
- .1 Interior application: Provide 50 mm thick insulation extending 600 mm vertically along foundation wall and 100 mm thick insulation extending 600 mm horizontally along underside of concrete floor slab. Apply suitable mastic adhesive for spot bonding insulation to foundation walls.

.3 Underslab insulation:
- .1 Install insulation boards in locations shown in accordance with manufacturer’s instructions.
- .2 Protect insulation board from damage by placing 200 mm layer of 19 mm crusher-run limestone over insulation board.
- .3 In drainage trenches, place insulation board to size and location as shown in Contract Drawings, with joints butted tight.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for sprayed foam insulation work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 ASTM D1621, Standard Test Method for Compressive Properties Of Rigid Cellular Plastics.

.3 ASTM D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.

.4 ASTM D1623, Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.

.5 ASTM D2842, Standard Test Method for Water Absorption of Rigid Cellular Plastics.

.6 ASTM E96, Standard Test Methods for Water Vapor Transmission of Materials.

.7 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Material Specification.

.8 CAN/ULC S705.2, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Application.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Elevations, sections, materials, details of joint conditions, including door, window, entrance framing, flashings, and roof parapet connection.

.3 Certificates: Submit the following certificates in accordance with Section 01 30 00:
- .1 Applicator’s current certificate of approval by CUFCA/NECA or BASF Canada’s training program.
- .2 Applicator’s current certificate of approval from material manufacturer.

1.4 **QUALITY ASSURANCE**

.1 Perform work of this Section by a company that has a minimum of five years proven experience in installations of similar size and nature.

.2 Contractor to be a certified member of the Canadian Urethane Foam Contractors Association/ National Energy Conservation Association (CUFCA/NECA) or be licensed under the BASF Canada Quality and Training Program “Raising Performance to New Heights” and in accordance with CAN/ULC S705.2 installation standard.

.3 Provide quality assurance testing in accordance with CAN/ULC S705.2. Record daily results in a log book for Consultant’s review.

.4 Provide adhesion tests on transition membranes, in accordance with manufacturer’s written instructions, at the perimeters of all openings. If the project comprises more than 10 openings, adhesion tests should be conducted on 15% of them. For jobs comprising 10 or fewer openings, 30% of these should undergo adhesion tests. Adhesion tests should be performed on the transition membranes at every tenth column or beam.

.5 Mock-up:
- .1 Construct mock-up of 3 m^2 minimum, of spray-in-place foam insulation to thickness as indicated on drawings, including one inside corner and one outside corner.
- .2 Arrange for Consultant's review and acceptance, allow 24 hours before proceeding with work.
- .3 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.5 **SITE CONDITIONS**

.1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
- .1 Ambient air and surface temperature: 5^0C to 40^0C.
- .2 Relative Humidity: Above 85%.

.2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 48 hours before, during, and 48 hours after installation.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Sprayed foam insulation: Sprayed/frothed polyurethane foam conforming to CAN/ULC S705.1. and utilizing a HFO blowing agent and conforming to the following minimum requirements:
- .1 Density (ASTM D1622): 29.6 kg/m3.
- .2 Open cell content (ASTMD2856): 5.6%.
- .3 Tensile strength (ASTM D1623): 313 kPa.
- .4 Compressive strength (ASTM D1621): 236 kPa.
- .5 Water absorption (ASTM D2842): 0.6% by volume.
- .6 Water vapour permeance (ASTM E96): 50mm sample 56 ng/Pa·s·m2 (0.98 Perms).
- .7 Flame spread: <500.
- .8 Sprayed urethane foam: 'Walltite CM01' by BASF or 'Heatlok Soya HFO' by Demilec Inc.

.3 Primers: As recommended by sprayed foam insulation manufacturer.

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 of this Section means acceptance of existing conditions.

3.2 PREPARATION

.1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.

.2 Provide ventilation in area to receive sprayed foam insulation, introducing and exhausting fresh air continuously during and for 24 hours after application.

.3 Provide temporary enclosures to prevent spray from contaminating air beyond application area, and damage from overspray and dusting on adjacent surfaces.

.4 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.

.5 If required, apply primer to substrate surfaces in accordance with manufacturer's written instructions.

3.3 SPRAY INSULATION

.1 Install insulation in accordance with manufacturer's written instructions and conforming to CAN/ULC S705.2.

.2 Apply sprayed foam insulation to thickness indicated on drawings and to provide continuous air retarder in locations indicated on the Drawings. Apply insulation to within 3 mm of thickness indicated on drawings. Provide one measuring pin for every 50 m^2.

.3 Apply insulation in maximum 50 mm pass thickness, with a minimum wait time between passes as recommended by manufacturer.

.4 Insulation to be continuous, level, plumb and uniform thickness throughout. Insulation shall be free of voids and imbedded foreign materials.

3.4 **INSPECTION AND TESTING**

.1 Arrange for third party site-inspection by approved company. Cost of inspections shall be included in bid price.

.2 Site inspection shall be carried out at 5%, 50% and 95% completion to verify conformance with CAN/ULC S705.2, manufacturers written instructions and this Section.

.3 Written inspection reports shall be forwarded to Consultant within three (3) working days of test being performed.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for air/vapour barriers Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM E1643, Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

.2 ASTM E1745, Standard Specification for Water Vapour Retarders used in contact with Soil or Granular Fill under Concrete Slabs.

.3 CAN/CGSB 19.21-M, Sealing and Bedding Compound, Acoustical.

.4 CAN/CGSB-51.34-M, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Samples: Submit following samples in accordance with Section 01 30 00:
- .1 Two 300 x 300 mm samples of air/vapour barriers.
- .2 Two samples, 300 mm long, of fastening bar.
- .3 Duplicate samples of pipe and conduit boot.

1.4 **QUALITY ASSURANCE**

.1 Mock-up:
- .1 Construct one 10 m^2 mock-up of each type air/vapour barrier in location acceptable to Consultant indicating as a minimum one lap joint, one inside corner, one window interface, one wall electrical box, and floor pipe penetration.
- .2 Arrange for Consultant's review and acceptance.
- .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.5 **SITE CONDITIONS**

.1 Do not install the Work of this Section outside of environmental ranges as recommended by manufacturer without Consultant's and Product manufacturer's written acceptance.

.2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements before, during, and after installation.

2 Products

2.1 **WALL AIR/VAPOUR BARRIER MATERIALS**

.1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Membrane air/vapour barrier: 1.0 mm thick, single-ply, self adhering, self sealing, rubberised asphalt, bonded to a cross-laminated high density polyethylene film.
- .1 'CCW 705' by Carlisle Coatings & Waterproofing.
- .2 'Blueskin SA' by Henry Company Canada Inc.
- .3 'Sopraseal Stick 1100 T' by Soprema.
- .4 'Exo-Air 110' by Tremco.
- .5 'Air-Shield" by W. R. Meadows.

.3 Primer:
- .1 'Cav-Grip Primer' by Carlisle Coatings & Waterproofing.
- .2 'Blueskin Adhesive' by Henry Company Canada Inc.
- .3 'Elastocol Stick' by Soprema.
- .4 'ExoAir Primer' by Tremco
- .5 'Mel-Prime' by W.R. Meadows.

.4 Mastic:
- .1 'CCW 704 Mastic' by Carlisle Coatings & Waterproofing.
- .2 'Polybitume 570-05' by Henry Company Canada Inc.
- .3 'Sopramastic' by Soprema.
- .4 'Acoustical Sealant' by Tremco
- .5 'Sealtight Pointing Mastic' by W.R. Meadows.

.5 Fastening bar: Continuous 25 mm wide x 3 mm thick aluminum bar, predrilled for mechanical attachment.

.6 Fasteners: As specified herein or manufacturer's recommended fastener for attaching to Substrate.

2.2 **UNDERSLAB AIR/VAPOUR BARRIER MATERIALS**

.1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Air/vapour barrier (under concrete slab-on-grade): ASTM E1745, Class A, 0.38 mm (15 mil) thick. Permeance as tested after conditioning, less than 0.010 perms (gr/ft2/hr/in.hg), 0.570 ng/(Pa*s*m2); 'Stego Wrap Vapor Barrier' by Stego Industries or 'Perminator' by W.R. Meadows.

.1 Joint sealing tape: High density polyethylene tape with pressure sensitive adhesive with minimum width 100 mm. Type recommended by sheet air/vapour barrier manufacturer.

.2 Pipe and conduit boots: Construct pipe and conduit boots from air/vapour barrier material and pressure sensitive tape as recommended by manufacturer.

2.3 **SHEET VAPOUR RETARDER MATERIALS**

.1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Sheet vapour retarder 'Super Six' Polyethylene film to CAN/CGSB-51.34, 0.15 mm (6 mil) thick.

.1 Joint sealing tape: Air and vapour resistant pressure sensitive adhesive tape, type recommended by sheet vapour retarder manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.

.2 Sealant: CAN/CGSB 19.21; One-part, non-sag, non-bleeding, non-drying, non-hardening, sealant shall remain tacky for permanent bonding to all surfaces; 'Tremco Acoustical Sealant' by Tremco Ltd. or approved alternative.

3 Execution

3.1 **EXAMINATION AND COORDINATION**

.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.

.2 Verify that existing substrates to receive air/vapour barrier are clean, dry, sound, smooth, and continuous.

.3 Coordinate installation of air/vapour barriers with work of other Sections to achieve a air/vapour tight building envelope.

3.2 **MEMBRANE WALL AIR/VAPOUR BARRIER INSTALLATION**

.1 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until continuous, smooth, substrate for air/vapour barrier is achieved.

.2 Prime substrate surfaces to receive air/vapour barrier in accordance with manufacturer's instructions, at recommended application rate, allow to dry. Vary coverage to suit surface porosity.

.3 Prime surfaces. Re-prime surfaces if not covered with air/vapour barrier within 4 hours.

.4 Install mastic where required to ensure integrity of air/vapour barrier installation at protrusions and other complex details.

.5 Install air/vapour barrier in accordance with manufacturer's instructions in locations indicated.

.6 Lap air/vapour barrier ends and edges 50 mm minimum. Roll air/vapour barrier and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.

.7 Extend air/vapour barrier as required to connect to other components of Work comprising air/vapour barrier system.

.8 Cut and fit air/vapour barrier as required for passage of protrusions, ensuring continuous adherence to substrate.

.9 At end of days' Work, trowel mastic water cut-off along uppermost edge of incomplete air/vapour barrier assembly, to prevent loss of adhesion and damage air/vapour barrier.

.10 Supply and install continuous mechanical fastening bar to clamp air/vapour barrier both sides of unfilled gaps, cracks, and joints.

3.3 UNDERSLAB AIR/VAPOUR BARRIER INSTALLATION

.1 Ensure services are installed and inspected prior to installation of barrier.

.2 Install sheet air/vapour barrier under the floor slab and return up adjacent walls prior to installation of floor slab, to form a continuous air/vapour barrier in accordance with ASTM E1643 and manufacturer’s written instructions.

.3 Lap air/vapour barrier over footings and seal to foundation walls.

.4 Overlap joints 150 mm and seal with manufacturer approved sealing tape.

.5 Seal all penetrations (including conduits and pipes) with manufacturer's pipe boot.

.6 Use sheets of largest practical size to minimize joints.

.7 Inspect for continuity. Repair punctures and tears by using patches of air/vapour barrier and overlapping damaged areas by minimum 150 mm on all sides and taping with sealing tape before work is concealed.

3.4 SHEET VAPOUR RETARDER INSTALLATION

.1 Ensure services are installed and inspected prior to installation of retarder.

.2 Install sheet vapour retarder on the warm side of exterior wall, roof, and ceiling assemblies, prior to installation of roof insulation or interior finishes to form a continuous vapour retarder.

.3 Use sheets of largest practical size to minimize joints.

.4 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.

.5 At exterior surface openings, cut vapour retarder to form openings and ensure material is lapped and sealed to frame.

.6 Ensure continuity of vapour retarder is maintained at junctures with other materials.

.7 At perimeter seals, 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 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

.8 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 150 mm and press into sealant bead.
- .4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

.9 Seal electrical switch and outlet device boxes that penetrate vapour retarder as follows:
- .1 Wrap boxes with film sheet providing minimum 300 mm perimeter lap flange.
- .2 Apply sealant to seal edges of flange to main vapour retarder and seal wiring penetrations through box cover.

3.5 FIELD QUALITY CONTROL

.1 Inspect air/vapour barrier continuity immediately prior to installation of subsequent construction. Repair punctures, rips and tears to ensure continuity of air/vapour barrier.

.2 Where punctures and tears are extensive, replace entire damaged section.

.3 Do not cover or permit to be covered any portion of air/vapour barrier until it has been inspected by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products equipment and services necessary for vapour permeable air barrier Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C920, Specification for Elastomeric Joint Sealants.

1.3 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating installation details, physical properties and detailed application and installation instructions.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Adjacent construction and typical details, dimensions, thickness, method of application, protection and penetration details.
  - .2 Location of each membrane penetration.

1.4 **QUALITY ASSURANCE**

.1 Installer's qualifications: Perform Work of this Section by company, approved by Product manufacturer and having 5 years recent experience in Work of comparable complexity and scope.

.2 Pre-installation meeting: Arrange with Consultant and manufacturer's representative to inspect substrates and review installation procedures 48 hours in advance of installation.

1.5 **DELIVERY, STORAGE AND HANDLING**

1. Protect materials from direct exposure to sunlight and physical damage.

2 Products

2.1 **MATERIALS**

.1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Vapour permeable air barrier: 23 mils thick, single-ply, self adhering membrane consisting of engineered film and permeable adhesive with poly-release film; ‘Blueskin VP160’ by Henry Company Canada Inc. or approved alternative by Cosella-Dörken Products, Inc. or VaproShield.

.3 Primer: Low VOC quick setting rubber based adhesive ‘Blueskin LVC Adhesive' by Henry Company Canada Inc. or approved alternative by Cosella-Dörken Products, Inc. or VaproShield.

.4 Sealant: ASTM C920, Type S, Grade NS, Class 25; Moisture sure, medium modulus polymer modified sealing compound ‘HE925 BES’ by Henry Company Canada Inc. or approved alternative by Cosella-Dörken Products, Inc. or VaproShield.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 **APPLICATION**

.1 Ensure surfaces to receive membrane are sound, dry, clean, and free from oil, grease, dirt, excess mortar or other contaminates.

.2 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until continuous, smooth, substrate for air barrier is achieved.

.3 Prime substrate surfaces to receive air barrier in accordance with manufacturer's instructions, at recommended application rate, allow to dry. Vary coverage to suit surface porosity.

.4 Prime surfaces. Re-prime surfaces if not covered with air barrier within 4 hours.

.5 Install mastic where required to ensure integrity of air barrier installation at protrusions and other complex details.

.6 Install air barrier in accordance with reviewed shop drawings and manufacturer's instructions in locations indicated.

.7 Lap air barrier ends and edges 50 mm minimum. Roll air barrier and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.

.8 Extend air barrier as required to connect to other components of Work comprising air barrier system.

.9 Cut and fit air barrier as required for passage of protrusions, ensuring continuous adherence to substrate.

.10 Seal around masonry reinforcing or ties and all penetrations with termination mastic.

.11 At end of days' Work, trowel mastic water cut-off along uppermost edge of incomplete air barrier assembly, to prevent loss of adhesion and damage air barrier.

.12 Do not expose air barrier to sunlight for more than 30 days prior to enclosure.

3.3 **FIELD QUALITY CONTROL**

.1 Do not cover or permit to be covered any portion of the membranes until they have been inspected by the Consultant or by an inspection agency appointed by the Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, tools, equipment and services necessary for exterior soffit system work complete in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3 **DESIGN REQUIREMENTS**

.1 Design soffit system to accommodate expansion and contraction of soffit elements without causing buckling, failure of joints, undue stress on fasteners or other effects detrimental to appearance or performance.

1.4 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and system limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Details, sections, dimensions, tolerances, connections, terminations, control joints, system components, installation sequence, accessories and other pertinent information required for proper and complete installation.
  - .2 Complete design data to confirm that soffit system meet design requirements specified.

.3 Samples: Submit two 300 x 300 mm samples of complete soffit system in accordance with Section 01 30 00.

.4 Reports: Submit written inspection reports within 5 working days after each inspection.

.5 Closeout submittals: Submit maintenance and cleaning instructions for soffit system for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

.6 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 **QUALITY ASSURANCE**

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience installing work of similar size and nature and that is approved by system manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Soffit system manufacturer shall conduct Site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed shop drawings. Perform inspections once per week minimum.

.3 Mock-up:
- .1 Construct one 3000 mm minimum mock-up of soffit system in location acceptable to Consultant.
- .2 Arrange for Consultant's review and acceptance.
- .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.6 **SITE CONDITIONS**

.1 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

.2 Do not proceed with application of materials immediately prior to, during or immediately after inclement conditions, or if wet weather is anticipated within 24 hours after application. Do not apply materials to wet, frozen, or frosted surfaces.

1.7 **EXTENDED WARRANTY**

.1 Submit an extended warranty for soffit system work in accordance with the General Conditions, except that the warranty period is extended to 5 years from date of Substantial Performance of the Work.
- .1 Warrant against failure to meet the design criteria and requirements such as failure to stay in place, cracking, warping, and finish degradation.
- .2 Coverage: Complete replacement including affected adjacent Work.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, coatings, sealants, primers, and sealers are to have low VOC content limits.

.2 Perforated sheet steel: ASTM A653/A653M; Classification LFQ, Grade A, Z275 zinc coating designation, 0.55 mm (24 ga.) minimum base steel thickness, commercial quality, perforations as indicated on drawings, prefinished with Perspectra Series coating system by U.S. Steel Canada, or WeatherX by Vicwest Steel. Colour as selected by Consultant.

.3 Accessories: Hot-dip galvanized in accordance with CAN/CSA-G164-M, in locations shown on Contract Drawings.

.4 Fasteners: Provide type 304 stainless steel fasteners.

.5 Soffit vents: 115 mm wide continuous, high impact, rigid, polyvinyl chloride type soffit vent with continuous insect screen, `AMBICO AMSV-300-50' by AMICO Canada Inc., or`Vinyltech Item No. 548-50' by Plastic Components Inc., or approved alternative.

.6 Sealant and sealant primer: In accordance with Section 07 92 00.

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 of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, and other foreign matter detrimental to performance. Ensure environmental and site conditions are suitable for installation of system.

.2 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.

.3 Prepare surfaces in accordance with manufacturer's written instructions.

.4 Protect finished work at end of each day or on completion of each section of work from water penetration. Protect completed installation from moisture for 48 hours minimum.

3.3 **SOFFIT SYSTEM**

.1 Install soffit system in accordance with reviewed shop drawings and manufacturer's written instructions. Comply with system manufacturer’s requirements regarding terminations at end of each days work and resumption of work.

.2 Seal all cut edges, ends, utility holes and fastener heads, as recommended by manufacturer.

.3 Tape and fill all joints and fastener heads using materials recommended by cement wallboard manufacturer.

.4 Install panels in accordance with reviewed shop drawings and manufacturer's written instructions. Comply with system manufacturer’s requirements regarding terminations at end of each days work and resumption of work.

.5 Install panels by nailing into center of nail slots. Drive nails straight, leaving 1/16 inch space between nail head and flange of panel.

.6 Install continuous soffit vents in soffits as indicated on drawings to provide ventilation of concealed soffit spaces in accordance with OBC requirements.

3.4 CONTROL JOINTS

.1 Install 12.7 mm control joints at the following locations:
- .1 Soffit abuts a structural element, dissimilar wall or other vertical penetration.
- .2 Construction changes within the plane of the soffit.
- .3 Ceiling or soffit dimensions exceed 15 m in either direction.
- .4 Locations indicated on drawings.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for aluminum panel siding, soffit and screen work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 2605, High Performance Organic Coatings on Architectural Extrusions and Panels.

.2 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.

.3 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.

.4 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.5 ASTM C920, Specification for Elastomeric Joint Sealants.

.6 CAN/CSA-G40.20/G40.21M, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels.

.7 CSA S136, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

.1 Design aluminum panel work in accordance with following Climatic Design Data for Brampton contained in the Ontario Building Code:
.1 Design temperature: January 1%, July 2 1/2%.
.2 Hourly wind pressures: 1 in 50 year occurrence.

.2 Design aluminum panel system as a “dry joint system” and to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads, imposed and other loads.

3. Prevent rain penetration through system. Design system based on “Rain Screen Principle” in accordance with the National Research Council. Volume to vent ratio should not exceed 25 m. Panels should be compartmentalized at joints. Incorporate means of draining to the exterior.

.4 Design aluminum panel system to accommodate thermal movements of the components and structural movements to provide an installation free of oil canning, buckling, delamination, failure of joint seals, excessive stress on fasteners or any other detrimental effects.

.5 Design aluminum panel system to prevent rattling and vibration of panels, overstressing of fasteners and clips, and other detrimental effects on the system.

.6 Panel removal: System design to allow removal of individual panels within system.

.7 Design miscellaneous, additional structural framing members as required to complete aluminum panel system, where not indicated on Contract Drawings.

.8 The attachment face of subgirts supporting the panel system must not deflect vertically more than 3 mm due to the dead load of the panel system.

1.4 SUBMITTALS

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Elevations, details, profiles, dimensions, thickness of materials, finishes, methods of joining, joint location, special joints, methods of anchoring, anchor and thermal clip details, types of sealants and gaskets, waterproof connections to adjoining work, details of other pertinent components of the work, and compliance with design criteria and requirements of related work.
  - .2 Seismic anchors, supports and accessories for complete installation.

.3 Samples:
- .1 Submit samples in accordance with Section 01 30 00:
  - .1 600 x 600 mm samples of panel system showing fully assembled components including face sheets, sub-girts, insulation, liner panel, thermal clip and concealed sealant. Sample to be fabricated using exact colour and gauges specified.
  - .2 300 x 300 mm face sheet samples for soffits and screens.

.4 Closeout Submittals: Provide maintenance instructions for incorporation into Operation and Maintenance Manual, specified in Section 01 78 00.

1.5 QUALITY ASSURANCE

.1 Retain a licensed Professional Engineer, registered in the Province of Ontario, to perform following services for prefinished panel work:
- .1 Design of aluminum panel system.
- .2 Design of anchors, supports and accessories to meet seismic requirements.
- .3 Review, stamp, and sign shop drawings.
- .4 Conduct shop and field inspections and prepare and submit inspection reports.

.2 Perform work of this Section only by a Subcontractor of recognized standing who has adequate plant, equipment, and skilled workers to perform it expeditiously, and is known to have been responsible for satisfactory installations similar to that specified during a period of at least the immediate past ten years.

.3 Execute steel welding to CSA W59-M by fabricators certified by the Canadian Welding Bureau to CSA W47.1.

.4 Execute aluminum welding by fabricators certified by the Canadian Welding Bureau to CSA W47.2-M.

.5 Execute finishing coatings and metal pre-treatments by applicators approved in writing by the manufacturer of the coatings and under the supervision of the manufacturer's qualified representative.

.6 Mock-up:
- .1 Fabricate, deliver, and erect a 3 m^2 mm high mock-up panel of aluminum panel system in location acceptable to Consultant.
- .2 Demonstrate full panel fabrication and installation techniques, confirm stiffness/absence of deformation, finish, anchoring devices, air barrier sealing, joint detailing and sealing, and quality of workmanship.
- .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.7 Pre-Installation Meeting: Arrange meeting on Site to be attended by Consultant, Contractor, and panel manufacturer’s representative to review installation procedures, interfaces with adjacent work, conditions under which work will be performed, inspect the surfaces to receive the vapour retarder, and installation procedures 48 hours in advance of installation.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Handle aluminum work in accordance with AAMA CW-10. Protect aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.

.2 Remove and replace all damaged and unsatisfactory materials which are deemed unsuitable for use at this Section's own expense.

1.7 EXTENDED WARRANTY

.1 Submit an extended warranty for aluminum panel work in accordance with General Conditions, except that warranty period is extended to 3 years from date of Substantial Performance of the Work.
- .1 Warrant against leaking, warping, twisting, joint, and finish failure.
- .2 Coverage: Complete replacement including affected adjacent parts.

.2 Manufacturer's Warranty: Provide panel manufacturer's written warranty naming Owner as beneficiary and covering failure of factory-applied exterior finish on prefinished metal panels within the warranty period; warrant finish per ASTM D4214 for chalk not in excess of 8 NBS units and fade not in excess of 5 NBS units. Warranty period for finish: 10 years from date Work is certified as substantially performed.

2 Products

2.1 **ACCEPTABLE PANEL MANUFACTURER(S)**

.1 Aluminum Panels: Horizontal or vertical, 1.78 mm aluminum alloy panels, pre-finished wood-look panels as manufactured by Longboard Inspiring Facades or approved alternative.

2.2 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealants, paints, and coatings are to have low VOC content limits.

.2 Sheet aluminum: Aluminum Association 6061-T6 to ASTM B209.

.3 Finish: Exposed to view: Powder coat finish complying to AAMA 2604, AkzoNobel / Interpon D2000. Colour: Light Fir. Concealed aluminum finish: Mill finish.

.4 Structural shapes, plates, sag rods, and similar items: CAN/CSA-G40.20-G40.21-M, Grade 350W.

.5 Air/Vapour barrier: In accordance with Section 07 26 00.

.6 Z-girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm thick, Z275 galvanized. Depth as indicated on Contract Drawings. Z-girts to be thermally broken at mid-point of insulation thickness.

.7 Thermal spacer: 100% pultruded glass fibre and thermoset polyester resin thermal spacer complete with fastener in depth indicated on Contract Drawings; Cascadia Clip by Interra Architectural Products or approved alternative.

.8 Provide all additional structural supports not shown on Drawings as required.

.9 Seismic anchors, supports and accessories: In accordance with reviewed shop drawings.

.10 Fasteners: Concealed, ANSI B18.6.4, stainless steel Type 304.

.11 Flashings, Closure Pieces, Trim: Same material and colour as panels.

.12 Insulation: Semi-rigid stone wool conforming to ASTM C612, minimum density 70 kg/m^3, thickness as indicated.
- .1 'CladStone 45' by Johns Manville.
- .2 'Thermafiber Rainbarrier 45' by Owens-Corning.
- .3 'CavityRock' by Rockwool Inc.

.13 Insulation fasteners:
- .1 Insulation clips: Galvanized steel clips with self locking type washers; 'Insul-Anchors by Continental Studwelding Ltd., 'Insulation Hanger Studs' by McMaster-Carr, or 'Stud Welders' by Midwest Fasteners Inc.
- .2 Clip adhesive: High strength adhesive having a bonding time of 0 to 30 minutes (rapid initial set) and 48 hours final set, compatible with insulation adhesive, insulation air barrier and substrate, non-corrosive to galvanized steel.

.14 Clips and Panel Reinforcement: Extruded aluminum.

.15 Sealant: ASTM C920, Type S, Grade NS, Class 100/50; One-part, low-modulus, moisture-curing, silicone. 'Dow Corning 790' by Dow Corning or 'Spectrem 1' by Tremco. Colour as selected by Consultant. Primer as recommended by manufacturer.

.16 Joint backing: Product as recommended by siding sealant manufacturer.

.17 Touch-up paint: as recommended by panel manufacturer.

.18 Isolation coating: Bituminous coating, acid and alkali resistant material.

2.3 FABRICATION

.1 Fabricate facings and concealed support members in a manner which will provide an installation free of exposed fastenings, with sufficient support and allowance for thermal movement to prevent facing distortion. Take site measurements before proceeding with production.

.2 Fabricate components of the system at factory, ready for field installation. Include full continuous joint reveals within system.

3. Fabricate facings flat, true, free of marks, without visible distortion and with edges straight and true. Make all planes true, and corners square and bend of minimum radius.

.4 Provide proprietary aluminum extrusions to manufacturer's standard profiles for a complete installation. Extrusions shall be full length around panel perimeter for panel reinforcement and alignment. Intermittent clips are unacceptable.

.5 Changes of plans, parallel or transverse to longitudinal axis shall be accomplished as detailed on shop drawings in the factory wherever practical and with a minimum of field fabrication.

.6 Form panels to dimensions indicated with tolerances to accommodate expansion and contraction between panels and structure members. Accurately form shaped panels.

.7 Fabricate panels with flanges on all sides.

.8 Factory fabricate accessory and trim components ready for installation.

.9 Polish smooth all exposed edges, corners and ends, free from sharp edges.

.10 Maximum allowable tolerances shall be as follows:
- .1 Panel bow: In a concave or convex direction to be 0.5% of panel dimension width and length.
- .2 Panel flatness: Rises and falls across the panel, (local bumps and depressions) will not be accepted.
- .3 Panel tolerance:
  - .1 Width: 2 mm.
  - .2 Length: 4 mm.
  - .3 Thickness: 0.2 mm.
  - .4 Squareness: 5 mm maximum.

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 of this Section means acceptance of existing conditions.

.2 Verify that backup construction is aligned for proper installation of panels before commencing erection.

.3 Protect metal surfaces in contact with concrete, masonry mortar, plaster or other cementitious surface and aluminum to steel surfaces with isolation coating.

3.2 **SOFFIT AND SIDING INSTALLATION**

.1 Supply and install miscellaneous, additional structural framing members, required to complete aluminum panel system, where not indicated on Contract Drawings.

.2 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.

.3 Apply isolation coating to supporting structural framing to isolate airseal liner panel and to prevent galvanic corrosion.

.4 Install air/vapour retarder in accordance with Section 07 26 00.

.5 Install thermal spacer to substrate in accordance with manufacturer's written instructions.

6. Erect panels complete with girts, clips, and fasteners, to meet design criteria. Anchor each individual panel over solid backing. Ensure that all penetrations through air/vapour barrier are sealed.

.7 Install panels, support and anchoring system, fasteners, trim and related items to lines and elevations indicated and in strict accordance with reviewed shop/erection drawings and manufacturer's printed instructions. Carefully co-ordinate work with other Sections.

.8 Anchor component parts to transmit wind loading and other stresses to anchorage system.

.9 Install insulation in continuous contact with air/vapour retarder and neatly fitted between girts, supports, and anchoring system.

- .1 Install insulation by adhesive clip method in accordance with manufacturer's specifications.
- .2 Locate clips 100 mm from edges of panels where they abut other materials and at joints between panels otherwise, spaced throughout at 300 mm to 450 mm centres each way.
- .3 At clip locations clean supporting surfaces and apply 50 mm square film of adhesive; coat clips with adhesive and press firmly to wall, holding in place until adhesive exudes through clip base perforations; remove excess adhesive to permit curing; impale insulation panels on clips and secure.

10. Erect panel system in accordance with manufacturer's instructions and under direct supervision of the manufacturer.

.11 Repair all damages and all penetrations in the installed membrane air barrier, caused by work of this Section, using the same air barrier material.

.12 Installed panels shall not deviate from overall plane or alignment by more than 1:1000. Joints shall be hairline wherever possible or a maximum of 15 mm where indicated. Joints shall not be wavy, out of line or of different width from panel to panel.

.13 Install all exposed work of this Section with concealed clips and fasteners. Exposed fasteners not acceptable.

.14 Install all metal flashings within and at bottom of metal panel system.

.15 Ensure drainage of any moisture which may occur within the system to the exterior.

.16 Damaged panels, waviness, warp or distortion of finished work will not be accepted.

.17 Completed installation shall be free from rattles, wind whistles, noise due to thermal movement and other noises.

.18 Install metal materials during suitable weather conditions only.

.19 Openings:
- .1 Provide all openings required in preformed metal panel system.
- .2 Provide required metal flashings around penetrations through metal panels. Ensure complete watertight seal.

.20 Joint Backing and Sealant:
- .1 Prepare substrate surface and mask as recommended by sealant manufacturer.
- .2 Install joint backing and sealant at perimeter of aluminum panel system and where indicated on drawings for weathertight installation. Tool sealant to concave profile.
- .3 Seal around all openings and all other locations indicated or required to provide weathertight and watertight seal.

3.3 SCREEN INSTALLATION

.1 Install screen in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Attach aluminum panels directly mounted to framing using approved concealed fasteners and clips.

.3 Isolate aluminum from dissimilar metal to prevent galvanic action.

3.4 REPAIR

.1 Remove damaged, dented, defaced, defectively finished, or tool marked components and replace with new, unless minor blemishes are approved by Consultant.

.2 Only with approval of Consultant, refinish shop applied finishes in field with compatible materials to manufacturer’s written instructions.

3.5 CLEANING

.1 Remove all strippable protective film from the work as it is erected and prior to moving on to the next bay or grid.

.2 Wash down exposed exterior surfaces using solution of mild non-acidic detergent in warm water, applied with soft clean wiping cloths.

.3 As work progresses, remove excess sealant with recommended solvent and which will not affect metal, finished surfaces, or adjacent surfaces and materials.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for metal siding work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.

.2 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.3 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.4 ASTM C920, Specification for Elastomeric Joint Sealants.

.5 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.

.6 CAN/CSA-G40.20/G40.21M, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels.

.7 CSA S136, Cold Formed Steel Structural Members.

.8 CSA S136.1, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

.1 Design metal siding system in accordance with CSA S136, S136.1, and to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads.

.2 Design metal siding system in accordance with following Climatic Design Data for Brampton contained in Ontario Building Code.
.1 Design Temperature: January 1%, July 2 ½%.
.2 Wind (Hourly Wind Pressures): 1 in 50 year occurrence.
.3 Seismic design: Class “C”.

.3 Design metal siding system to limit deflection under design loads, to L/240.

.4 Design metal siding system to prevent restriction of thermal induced movement which would induce deformation such as warping, buckling, and failure of joint seals and fasteners. Design metal siding system to prevent vibration when subject to the effects of wind.

.5 Design miscellaneous, additional structural framing members and sag rods, required to complete metal siding system, where not indicated on Contract Drawings.

1.4 SUBMITTALS

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Elevations, details, profiles, dimensions, thickness of materials, finishes, methods of joining, arrangement of sheets, joints, and seams, special shapes, methods of anchoring, anchor and clip details, types of sealants and gaskets, waterproof connections to adjoining work, details of other pertinent components of the work (i.e. windows, penetrations, membranes, etc), and compliance with design criteria and requirements of related work.
  - .2 Seismic anchors, supports and accessories for complete installation.

.3 Samples:
- .1 Submit samples in accordance with Section 01 30 00:
  - .1 600 x 600 mm samples of siding system showing fully assembled components including face sheets, sub-girts, insulation, liner panel, and concealed sealant. Sample to be fabricated using exact colour and gauges specified.

.4 Reports: Submit written field inspection and test report results after each inspection.

.5 Extended warranty: Submit extended warranties signed and registered by the manufacturer providing the warranties in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 QUALITY ASSURANCE

.1 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for metal siding work:
- .1 Design of metal siding work.
- .2 Design of anchors, supports and accessories to meet seismic requirements.
- .3 Review, stamp, and sign shop drawings.
- .4 Conduct shop and field inspections and prepare and submit inspection reports.

.2 Mock-up:
- .1 Fabricate, deliver, and erect one full scale 3 m^2 high mock-up panel of metal siding construction, in location acceptable to Consultant.
- .2 Demonstrate finish, colours, and quality of workmanship.

.3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.3 Pre-installation meeting: Arrange with manufacturer's representative, Contractor, and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Stockpile panels tilted to provide water run-off, free from ground contact on firm, level, non-staining supports extending full width of sheet and spaced not more than 450 mm apart. Cover components with opaque polyethylene sheet. Vent to allow air movement.

1.7 **EXTENDED WARRANTY**

.1 Submit an extended warranty for metal siding work in accordance with General Conditions, except that warranty period is extended to 2 years from date of Substantial Performance of the Work.
.1 Warrant against warping, twisting, joint, finish failure and water penetration.
.2 Coverage: Complete replacement including affected adjacent parts.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, paints and sealants are to have low VOC content limits.

.2 Metal siding: ASTM A653/A653M, Z275 galvanized steel, 0.76 mm minimum base metal thickness.
.1 'AD275R' by VicWest Steel, nominal 39 mm deep.
.2 Or approved alternative by Agway Metals Inc., or Roll Form Group.

.3 Metal siding finish: Perspectra Series coating system by ArcelorMittal Dofasco, or WeatherX by Vicwest Steel. Colour as selected by Consultant.

.4 Airseal liner panel: ASTM A653/A653M; 0.70 mm minimum base metal, Z275, galvanized steel, with interlocked male and female edge lips, factory caulked with liner sealant.
.1 V-Rib Liner by Canadian Metal Rolling Mills.
.2 L-800FR by Flynn Canada Ltd.
.3 L-800 Liner by Vic West Steel.

.5 Structural shapes, plates, sag rods, and similar items: CAN/CSA-G40.20-G40.21-M, Grade 300W.

.6 Hollow structural sections: CAN/CSA-G40.20/G40.21-M Grade 350W, Class H.

.7 Liner sealant: Type as recommended by liner manufacturer.

.8 Airseal transition membrane: ‘Perm-a-Barrier Detail Membrane' by gcp applied technologies, ‘Blueskin SA’ by Henry Company Canada, or ‘Sopraseal Stick 1100T' by Soprema Inc. Membrane to come complete with applicable primer.

.9 Z-girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm thick, Z275 galvanized. Depth as indicated on Contract Drawings. Z-girts to be thermally broken at mid-point of insulation thickness.

.10 Insulation: ASTM C553, 32 kg/m^3, Semi-rigid mineral fibre. Thickness as indicated on Contract Drawings. Temporary adhesive: Type as recommended by insulation manufacturer.
.1 ‘Rockwool Plus MB’ by Rockwool Inc.
.2 Or approved alternatives by Johns Manville or Owens-Corning.

.11 Fascia, trim, closures, and flashings: Material, finish, colour, and fasteners to match siding material, 0.76 mm minimum base metal thickness minimum.

.12 Screw fasteners: ANSI B18.6.4, stainless steel Type 304. Exposed locations: With coloured nylon heads to match metal siding.

.13 Seismic anchors, supports and accessories: In accordance with reviewed shop drawings.

.14 Primer paint: CISC/CPMA 1.73a

.15 Isolation coating: Black bituminous coating, acid and alkali resistant material.

.16 Joint backing: Product as recommended by siding sealant manufacturer.

.17 Siding sealant: ASTM C920, Type S, Grade NS; One-part, ultra-low modulus, moisture curing silicone sealant, ‘Dowsil 790' by Dow Consumer or Spectrem 1 by Tremco Ltd. Colour: As selected by Consultant.

.18 Thermal Separation: Continuous 3 mm thick x 38 mm wide self adhering cork.

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 of this Section means acceptance of existing conditions.

3.2 **STRUCTURAL FRAMING**

.1 Supply and install miscellaneous, additional structural framing members, required to complete metal siding system, where not indicated on Contract Drawings.

3.3 **AIRSEAL LINER PANEL**

.1 Apply isolation coating to supporting structural framing to isolate airseal liner panel and to prevent galvanic corrosion.

.2 Apply continuous beads of liner sealant on face of top and bottom supports of siding liner sheet to provide a complete seal. Ensure a complete seal is obtained between all components from back of liner panel to face of supporting members.

.3 Install airseal liner panel to achieve continuous airseal, rigidly secured to resist design wind loading. Where possible, liner sheets to be one piece full height. Seal liner panel laps airtight with sealant.

.4 Coordinate airseal transition to adjacent parts of Work.

3.4 **AIRSEAL TRANSITION MEMBRANE**

.1 Install primer and airseal transition membrane with 150 mm overlap of metal airseal, continuously onto entire head, jamb, and sill surfaces of openings such as doors, windows, louvres and similar items, and metal siding system perimeter.

.2 Install additional layer of airseal transition membrane to serve as flashing over openings in, and at bottom side termination of metal siding panel system.

.3 Overlap airseal transition membrane 50 mm along sidelaps and 75 mm on end laps and lap in direction of waterflow.

.4 Coordinate airseal transition to adjacent parts of Work.

.5 Provide end-dams and terminations fabricated from same material as airseal transition membrane or material recommended by membrane manufacturer at sills, lintels, openings, and where horizontal surfaces intersect with vertical surfaces to ensure moisture is shed to exterior.

3.5 **GIRTS AND CHANNELS**

.1 Notch Z girts and C channels as required to accommodate airseal liner panel ribs and fins and to allow drainage of cavity.

.2 Provide thermal break between sub-girts and liner sheets. Direct metal-to-metal contact between liner sheet and exterior sheets will not be accepted.

.3 Install Z girts, fastened through airseal liner, and into structural framing beneath. Orient Z girts to drain water from cavity.

.4 Install C channels to frame openings such as doors, windows, and louvre openings, and orient channel webs to form heads, jambs and sills of openings.

3.6 SIDING INSULATION

.1 Install siding insulation in continuous contact with airseal liner and neatly fitted between Z girts and C channels. Adhere insulation with temporary adhesive.

3.7 FASCIA, TRIM, CLOSURES, AND FLASHINGS

.1 Install fascia and trim including inside and outside corners, flashing, edgings, cap strips, drips, under-sill trim, fillers, closure strips, starter strips, and window or door trim, carefully formed and profiled.

3.8 METAL SIDING

.1 Install metal siding in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.

.3 Install metal siding in one piece, full height, except as indicated otherwise.

.4 Maintain joints in exterior siding, plumb, true to line, tight fitting, hairline joints.

.5 Attach metal siding system components to prevent warping, buckling, and deformation induced by restriction of thermal induced movement .

.6 Install corner pieces, closures, flashings, etc, where shown and where required. Provide formed steel closures around opening.

.7 Bed flashings, closures, and corner pieces in sealant to provide a weathertight installation.

3.9 JOINT BACKING AND SIDING SEALANT

.1 Prepare substrate surface and mask as recommended by sealant manufacturer.

.2 Install joint backing and sealant at siding system joints and perimeter for weathertight installation. Tool sealant to concave profile.

3.10 TOUCH UP

.1 Touch up marred surfaces with air dry formulation to match pre-finished siding if approved by Consultant, otherwise remove and replace damaged metal siding.

.2 Clean and touch up marred galvanized surfaces after installation, with zinc rich primer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for modified bituminous roofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C1177/C1177M, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing

.2 ASTM D6162/D6162M, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements

.3 CSA A123.4-M, Bitumen for Use in Construction of Built-Up Roof Coverings and Dampproofing and Waterproofing Systems.

.4 CSA A123.21, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems.

.5 CSA A231.1/A231.2, Precast Concrete Paving Slabs/Precast Concrete Pavers.

.6 CGSB 37-GP-9Ma, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.

.7 CGSB 37-GP-15M, Application of Asphalt Primer for Asphalt Roofing, Dampproofing and Waterproofing.

.8 CAN/ULC S107, Fire Test For Roof Coverings.

.9 CAN/ULC S704, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced.

.10 CRCA Roofing Manual, Canadian Roofing Contractors Association.

.11 OIRCA, Ontario Industrial Roofing Contractors Association.

1.3 **SYSTEM DESCRIPTION**

.1 Roof assemblies specified herein are based on a two ply modified bituminous roofing system with two ply modified bituminous flashings. All plies of membrane and flashings will be torch applied. Roof assembly types referenced are as indicated on the Roof Plan;

.1 RF1 (Steel deck):

.1 Underlayment board

.2 Vapour retarder

.3 Rigid insulation (two layers, 65 mm thick each, adhered).

.4 Tapered insulation (adhered).
.5 Overlay board (adhered).
.6 Base and Cap membrane roofing (mopped/torched).
.7 Base and Cap flashing membranes (mopped/torched).

1.4 SUBMITTALS

.1 Product data:
  .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    .1 Systems, materials, and methods of installation proposed for use, showing system and each component. Certify compliance of each component with applicable standards.
    .2 Submit cold weather construction procedures and methods of protection which will be initiated, installed and maintained when ambient temperature falls below 0^0C.

.2 Shop Drawings: Submit Shop Drawings in accordance with Section 01 30 00 indicating roof layout, sections, details, materials, flashings and membrane terminations, perimeter securement, vapour barrier terminations, insulation wrapping procedures, tapered insulation layout, membrane penetrations, control joints, and roof accessories.

.3 Samples:
  .1 Submit following samples in accordance with Section 01 30 00:
    .1 Substrate board and adhesive.
    .2 Vapour retarder and adhesive.
    .3 Insulation boards.
    .4 Tapered insulation.
    .5 Insulation overlay.
    .6 Roofing membranes.
    .7 Roof accessories.

.4 Reports and Certificates:
  .1 Submit copy of membership in good standing of OIRCA.
  .2 Submit certification from manufacturer that roof system has a minimum Class C classification in accordance with CAN/ULC-S107.
  .3 Submit Pre-Installation Notice (PIN): Copy to show that manufacturer's required Pre-Installation Notice (PIN) has been accepted and approved by the manufacturer.
  .4 Submit project specific report, issued by certified material testing laboratory, confirming that proposed roofing assembly conforms to CSA A123.21. As a minimum report shall indicate uplift pressures for field of roof, perimeter of roof and corners of roof.
  .5 Submit written inspection reports in duplicate from manufacturer, stating that materials proposed for use on this project meet criteria specified and are compatible with each other.

.5 Project close-out submittals:
.1 Submit close-out submittals in accordance with Section 01 78 00.
.2 Submit membrane manufacturer's certificate that membrane has been installed in accordance with Contract Documents.

.6 Extended warranties: Submit extended warranties signed and registered by the manufacturer providing the warranties in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 QUALITY ASSURANCE

.1 Qualification: Perform work of this Section by a company that is a member in good standing of the Ontario Industrial Roofing Contractors Association (OIRCA) and has a minimum of 5 years proven acceptable roofing experience on installations of similar complexity and scope.

.2 Testing: Provide flood testing conducted by an independent testing agency of the specified roofing products.

.3 Perform roofing work in accordance with the CRCA Roofing Specifications Manual and in accordance with membrane manufacturer's printed installation instructions.

.4 Ensure roofing system has been tested and conforms to CAN/CSA A123.21 to ensure wind uplift resistant applicable to the Place of Work.

.5 Roof system shall have a minimum Class C classification in accordance with CAN/ULC-S107.

.6 Ensure torching is performed by skilled workers who have successfully completed and passed a course of instruction by membrane manufacturer in torch-applied-membrane techniques.

.7 Ensure membrane manufacturer's representative has full access to this work for proper inspection prior to and during membrane installation. Roof inspections shall be conducted when the roof is 10%, 50%, and 100% complete minimum. Membrane manufacturer to certify that roof installation was in conformance to manufacturer’s written requirements.

.8 Pre-installation meetings: Arrange meeting on Site to be attended by Consultant, Contractor, and roofing manufacturer's representative to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle Products in accordance with the Conditions of the Contract and as specified herein.

.2 Deliver Products in original containers and keep in protective storage until used.

.3 Indicate on containers or wrappings of Products:
- .1 Manufacturer's name and brand.
- .2 Compliance with applicable standard.
- .3 Weight of material, where applicable.

.4 Handle and store Products to prevent damage. Keep manufacturer's labels and seals intact. Store roofing rolls on end to prevent flattening. Ensure that shelf life of Products has not expired.

.5 Protect Products from inclement weather. Keep insulation, insulation overlay, and roofing membranes absolutely dry. Remove from storage only as much Product as can be applied, made weathertight, and covered with roofing in same day. Do not install Products which are damp at time of installation or showing evidence of having been damp or exposed to moisture.

.6 Store roofing membranes for 24 hours minimum in area kept at 10^0C minimum and remove for application with minimum exposure to low temperatures. Keep membranes dry, stored off-the-ground, on end and well ventilated.

.7 Do not store more than one day's supply of Products on the roof at any time. Stack materials on pallets on roof. Cover Products with incombustible waterproof tarpaulin whenever work is interrupted, or when there is precipitation of any kind.

.8 Distribute Products stored on roof. Install bases under equipment and Products to distribute weight. Do not store Products on, or transport materials across, completed roof areas.

.9 Place 19 mm thick plywood runways over work to enable movement of Products and other traffic.

.10 Where hoisting or pumping occurs adjacent to construction, hang tarpaulins to protect walls and other surfaces. Locate kettle so smoke will not discolour adjacent building surfaces.

.11 Locate a 9 kg fire extinguisher fully charged and in operable condition at installation location, of proper type for Products being used and stored.

.12 Cover walls and adjacent work where Products are hoisted or used.

.13 Use warning signs and barriers and maintain in good order until completion of work.

.14 Clean off drips and smears of bituminous immediately.

.15 Dispose of rain water off roof and away from face of building until roof drainage system has been installed and connected.

.16 At end of each day's work or when stoppage occurs due to inclement weather, protect completed work and Products.

1.7 **SITE CONDITIONS**

.1 Install roofing on dry deck, free of snow and ice, use only dry Products and apply only during weather that will not introduce moisture into roofing system.

.2 Apply roofing only when air and surface temperatures are above 4^0C, have been so for at least 48 hours and are not likely to go below 4^0C, until work is completed.

.3 Proceed with work when temperatures are below 4^0C only with mutual documented agreement between Contractor and Consultant.

1.8 **EXTENDED WARRANTY**

.1 At completion of this work, provide a signed OIRCA warranty to the Owner covering defects of workmanship for a period of 2 years commencing from Contract Completion. Agree to make good promptly any defects which occur or become apparent within the warranty period in conjunction with the membrane manufacture's warranty. Defects shall include but not be limited to leakage, failure to stay in place, lifting, and deformation.

.2 At completion of this work, provide a signed warranty from the roofing system manufacturer to the Owner covering defects in workmanship and materials for a period of 5 years commencing from Contract Completion. Warranty shall include vapour retarder, membrane, roof insulation, sloped insulation, and all other products supplied by roofing system manufacturer. Scope of coverage: Repair and/or replace damaged roofing material caused by the ordinary wear and tear of the elements, manufacturing defect, and the workmanship used to install these materials.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, adhesives and primers are to have low VOC content limits.

.2 Acceptable membrane manufacturers:
- .1 Henry Company Canada Inc.
- .2 IKO Industries Inc.
- .3 Soprema Waterproofing Inc.

.3 Deck Sheathing: ASTM C1177/C117M, 12.7 mm thick, unless otherwise indicated, 'Dens Deck' by G-P Products or 'Securock Gypsum Fiber Roof Board' by CGC.

.4 Sheathing and insulation adhesive: Single component polyurethane adhesive as recommended by roof system manufacturer.

.5 Asphalt primer: CGSB 37-GP-9Ma; Asphalt modified bitumen with thermoplastic polymers.

.6 Asphalt: CSA 123.4-M;
- .1 Type 2 for slopes up to 1:8.
- .2 Type 3 for slopes from 1:8 to 1:4.

.7 Vapour retarder: Minimum 0.8 mm thick self adhesive membrane consisting of SBS modified bitumen adhesive bottom and tri-laminated woven polyethylene top with silicone release film. 'Vapour Block SA' by Henry, 'M.V.P.' by IKO, or 'Sopravap'r by Soprema.

.8 Insulation:
- .1 Polyisocyanurate insulation: CAN/ULC S704, rigid, closed cell, polyisocyanurate foam insulation integrally laminated to perforated black glass reinforced felt facers, square edges, thickness as indicated on Drawings, use maximum size board possible. Insulation thickness under 50 mm use single layer board. Insulation thickness over 50 mm use two equal thickness boards.
- .2 Tapered Insulation: Factory pre-engineered tapered polyisocyanurate insulation in thickness sufficient for slopes indicated; manufactured by Accu-Plane Systems Inc. IKO, Posi-Slope Manufacturing Ltd. or Soprema.

.9 Overlay board:
- .1 Bituminous Board; Multi-ply, semi-rigid asphaltic roofing substrate board composed of a mineral fortified asphaltic core formed between two asphaltic saturated fibreglass liners. 1200 x 1500 x 8mm thick; 'IKO Protection Board' by IKO or 'Sopraboard' by Soprema or approved alternate.

.10 Base sheet membrane and flashing: ASTM D6162, Type 1, Grade S, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, non-woven polyester and glass fiber composite reinforcing, having the following minimum characteristics:
- .1 Thickness: 2.2 mm.
- .2 Reinforcing fabric weight: 200 g/m^2.
- .3 Cold flex: -18 deg. C.
- .4 Tensile strength: 13 kN/m.
- .5 Ultimate elongation: 26%.
- .6 Tensile-tear: 289 N.
- .7 Bottom and top surfaces: Sanded/Polyethylene.

.11 Cap sheet membrane and flashing: ASTM D6162, Type 1, Grade S, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, non-woven polyester and glass fiber composite reinforcing, having the following minimum characteristics:
- .1 Thickness: 4.0 mm.
- .2 Reinforcing fabric weight: 200 g/m^2.
- .3 Cold flex: -18 deg. C.
- .4 Tensile strength: 13 kN/m.
- .5 Ultimate elongation: 26%.
- .6 Tensile-tear: 289 N.
- .7 Granule loss: 2.0 g maximum.

.8 Bottom and top surfaces: Polyethylene/Granules.
.9 Top surface to providing a minimum SRI of 78.

.12 Expansion Joints: 2.2 mm thick mopped, waterproof expansion joint in width to suit expansion joint width. 'Redline' by Situra Inc. or approved alternative.

.13 Plastic cement: Trowel grade asphalt mastic.

.14 Roofing nails: Galvanized steel, minimum 19 mm head of length to penetrate wood nailer minimum 19 mm.

.15 Roof drains: In accordance with Division 22 - Mechanical

.16 Stack flashing units: In accordance with Division 22 - Mechanical

.17 Stack Jacks: to CSA-B272, insulated aluminum stack jacks complete with bitumen protection dam and screw-secured cover;
.1 SJ-26/SJ-27, by Thaler Metal Industries Ltd.
.2 Flash-Tite VSC-S Series, by Lexcor.

.18 Roof Penetration Flashings: to CSA-B272, insulated aluminum, complete with bitumen protection dam and screw-secured cover. Acceptable products and manufacturers by Thaler Metal Industries Ltd. or Flash-Tite by Lexcor as follows:
.1 Rigid Conduits: MEF-AE1.
.2 Flexible Conduits: MEF-2A.
.3 Gas Pipe Protrusion: MEF-9.
.4 Mechanical Unit Supply Piping & Tubing: MEF-AE2/AE4 series.

.19 Irregular Roof Protrusion Flashings: Pre-fabricated mastic sealer pockets; 127 mm high x appropriate diameter to exceed diameter or width of protrusion by 50 mm. Pockets to be sealed with pourable self-leveling sealant;
.1 Chemlink Advanced Construction Products.
.2 Hi-Tuff TPO Molded Sealant Pockets by Lexcan Limited.

.20 Gas Line supports: PPH Portable Pipe Hangers Ltd. Model PP10 with strut and Hanger.

.21 Precast Pavers: 610 X 610 x 45 mm thick non-interlocking roof slabs, less then 5% absorption, minimum 55MPa compressive strength, standard diamond finish, chamfered edges, patio quality, conforming to CSA A231.1/A231.2. 'Diamond' concrete roof slab by armtec Brooklin or approved alternative.

.22 Pedestals: Provide pedestals at each corner of paving slabs to product a level, smooth surface for pedestrian traffic; 'Pave-el' by Envirospec Inc. or approved alternative by Bison.

.23 Roof hatch: Preassembled 915 x 762 mm single leaf metal roof scuttle. EPDM rubber gasket adhered to hollow metal cover. Insulation 25 mm thick with metal liner protector. 305 mm high curb with integral flashing and full welded corners. Lifting mechanism will be compression spring operators enclosed in telescopic tubes. Slam latch with interior and exterior turn handles and padlock hasps. 'Type S' by Bilco or approved alternative.

.24 Roof hatch safety railing: Powder coated aluminum posts and rails in high visibility, safety yellow colour. Aluminum extrusion mounting brackets and cast aluminum locking mechanism. All fasteners and hinges are type 316 stainless steel. 'Bil-Guard 2.0' by Bilco or approved alternative.

.25 Roof hatch safety post: High strength square steel post with high visibility, powder coat finish in safety yellow colour. Design post to automatically lock into position when fully extended and to have release lever to disengage. All fasteners are type 316 stainless steel. 'LadderUp' by Bilco or approved alternative.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Prior to commencement of work ensure:
- .1 Environmental and Site conditions are suitable for material installation in accordance with manufacturer's recommendations.
- .2 Decks are sound, straight, smooth, dry, free of oils, grease, snow, ice or frost, and swept clean of dust and debris.
- .3 Curbs have been built and plywood and lumber nailer plates have been installed.

.2 Supply to trades concerned in ample time, inserts, reglets and accessories to be built into Work. Assist in setting such items.

.3 Cooperate with respective trades to determine methods and procedures to ensure watertight junctions to items passing through roof.

.4 Locate kettles in a safe place outside of building. When locating kettles, give consideration to direction of prevailing winds, building fans and air handling units to minimize possibility of smoke and fumes entering surrounding occupied buildings. If wind direction causes smoke and fume problems, relocate kettles on a daily basis as directed by the Consultant.

.5 Maintain supervision while kettles are in operation and maintain metal covers for kettles to smother flames in case of fire. Supply suitable fire extinguishers.

.6 Maintain efficiency of equipment by frequent cleaning. Remove carbonized bitumen.

.7 Control heating of bitumen, prevent overheating. Maintain an accurate, easily read thermometer during heating. Comply with the following bitumen heating tolerances:
- .1 Maximum heating temperature: 240^0C.
- .2 Application temperature: Equiviscous Temperature (EVT).
- .3 Kettles: Holding time maximum 4 hours at maximum 177^0C.

.8 Use heating equipment equipped with thermometers which show temperature of asphalt at all times. During cold weather however, it may become necessary to heat bitumen beyond the normal temperatures specified herein, to obtain EVT temperature range at point of application on roof. If such conditions occur, implement cold weather procedures, and before proceeding with higher temperatures, obtain prior review from Consultant and inspection authorities approval, and take necessary safety precautions.

.9 In cold weather insulate hauling equipment and re-circulation lines to minimize heat loss.

3.3 DECK SHEATHING

.1 Over metal deck, Install sheathing in straight parallel rows, with long dimension perpendicular to metal roof deck rib direction, and with short dimension edges centred on and supported by ribs of metal deck in both directions.

.2 Place sheathing in moderately tight contact at joints between boards and abutting surfaces with gaps between boards not exceeding 3 mm. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 3 mm.

.3 Adhesively fasten sheathing to metal deck with in accordance with sheathing manufacturer’s and adhesive manufacturer’s written instructions.

3.4 PRIMING

.1 Perform priming at rate and to surfaces recommended by the manufacturer in accordance with CGSB 37-GP-15M.

3.5 VAPOUR RETARDER

.1 Primer substrate to manufacturers recommendations.

.2 Install vapour retarder in accordance with manufacturers written instructions.

.3 Lap vapour retarder ends and edges 50 mm minimum. Roll vapour retarder and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.

.4 Cut and fit vapour retarder as required for passage of protrusions, ensuring continuous adherence to substrate.

.5 At junction of deck to vertical surfaces and along perimeter of roof deck, extend vapour retarder, set in adhesive, beyond the point where insulation will terminate.

.6 Seal penetrations, end and side laps, and ends of vapour retarder to substrates and to wall system air/vapour retarder to maintain continuity of building air/vapour retarder system.

3.6 **INSULATION**

.1 Prior to installation of insulation, examine vapour retarder and make good damage.

.2 Use full size insulation boards wherever possible, and minimum half boards at abutting vertical surfaces.

.3 Install insulation promptly to avoid possibility of condensation beneath vapour retarder.

.4 Install insulation in straight parallel rows, with long dimension parallel to long dimension of roof. Stagger end joints of insulation boards in adjacent rows 50%.

.5 Place insulation boards in moderately tight contact at joints between boards and abutting surfaces with gaps between boards not exceeding 1.5 mm. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 3 mm.

.6 When cutting insulation board cut completely through board thickness; do not break or tear insulation board to fit a detail. Any areas of insulation system having voids will be rejected.

.7 When installing multiple layers of insulation, all joints between layers shall be staggered at least 300 mm.

.8 Do not lay more insulation than can be completely covered as finished roofing system on the same day.

.9 Do not cut off insulation in straight lines at the end of a work period, allow stepped boards for toothing-in.

.10 Install polyisocyanurate insulation in a minimum of two layers.

.11 Install Polyisocyanurate insulation, in adhesive, in straight parallel rows, with long dimension parallel to long dimensions of roof.

.12 Install subsequent layers of insulation, in adhesive, in straight parallel rows, with long dimension parallel to previous layer of insulation with joints offset as recommended by insulation manufacturer.

.13 Install tapered insulation in accordance with manufacturer's details and instructions. Miter roof insulation edges at ridge, valley and other similar non-planar conditions.

.14 Install overlay board over tapered insulation in straight parallel rows, with long dimension parallel to long dimensions of insulation. Stagger side joints in adjacent rows minimum 50%.

3.7 MEMBRANE INSTALLATION

.1 Install materials in accordance with manufacturer's instructions.

.2 Install membrane free of blisters, wrinkles and fishmouths in accordance with membrane manufacturer's instructions. Avoid asphalt seepage at seams in cap sheet greater than 5 mm.

.3 Base sheet application:
- .1 Starting at low point of roof, perpendicular to slope, unroll base sheet dry over substrates, align and reroll for both ends.
- .2 Unroll and install membrane in full moppings of asphalt. Extend base sheet to base of cant.
- .3 Lap sheets 75 mm minimum for side and 150 mm minimum for end laps.

.4 Cap sheet application:
- .1 Starting at low point on roof, perpendicular to slope, unroll cap sheet, dry over base sheet, align and reroll from both ends.
- .2 Unroll and torch cap sheet onto base sheet extending to base of cant taking care not to burn membrane or its reinforcement.
- .3 Lap sheets 75 mm minimum for side laps and 150 mm minimum for end laps. Offset joints in cap sheet 300 mm minimum for those in base sheet.
- .4 Embed surface granules on end laps by heating and using a round-nosed roofing trowel, prior to installation of following sheet.

3.8 EXPANSION JOINT

.1 Roll out expansion joint and allow to relax prior to installation. Ensure joint is clean and packed with batt insulation. Install expansion joint in accordance with manufacturer's instructions to ensure joint is watertight.

.2 Apply flood coat of asphalt to roof and unroll expansion joint into it. Press expansion joint into hot asphalt with smoothing motion.

.3 Strip in joint by coating top side of polyester fleece with flood coat of asphalt and installing top ply of bitumen.

.4 Provide additional protection coarse over flashing by mopping a additional strip of modified bitumen membrane on one side of expansion joint to lay completely over joint.

3.9 FLASHING INSTALLATION

.1 Install flashing free of blisters, sags, wrinkles and fishmouths in accordance with the manufacturer's recommendations. Avoid asphalt seepage at seams greater than 5 mm.

.2 Base flashing:
- .1 Lay base flashings in vertical strips 1000 mm wide to curb surfaces as shown.
- .2 Extend on to flat roof surface minimum 100 mm from toe of cant.
- .3 Make 75 mm side laps and 100 mm end laps from laps in base sheet of roof membrane.
- .4 Install flashings in full moppings of asphalt directly to substrates, proceeding from bottom to top.
- .5 Nail top leading edge to nailer at 300 mm o.c.

.3 Cap flashing:
- .1 Lay cap flashing in vertical strips 1000 mm wide to curb surfaces as shown.
- .2 Extend on to flat roof surface minimum 150 mm from toe of cant.
- .3 Make 75 mm side laps and 100 mm end laps from cap sheet laps and base flashing laps.
- .4 Embed surface granules on laps over cap sheet roofing by heating and use of round-nosed roofing trowel.
- .5 Torch cap flashing directly to cap sheet roofing and to base sheet flashing proceeding from bottom to top
- .6 Soften underside of membrane by torching, without overheating, resulting in uniform adhesion over surface of base flashing.
- .7 Extend cap sheet as shown and nail leading edge to nailers 300 mm o.c.

3.10 ROOF ACCESSORIES

.1 Prior to application of membrane set stack flashing units, roof hatch, prefabricated equipment curbs, and other roof penetration accessory units in accordance with manufacturer's Product data. Install removable cap per accessory manufacturer's Product data as applicable.

.2 Seal joints at items projecting through membrane watertight to acceptance of Consultant.

3.11 FIELD QUALITY CONTROL

.1 Check completed membrane welds for continuity after cooling by use of screw driver run along welded seams and showing uninterrupted extrusion of melted asphalt material.

.2 Inspect completed membrane and flashings for punctures, tears and discontinuous weld seams. Apply additional layer of cap sheet membrane over punctures and tears, extending beyond damaged area or open seam in all directions, torch in-place.

3.12 **CLEANING**

.1 Clean roofing, metal, masonry, and similar items of dirt, cuttings, stains and foreign matter upon completion of the work.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for metal roofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.

.2 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.3 ASTM A792-M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

.4 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.5 ASTM C1177M, Specification for Glass Mat Gypsum Substrate for Use as Sheathing.

.6 ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.

.7 CAN/CGSB-19.13-M, Sealing Compound, One Component, Elastomeric, Chemical Curing.

.8 CAN/CSA S136-M, Cold Formed Steel Structural Members.

.9 CAN/CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

1.3 **SYSTEM DESCRIPTION**

.1 Roof assemblies specified herein are based on a standing seam metal roof, complete with expansion clip system and drainage mat system. Roof assembly type referenced are as indicated on Drawings;

.1 RF2 (Steel deck):

.1 Underlayment board
.2 Vapour retarder (self-adhered).
.3 Rigid insulation (two layers, 65 mm thick each, adhered).
.4 Z-Grits
.5 Sheathing
.6 Self-adhered waterproof membrane (breathable)
.7 Standing seam metal roof complete with expansion clip and drainage mat system.

1.4 DESIGN REQUIREMENTS

.1 Design metal roofing elements in accordance with CAN/CSA S136-M, S136.1-M and to withstand live, dead, lateral, wind, seismic, handling, transportation and erection loads.

.2 Design metal roofing elements in accordance with following Climatic Design Data for Brampton contained in Ontario Building Code:
- .1 Design temperature: January 1%, July 2 1/2%.
- .2 Wind (Hourly wind pressures): 1 in 50 year occurrence.
- .3 Earthquake: Seismic Data as listed.

.3 Design metal roofing system to limit deflection under design loads to L/240.

.4 Design metal roofing system to prevent restriction of thermal induced movement which would induce deformation such as warping, buckling, and failure of joint seals and fasteners.

.5 Design metal roofing system to prevent the infiltration of water into the roof system and to prevent roofing system components from vibrating due to design wind loads.

1.5 SUBMITTALS

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Arrangements of sheets and joints, materials, thicknesses, dimensions, layouts, types and locations of supports and fasteners and special shapes.
  - .2 Relationship of panels to structural frame.
  - .3 Details of waterproofing membrane, insulation, connections, and all other components in the system.

.3 Samples:
- .1 Submit following samples in accordance with Section 01 30 00.
  - .1 Submit 300 x 300 mm samples of each sheet metal material and finish.
  - .2 Waterproofing membrane.
  - .3 Insulation.

.4 Reports: Submit written field inspection and test report results within 3 days after each inspection.

.5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.6 QUALITY ASSURANCE

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of metal roofing of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Retain a Professional Engineer, licensed in Province of Ontario, with experience in metal roofing work of comparable complexity and scope to perform following services as part of work of this Section:
- .1 Design of metal roofing
- .2 Review, stamp, and sign shop drawings.
- .3 Conduct shop and on-Site inspections and prepare and submit inspection reports.

.3 Mock-up:
- .1 Construct one full scale 1200 mm wide x 1800 mm long mock-up panel of metal roofing construction, in location acceptable to Consultant.
- .2 Demonstrate installation of underlay board, insulation, metal roofing, finish, and quality of workmanship.
- .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.4 Pre-installation meeting: Arrange with manufacturer's representative, Contractor, and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Stockpile panels tilted to provide water run-off, free from ground contact on firm, level, non-staining supports extending full width of sheet and spaced not more than 450 mm apart. Cover components with opaque polyethylene sheet. Vent to allow air movement.

1.8 **EXTENDED WARRANTY**

.1 Submit an extended warranty for metal roofing work In accordance with the General Conditions, except that the warranty is extended to 2 years from date of Substantial Performance of the Work.
- .1 Warrant against panel warping, twisting, failure, jointing, finish failure, water penetration below waterproofing membrane and failure to drain water from rainscreen cavity and painting finishes.
- .2 Coverage: Complete replacement including affected adjacent parts.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealants and coatings are to have low VOC content limits.

.2 Standing seam metal: ASTM A653M; 0.61 mm (24 Ga.) minimum base metal, Z275, galvanized steel. ‘Tradition 150’ by VicWest Steel or CRS-38 by CR Systems, or approved alternative by Agway Metals Inc., or Roll From Group.

.3 Metal roofing finish: Perspectra Series coating system by ArcelorMittal Dofasco, or WeatherX by Vicwest Steel or ‘SMP Prepainted Steel’ by Cascadia Metals Ltd. Colour as selected by Consultant.

.4 Galvalume: ASTM A792M, AZM165 coating designation, 0.61 mm thick minimum base metal.

.5 Steel deck: Refer to Structural Drawings and Specification for steel deck.

.6 Deck closures: ASTM A653/A653M, Z275 hot-dip galvanized steel, 0.61 mm thick base steel thickness.

.7 Deck reinforcements: ASTM A653/A653M, Z275 hot-dip galvanized steel, 2.0 mm thick base steel thickness.

.8 Underlay board: ASTM C1177; 6 mm thick, ‘Dens-Deck Roof Board’ by Georgia-Pacific Corp.; tested to ASTM E84, 0 flame spread, 0 smoke developed, glass fibre faced both sides, silicone treated gypsum core. 1200 mm wide sheets x maximum practical lengths to minimize end joints.

.9 Waterproof membrane: 1.0 mm thick composite sheet comprised of SBS modified bitumen with woven polyethylene reinforcement; ‘CCW 300 HT’ by Carlisle Coatings and Waterproofing, ‘Lastobond Shield HT’ by Soprema, ‘Platinum HT SA’ by FT Synthetics or approved alternative by Henry Company Canada. Primer recommended by membrane manufacturer.

.10 Drainage mat: 7.6 mm thick, ‘Viper CDR Vent’ by Keene or approved alternative.

.11 Z girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm, Z275 galvanized Z girts and C channels. Depth: As indicated on Contract Drawings.

.12 Seam clips: ASTM A653M; Z275 galvanized steel, thermal clip system.

.13 Insulation: ASTM C612, 96 kg/m^3, Semi-rigid mineral fibre. Thickness as indicated on Contract Drawings. Temporary adhesive: As recommended by insulation manufacturer.
.1 'Rockboard 60' by Rockwool Inc.
.2 Or approved alternative by Owens Corning Canada Inc.

.14 Fascia, trim, closure, and flashings: Material, finish, colour, hidden fastener and thickness to match metal roofing material.

.15 Screw fasteners: Hot dipped galvanized steel fasteners. All fasteners to be concealed and hidden. Fasteners to be complete with coloured heads to match metal roofing.

.16 Sealant: CAN/CGSB-19.13-M. Primer as recommended by sealant manufacturer.

2.2 FABRICATION

.1 Fabricate roof components in accordance with reviewed shop drawings factory-ready for field installation.

.2 Fabricate individual metal roofing panels in maximum lengths.

.3 Fabricate metal roofing panels square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.4 Notch Z girts and C channels as required to allow for drainage of rainscreen cavity.

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 of this Section means acceptance of existing conditions.

3.2 STEEL DECK

.1 Install steel deck in accordance with CSA S136 and manufacturers written instructions ensuring it is securely fastened with minimum bearing on structural support equal to depth of steel roof deck profile.

.2 Fasten steel roof deck to structural supports with a maximum fastener spacing along bearing supports of 400 mm or two flute spacings, whichever is less.

.3 Provide arc spot welds with a nominal 20 mm top diameter.

.4 Mechanically fasten side laps of adjacent units at maximum 900 mm. Provide closer spacing where required by design.

.5 Provide deck closures and reinforcing as required for design loads.

3.3 **UNDERLAY BOARD**

.1 Stagger underlay board joints at least 25% of full board length. Orient long side of boards perpendicular to metal deck flutes. Locate end joints over supporting ribs of metal deck.

.2 Do not install imperfect, damaged or damp boards. Butt boards together with no spaces between boards.

.3 Screw fasten underlay board to metal deck substrate at 600 mm o.c. and continuously around perimeter of each board at 300 mm o.c.. Maintain 15 mm minimum from edge of board to centre of screw.

3.4 **WATERPROOF/AIRSEAL MEMBRANE**

.1 Install primer and waterproof membrane continuously over underlay board, in accordance with manufacturer's instructions.

.2 Overlap waterproof membrane 50 mm along sidelaps and 75 mm on end laps and lap in direction of waterflow.

.3 Coordinate airseal transition to adjacent parts of work.

3.5 **GIRTS AND CHANNELS**

.1 Install Z girts, fastened through waterproof membrane and into structural framing beneath. Orient Z girts to drain water from rainscreen cavity.

.2 Frame roofing system edges, with C channels and orient channel webs to face outwards.

3.6 **METAL ROOF INSULATION**

.1 Prior to installation of insulation, examine waterproofing membrane and make good damage.

.2 Install metal roof insulation in continuous contact with waterproof membrane and fitted between Z girts and C channels. Butt boards together with no spaces between boards. Areas of insulation system having voids will be rejected.

.3 When cutting insulation board, cut completely though board thickness and trim to provide plain but joints. Do not break or tear insulation board to fit detail.

3.7 FASCIA, TRIM, CLOSURES, AND FLASHINGS

.1 Form and profile fascia and trim including inside and outside corners, flashing, edgings, cap strips, drips, fillers, closure strips, and starter strips in accordance with the drawings.

.2 Flashings to utilize a “S” locking joint for concealed fastening.

.3 Cut neat holes in metal roofing to accommodate roof penetrations and install flashing for a watertight installation.

3.8 METAL ROOFING (STANDING SEAM)

.1 Install metal roofing in accordance with reviewed shop drawings and manufacturer’s written instructions. Used concealed fasteners unless otherwise approved by the Consultant.

.2 Install seam clips spaced as indicated on reviewed shop drawings to comply with design criteria. Secure cleats with two fasteners each minimum, into Z girts or metal deck.

.3 Apply sheet metal roofing beginning at eaves. Loose lock pans to valley flashing and edge strips at eaves and gable rakes.

.4 Fold lower ends of seams at eaves over at 45° angle. Terminate standing seams at ridge and hips by turning down in tapered fold.

.5 Install metal roofing panels in one piece, for entire slope, except as indicated otherwise. In locations that roof panels cannot be installed in one piece, provide 100 mm starter strip to join the panels together. Provide a continuous sealant bead under starter strip.

.6 Metal roof panels terminating at eaves or valleys shall not have a raw metal edge or exposed fasteners. Fold panel ends and install in accordance with reviewed shop drawings.

.7 Insert metal roof panels terminating at hips or ridges into concealed metal closures. Metal closures shall allow for expansion of the metal roof panel and also act as a starter strip for hip or ridge flashings.

.8 Install valley sheets not exceeding 3 m in length. Shingle lap joints 150 mm in direction of flow. Extend valley sheet minimum 150 mm under roofing sheets. Double fold valley and roofing sheets and secure at 450 mm oc.

.9 Apply isolation coating to metal surfaces in contact with concrete or mortar.

.10 Remove and replace damaged metal roofing. Do not touch-up damaged panels.

3.9 **SEALANT**

.1 Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other work. Sealing work consists of bedding between members where possible. Dry tool sealant to concave profile where exposed.

3.10 **CLEANING AND TOUCH-UP**

.1 Clean exposed finished surfaces of complete installation free of dirt, grease and smudges.

.2 Touch-up scratches with air dry formulation of coating system to match original factory finish.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for flashing and sheet metal Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 ASTM C920, Specification for Elastomeric Joint Sealants.

.3 CRCA Roofing Manual, Canadian Roofing Contractors Association.

.4 Canadian Steet Steel Building Institute (CSSBI) Bulletin No. 9, Core and Maintenance of Pre-finished Sheet Steel Building Products.

1.3 **SUBMITTALS**

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Proposed method of shaping, forming, jointing.
  - .2 Fastening, and application of flashing and sheet metal Work.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 30 00:
  - .1 50 x 50 mm samples of sheet metal material, colour and finish.
  - .2 Representative sample section of prepainted metal flashing illustrating S locking jointing method, minimum 600 mm long.

1.4 **QUALITY ASSURANCE**

.1 Mock-Up:
- .1 Fabricate mock-up in minimum 2400 mm length with reviewed materials, approved methods including joints, seams, expansion joints, starter strips and fasteners.
- .2 Mock-up, if accepted, shall represent the minimum standard for Work. Mock-up may form part of finished Work.

.2 Flashing and Sheet Metal Work shall be executed in accordance with SMACNA Architectural Sheet Metal Manual - 1993 (Addendum No. 1 - October 31, 1997), by skilled trades having a minimum of five (5) years related experience.

1.5 **WARRANTY**

.1 Provide minimum two (2) year Warranty from date of Substantial Performance, as certified by Consultant. Warranty shall be submitted against defects in workmanship and materials.

.2 Contractor must extend the Warranty on replaced parts and workmanship for a period of two (2) years from date of acceptance of replacement parts and workmanship. Defects will include but will not be limited to leaking, failure to stay in place, lifting, deformation and breaking of weathertight seals.

.3 Provide all additional Warranties that may be available from manufacturer.

2 Products

2.1 **MATERIALS**

.1 All materials under Work of this Section, including but not limited to, sealants and paints are to have low VOC content limits.

.2 Prepainted sheet steel: ASTM A653/A653M; Classification LFQ, Grade A, Z275 zinc coating designation, minimum base metal thickness of 0.71 mm (24 gauge), commercial quality, prefinished with Perspectra Series coating system by U.S. Steel Canada, or WeatherX by Vicwest Steel. Colour as selected by Consultant.

.3 Plastic cement: Trowel grade asphalt mastic.

.4 Sealant: ASTM C920, Type S, Grade NS, Class 25; High-performance, medium-modulus, one-part, neutral-cure silicone sealant. 'CWS' by Dow Corning or approved alternative.

.5 Cleats and starter strips: Starter strips to be continuous, of same material as flashing used, 1.2 mm thick. Minimum 100 mm wide face or as detailed and to be continuous.

.6 Fasteners: Flat head roofing nails of length, type and thickness suitable for metal flashing application.

.7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

.8 Touch-up paint: Same colour and material as prepainted sheet steel, as recommended by prefinished coating manufacturer.

2.2 **FABRICATION**

.1 Shop fabricate flashing, sheet metal and trim in accordance with requirements of SMACNA, CRCA and the Contract Documents. Form sheet metal on bending brake, shaping, trimming and hand seaming on bench.

.2 Brake-form sections square, true, and accurate to size. Flashings shall be free from distortion, oil canning, twists, buckles, discolouration and other defects detrimental to appearance and performance.

.3 Hem exposed edges 13 mm minimum on underside for appearance and stiffness. Mitre and seal corners with sealant.

.4 Form joints with 'S-locks' and make allowances for movement. Mitre and form standing seams at all corners. Make allowance for movement at joints.

.5 Fabricate copings, cap flashings, counter flashings and starter strips, scuppers, fascia and miscellaneous flashings to details shown and where required.

.6 Fabricate metal in 2400 mm maximum lengths with an unbroken face less than 225 mm. Form flashings with an exposed unbroken face exceeding 225 mm and a girth greater than 610 mm in 1220 mm maximum lengths.

.7 Provide an 'S-Lock' joint at all end joints and at all horizontal joints between the cap flashing and the vertical flashing and between the vertical flashing and base counter flashing.

.8 Provide double locking standing seam at interior and exterior corners where flashings meet.

.9 Scuppers:
- .1 Form scuppers from prefinished steel sheet metal.
- .2 Sizes and profiles as indicated.
- .3 Provide necessary fastenings.
- .4 Provide Zurn Z198 cast metal parapet scupper sleeve with collar clamp where indicated on drawings.

.10 Sheet metal coming in contact with a metal of a different type must be back painted with two (2) coats of isolation coating.

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 FLASHING INSTALLATION

.1 Install coping flashings, curb counter flashings, starter strips, scuppers, and miscellaneous flashings to details shown on the Contract Drawings and in accordance with CRCA.

.2 Use concealed fasteners. Exposed fasteners such as pop rivets are not allowed.

.3 Install continuous starter strips to present a true, non-waving, leading edge. Anchor to back-up for a rigid, secure installation.

.4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs. Flash joints using S-lock forming tight fit over hook strips.

.5 Make end joints using an S lock joint. Execute by inserting end coping length in 25 mm deep S lock formed in end of adjacent length. Extend concealed portion of S lock 25 mm outwards and nail to substrate. Face nailing of joints will not be permitted.

.6 Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other Work. Sealing Work consists of bedding between members where possible. Tool sealant to concave profile where exposed.

.7 Insert metal flashing under cap flashing to form weathertight junction.

.8 Caulk flashing at cap flashing with sealant.

.9 Install pans, where shown around items projecting through roof membrane.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary to protect spray applied foam insulation not otherwise concealed within masonry or gypsum clad wall assemblies with a spray applied thermal barrier in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 CAN4 S124, Standard Methods of Test for the Evaluation of Protective Coverings for Foamed Plastics.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Certification:
- .1 Submit certified documentation for each worker performing Work of this Section, to substantiate 5 years minimum of experience in sprayed thermal barrier installation.
- .2 Submit installer's and Product manufacturer's certification verifying compliance with Contract Documents.
- .3 For assemblies not tested and rated in accordance with CAN4 S124, submit proposals based on related designs using accepted thermal barrier design criteria.

1.4 **QUALITY ASSURANCE**

.1 Qualifications: Execute Work of this Section by manufacturer-approved, skilled, qualified, and experienced workers, trained in installation of Work of this Section.

1.5 **SITE CONDITIONS**

.1 Maintain a 5^0C air and substrate temperature for 24 hours before, during, and 24 hours after application in accordance with manufacturer's instructions.

.2 Ventilate to dry thermal barrier. In enclosed areas circulate interior air and exhaust to the exterior.

.3 Protect adjacent surfaces and equipment around application areas from overspray, marring or damage. Clean, polish or replace materials damaged to acceptance of Engineer.

2 Products

2.1 **MATERIALS**

.1 All materials under Work of this Section, including but not limited to, primers are to have low VOC content limits.

.2 Primer/bonding agent: As recommended by spray thermal barrier manufacturer.

.3 Thermal Barrier: CAN4 S124, Spray applied, single component cementitious thermal barrier with a density of 370 to 380 kg/m3:
.1 'A/D Cementitious Thermal Barrier' by A/D Fire Protection Systems Inc.
.2 'Monokote Z-3306' by Grace Construction Products.

.4 Water: Clean, free from organic and mineral impurities which would be harmful to application.

2.2 **MIXING**

.1 Mix Products in accordance with manufacturer's instructions.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Engineer. Commencement of Work means acceptance of existing conditions.

.2 Verify that substrates are compatible and have suitable bonding characteristics to receive thermal barrier.

.3 Ensure that items required to penetrate thermal barrier are placed before installation of thermal barrier.

.4 Ensure that ducts, piping, equipments, or other items which would interfere with application of thermal barrier are not positioned until thermal barrier is completed.

3.2 **APPLICATION**

.1 Use temporary enclosures to prevent spray from contaminating air beyond application area. Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of thermal barrier material. Protect walls, windows, floors and other surfaces around areas to be fireproofed, from marring or damage.

.2 Clean surfaces to be fireproofed of any foreign matter which would affect adhesion.

.3 Apply primer as recommended by thermal barrier manufacturer for the particular substrate to be fireproofed.

.4 Apply thermal barrier in separate coats in accordance with the manufacturer's instructions to total thickness required to achieve fire ratings shown on the Contract Drawings. Comply with accepted ULC or WHI design.

.5 Maintain continuity of thermal barrier without gaps or voids. Board tamp or trowel thermal barrier before curing.

.6 Repair thermal barrier damaged by other trades, to acceptance of Consultant.

3.3 **FIELD QUALITY CONTROL**

.1 Perform field tests required by authorities having jurisdiction.

3.4 **CLEANING UP**

.1 Clean exposed wall, ceiling or other surfaces of thermal barrier materials to the acceptance of Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for intumescent fireproofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D2240, Standard Test Method for Rubber Property - Durometer Hardness.

.2 ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

.3 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.4 ASTM E761, Standard test method for Compressive Strength of Sprayed Fire-Resistive Materials Applied to Structural Members.

.5 AWCI, Association of the Wall and Ceiling Industries - International.

.6 AWCI Technical Manual 12-B, Standard Practice for the Testing and Inspection of Field Applied Thin-Film Intumescent Fire-Resistive Materials; an Annotated Guide.

.7 Technical Manual 12-B, 'Standard Practice for the Testing and Inspection of Field Applied Thin-Film Intumescent Fire-Resistive Materials by Association of the Wall and Ceiling Industry (AWCI)

.8 ULC, Underwriter's Laboratories of Canada.

1.3 **SYSTEM DESCRIPTION**

.1 Provide intumescent fireproofing to provide a fire resistance rating of 60 minutes for all columns and items indicated on drawings.

1.4 **SUBMITTALS**

.1 Product data:
  .1 Submit duplicate copies of manufacturer's Product data for each material used in accordance with Section 01 30 00 indicating:
    .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
    .2 Product transportation, storage, handling and installation requirements.

.2 Samples:
  .1 Submit following samples in accordance with Section 01 30 00.
    .1 Two 150 x 300 mm samples of intumescent fireproofing applied to 3 mm steel plate cut back to show primer, intumescent coating and topcoat demonstrating colour and finish for Consultant approval.

.3 Certificates:
.1 Submit ULC certification for designs of fire resistive coating application to substrate materials required and test reports showing compliance with specified physical performance characteristics and physical properties.

1.5 QUALITY ASSURANCE

.1 Installers qualifications:
.1 Perform work of this Section by a company that has a minimum of five years proven experience in the installation of intumescent fireproof coatings on project of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Inspection and Testing:
.1 An independent testing laboratory/company may be selected by the Consultant to test random samples as applied, to verify thickness of thin-film intumescent fire-resistive coating in accordance with AWCI Technical Manual 12-B. Inspection shall be carried out prior to application of topcoat.
.2 Correct deficiencies and have such corrected work approved by Inspection/Testing Company before work is continued.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Ship, store and deliver at temperatures not less than 50°F (10°C); protect from freezing.

.2 Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.7 SITE CONDITIONS

.1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
.1 Ambient air and surface temperature: 10^0C minimum.
.2 Precipitation: None.
.3 Relative Humidity: 40-60%.

.2 Do not install work of this Section outside of environmental ranges as recommended by the intumescent coating manufacturer without the Consultant's and Product manufacturer's written acceptance.

.3 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, coatings are to have low VOC content limits.

.2 Intumescent fireproofing system: 'A/D Firefilm III System' by A/D Fire Protection Systems, 'Sprayfilm' by Cafco or approved alternative by StonCor, consisting of the following components.
- .1 Primer: Recommended by manufacturer for substrate being fireproofed.
- .2 Intumescent coating: A/D Firefilm III, conforming to:
  - .1 Hardness (Shore "D"): Durometer D65-70 in accordance with ASTM D2240.
  - .2 Surface Burning Characteristics: Class "A", in accordance with ASTM E84.
  - .3 Density 1425 kg/m^2.
  - .4 Bond strength: 861 kPa in accordance with ASTM D4541.
  - .5 Compressive strength: 5.2 MPa at 10 % deformation, in accordance with ASTM E761.
- .3 Top coat: A/D TC-55 Sealer. Colour: Clear.

.3 Intumescent fireproofing system: Two component, epoxy based, thermally activated, subliming coating. Intumescent coating system to include primer, intumescent coating, and top coat as indicated below.
- .1 'Thermo-Lag 3000-SA' by A/D Fire Protection Systems or approved alternative by Cafco or approved alternative manufacturer that meets or exceeds the specifications.
- .2 Primer: Recommended by manufacturer for substrate being fireproofed.
- .3 Intumescent coating: Provide first and final coat of 'Thermo-Lag 3000-SA' by A/D Fire Protection Systems, meeting the following criteria:
  - .1 VOC content: 0.53 lbs/gal.
  - .2 Density: 1313 kg/cm. (82 pcf) conforming to ASTM E605.
  - .3 Hardness (Shore "D"): Durometer of 55 in accordance with ASTM D2240.
  - .4 Surface Burning Characteristics: Flame Spread: 0, Smoke Development: 0-20, Class "A", in accordance with ASTM E84.
  - .5 Bond Strength: 2.73 MPa (57,000 psf) in accordance with ASTM E736.
  - .6 Compressive strength: 19.65 MPa (2,850 psi) in accordance with ASTM E761.
- .4 Top coat: Top coat as approved by intumescent film manufacturer for intended application. Colour to be selected by Consultant.

2.2 **MIXES**

.1 Mix intumescent fireproof coating components in accordance with manufacturer's written instructions.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Verify that all clips, hangers, sleeves and similar devices have been attached. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Protect work of other trades against overspray and make good at own expense any such damage. Provide adequate covering by drop cloths, masting or tarpaulins to surfaces, or on fitments in contact with, or adjacent to, surfaces to be fireproofed.

.2 Clean surfaces, to be fireproofed, free of dust, grease, oils, etc. in accordance with manufacturer's recommendations. Ensure surfaces are free of any extraneous matter which could be detrimental to a satisfactory and acceptable finish.

.3 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.

.4 Prime surfaces to be fireproofed with specified primer in accordance with manufacturer's recommendations.

.5 Inspect primed surfaces to be fireproofed for gouges, marks, pinholes, nibs, etc. Properly prepare same by patching, filling, smoothing or any other surface preparation necessary to ensure a satisfactory surface finish.

.6 Ensure written confirmation is received from steel fabricators of the specific surface preparation procedures and primers used for the application of fireproofing materials to ascertain compatibility with work of this Section:

.1 Verify that substrate surfaces are ready to receive work. Commercial blast cleaning (SSPC SP6) is required for minimum surface preparation. Weld flashes should be ground smooth prior to commencement of application. Select primer from manufacturer's list of approved primers.

3.3 **APPLICATION**

.1 Install intumescent fireproofing in accordance with manufacturer's written instructions.

.2 Install intumescent fireproofing at the proper consistency to ensure a satisfactory surface finish.

.3 Use-up materials within shelf life period recommended by manufacturer.

.4 Ensure finished work is uniform as to sheen, gloss, colour, and texture.

.5 Patching: Patch and repair any fire resistive coating that has been damaged in accordance with patching recommendations of material manufacturer. If coating becomes damaged, rebuild thickness by spray or brush. Fill small areas with trowel. When dry, smooth and finish to match adjacent surfaces.

3.4 FIELD QUALITY CONTROL

.1 Perform field tests as required by Authorities having Jurisdiction. Tests to be carried out as outlined in Technical Manual 12-B by AWCI.

3.5 CLEANING

.1 Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions. Remove and legally dispose of construction debris.

.2 Work will not be considered complete until all spatters, drippings, smears and overspray have been cleaned and removed to the satisfaction of Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for firestopping and smoke seals work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C303, Standard Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation.

.2 ASTM C920, Standard Specification for Elastomeric Joint Sealants.

.3 ASTM C1104, Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.

.4 ASTM E814, Test Method for Fire Tests of Through-Penetration Fire Stops.

.5 ASTM E2174, Standard Practice for On-Site Inspection of Installed Fire Stops.

.6 CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.

.7 CAN/ULC S114, Standard Method of Test for Determination of Non-Combustibility in Building Materials.

.8 CAN/ULC S115, Standard Method of Fire Tests of Firestop Systems.

.9 CAN/ULC S129, Standard Method Of Test For Smoulder Resistance Of Insulation (Basket Method).

.10 CAN/ULC S702, Thermal Insulation, Mineral Fibre for Buildings.

1.3 **DEFINITIONS**

.1 Fire Separation: A construction assembly, plane or device, either vertical or horizontal, which is required to prevent the passage of fire and smoke for a prescribed period of time. Proof of compliance to required time rating shall be by ULC, Warnock Hersey (or similar approved) certification or shall be as listed in the Ontario Building Code Supplementary Standard SB-2.

.2 Smoke Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time but is required to prevent the passage of smoke. A "Smoke Separation" is also known as a "Fire Separation with No Rating" or a "Zero Hour Rated Separation".

.3 Non-Rated Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time and is not required to prevent the passage of smoke.

1.4 SYSTEM DESCRIPTION

.1 Firestopping and smoke seals: ULC or Intertek Testing Services listed Products and systems in accordance with CAN/ULC S115 suitable to actual application and installation conditions.

.2 Firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

.3 Firestop and smoke seal system shall achieve a fire resistance rating and smoke seal rating equal to that of assemblies into which they are installed.

.4 Provide smoke sealants over firestopping materials or combination smoke seal/firestop seal material to form air tight barriers to retard the passage of gas and smoke.

.5 Firestopping and smoke seals located at movement joints shall be designed with movement capability.

.6 Firestopping and smoke seals within mechanical and electrical assemblies shall be provided as part of the work of Divisions 21, 22, 23, 26, 27, and 28 respectively.

1.5 SUBMITTALS

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate cUL or ULC reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.
  - .3 Submit firestop and smoke seal manufacturer's Product data for materials and prefabricated devices, including manufacturer's printed installation instructions.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Fire rated and smoke sealed systems for each typical application.
  - .2 Construction details, accurately reflecting actual job conditions.
  - .3 ULC or Intertek Testing assembly listing.
  - .4 Each floor and wall assembly requiring firestop system with each corresponding ULC firestop system.

.3 Certification:
.1 Submit certified documentation from manufacturer for each worker performing work of this Section.
.2 Submit installer's and Product manufacturer's certification verifying compliance with the Contract Documents and conformance with ASTM E814 and CAN/ULC S115.

1.6 **QUALITY ASSURANCE**

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of firestopping and smoke seal work of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Manufacturer's direct representative and/or fire protection specialist shall be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures conforming to manufacturer's written recommendations published in their literature and drawing details.

.3 Pre-construction meetings: Arrange with manufacturer's representative, Contractor, Consultant and Field Engineer to determine responsibility for handling such issues as FT rated partitions, firestop custom details, compatibility, mixed penetrations, and to review installation procedures 48 hours in advance of installation.

1.7 **DELIVERY STORAGE AND HANDLING**

.1 Deliver materials to Place of Work in manufacturer's unopened containers, containing classification label with labels intact and legible at time of use.

.2 Do not use damaged or adulterated materials exceeding their expiry date.

1.8 **SITE CONDITIONS**

.1 Conform to manufacturer's requirements and maintain a minimum temperature of 5^0 C for a minimum period of 24 h before application, during, and until application is fully cured.

.2 Maintain sealant at a minimum 18° C for best workability.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Acceptable manufacturers of rated systems include:
.1 3M
.2 Hilti Canada Corporation.
.3 Specified Technologies Inc. (STI Firestop)
.4 Tremco Ltd.

2.2 GENERAL SYSTEM REQUIREMENTS

.1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Do not use Products containing asbestos.

.3 Firestopping components shall not contain volatile solvents or require special application to protect plastic pipe from firestopping compound.

.4 Provide smoke seal sealant in following colours:
- .1 Grey or white in finished areas.
- .2 Red in unfinished areas.

.5 Smoke sealant for overhead and vertical joints for floor to be self-levelling and non-sagging sealant.

.6 Smoke sealant at vertical through penetrations in areas with floor drains shall be waterproof type.

2.3 MATERIALS

.1 Following materials have been provided for convenience. Contractor shall provide complete system with all components and accessories as required for fire resistant and smoke seal installation.

.2 Firestop sealant: single component, low modulus, silicone rubber, moisture curing sealant to ASTM C920, ULC labelled to CAN/ULC S115.

.3 Pre-Installed firestop devices for use with non-combustible and combustible pipes, conduit and/or cable bundles penetrating concrete floors and walls.
- .1 Cast-in place firestop device complete with aerator adaptor when used in conjunction with aerator system. Model CP 680-P by Hilti or approved alternative.
- .2 Cast-in place firestop device for use with noncombustible penetrants. Model CP 680-M by Hilti or approved alternative.
- .3 Speed sleeve for use with cable penetrations. Model CP 653 by Hilti or approved alternative.
- .4 Firestop block. Model CFS-BL by Hilti or approved alternative.

.4 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating walls:
- .1 Speed sleeve with integrated smoke seal fabric membrane. Model CP 653 by Hilti or approved alternative.
- .2 Firestop Sleeve. Model CFS-SL SK by Hilti or approved alternative.
- .3 Retrofit sleeve for use with existing cable bundles. Model CFS-SL RK by Hilti or approved alternative.
- .4 Gangplate for use with multiple cable management devices. Model CFS-SL GP by Hilti or approved alternative.

.5 Gangplate Cap for use at blank openings in gangplate for future penetrations. Model CFS-SL GP CAP by Hilti or approved alternative.

.5 Firestop insulation: to CAN/ULC S702, Type 2; mineral fibre manufactured from rock or slag, suitable for manual application.
- .1 Density: Minimum 64 kg/m^3 when tested to ASTM C303.
- .2 Combustibility: Noncombustible to CAN/ULC S114.
- .3 Melt temperature: >1175 degrees C.
- .4 Surface burning characteristics: to CAN/ULC S102, maximum flame spread of 0, smoke developed of 0.
- .5 Moisture Absorption: 0.04 percent when tested to ASTM C1104.
- .6 Smoulder Resistance: 0.01 percent when tested to CAN/ULC S129.

.6 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.

.7 Primer: As recommended by firestopping sealant manufacturer.

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 of this Section means acceptance of existing conditions.

.2 Verify that substrates and surfaces to receive firestopping and smoke seals are clean, dry, and frost free.

3.2 PREPARATION

.1 Prepare, modify, and adjust void sizes, proportions, and conditions to conform to fire rated and smoke sealed assembly requirements such as assembly opening size and dimensional restrictions.

.2 Clean surfaces to remove material detrimental to bond including dust, paint, rust, oil, grease, moisture, frost and other foreign matter to manufacturers recommendations.

.3 Mask adjacent surfaces to avoid spillage and over-coating of adjacent surfaces. Remove stains from adjacent surfaces.

3.3 INSTALLATION

.1 Install firestopping and smoke seal systems in accordance with reviewed Shop Drawings, manufacturer's instructions and fire rated assembly to establish continuity and integrity of fire separations.

.2 Install firestop insulation in compacted thicknesses required by ULC design. Compress insulation approximately 50 percent.

.3 Install primers as recommended by firestop and smoke seal Product manufacturers.

.4 Install temporary forming, damming, back-up as required, remove after materials have achieved initial cure and will resist displacement.

.5 Install firestop and smoke seal filler in horizontal joints providing 25% compression fit.

.6 Use resilient, elastomeric firestopping and smoke seal systems in following locations:
- .1 Openings and sleeves for future use.
- .2 Penetration systems subject to vibration or thermal movement.
- .3 Penetration systems in acoustical containment enclosures.

.7 Trowel and tool exposed firestop and smoke seal. Product surfaces to uniform, smooth finish.

.8 Seal joints to ensure an air and water resistant seal capable of withstanding compressions and extensions due to thermal wind or seismic joint movement.

.9 Taped joints will not be acceptable.

.10 Repair damaged firestopped and smoke sealed surfaces to acceptance of Consultant.

.11 Identify each firestop and smoke seal penetration assembly with permanent label listing following:
- .1 Assembly and rating in hours.
- .2 Date of installation.
- .3 Installing company's name and telephone number.

.12 Do not cover materials until full cure has taken place.

3.4 INSPECTION AND TESTING

.1 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E2174 to ensure that firestopping and smoke seals have been installed in accordance with Contract documents and to tested and listed firestop system.

3.5 CLEAN-UP

.1 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

.2 Remove excess materials and debris immediately after application.

3.6 SCHEDULE OF FIRESTOP AND SMOKE SEAL LOCATIONS

.1 Following firestop and smoke seal location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of work of this Section. Generally provide systems with required fire and smoke ratings at following locations:

- .1 Gaps at intersections of fire-resistance rated walls and partitions.
- .2 Control and sway joints in fire-resistance rated walls and partitions.
- .3 Gaps at top of fire-resistance rated partitions and walls.
- .4 Penetrations through fire-resistance rated walls and partitions including but not limited to mechanical and electrical services and openings and sleeves for future use.
- .5 Penetrations through fire-resistance rated floor slabs, ceilings, and roofs.
- .6 Gaps at edge of floor slabs at exterior walls.
- .7 Perimeter of retaining angles on rigid ducts greater than 0.012 m^2, firestopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.
- .8 Where indicated on drawings.
- .9 At non-rated assemblies that require a smoke seal.
- .10 Where required by Ontario Building Code.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for sealant Work in accordance with the Contract Documents.

.2 Work of this Section does not include sealants in firestopping and smoke sealed assemblies.

.3 Work of this Section does not include sealant work identified in individual specification sections.

1.2 **REFERENCES**

.1 ASTM C834, Specification for Latex Sealants.

.2 ASTM C920, Specification for Elastomeric Joint Sealants.

.3 ASTM C1330, Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.

1.3 **SUBMITTALS**

.1 Product data: Submit copies of Product data in accordance with Section 01 30 00 describing type, composition and recommendations or directions for surface preparation, material preparation and material installation.

.2 Samples:
.1 Submit following samples in accordance with Section 01 30 00.
.1 Two samples of sealant/caulking, for colour selection.
.2 Two samples of back-up material and primer for physical characteristics.

1.4 **QUALITY ASSURANCE**

.1 Qualifications: Work of this Section shall be executed by trained applicators approved by sealant manufacturer and having a minimum of 5 years proven experience.

1.5 **SITE CONDITIONS**

.1 Do not install materials when ambient air temperature is less than 5 °C, when recesses are wet or damp, or to manufacturer's recommendations.

1.6 **DELIVERY, STORAGE AND HANDLING**

.1 Arrange delivery of materials in original, unopened packages with labels intact, including batch number, and ensure that on-site storage is kept to a minimum. Do

not store materials on site where there exists any danger of damage from moisture, direct sunlight, freezing and other contaminants.

1.7 **EXTENDED WARRANTY**

.1 Submit a extended warranty for Sealant Work in accordance with General Conditions, except that warranty period is extended to 2 years. Warrant against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion and staining adjacent surfaces. Warranty shall be for complete replacement including affected adjacent Work.

2 Products

2.1 **MATERIALS**

.1 General:
- .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Use materials as received from manufacturers, without additives or adulterations. Use one manufacturer's Product for each kind of Product specified.

.2 Sealant **Type 1**: ASTM C920, Type M, Grade NS, Class 50; Multi-Component, polyurethane sealant, in standard colours selected.
- .1 'DC CWS' by Dow Corning Inc.
- .2 'Dymeric 240' by Tremco.

.3 Sealant **Type 2**: ASTM C920, Type S, Grade NS, Class 25; One-Component, polyurethane sealant, in standard colours selected.
- .1 'DC CWS' by Dow Corning Inc.
- .2 'Dymonic' by Tremco.
- .3 'Novalink' by Chemlink Advanced Architectural Products.

.4 Sealant **Type 3**: ASTM C834; Pure acrylic siliconized sealant; in standard white colour (paintable).
- .1 'Tremflex 834 Silconized Sealant' by Tremco Ltd.

.5 Sealant **Type 4**: ASTM C920, Type S, Grade NS; One-part mildew-resistant silicone, in standard colours selected.
- .1 '786 Mildew Resistant Silicone Sealant' by Dow Corning Inc.
- .2 'Tremsil 200 Silicone Sealant' by Tremco Ltd.

.6 Sealant **Type 5**: ASTM C920, Type S, Grade NS, Class 50; One-part neutral-cure silicone, in standard colours selected.
- .1 '795 Weather Sealant' by Dow Corning Inc.
- .2 'Spectrum 2' by Tremco Ltd.

.7 Sealant **Type 6**: Acoustical sealant in accordance with Section 09 21 16.

.8 Sealant **Type 7**: ASTM C920, Type S, Grade NS, Class 50; One-part neutral-cure, low modulus silicone, in standard colours selected.
- .1 '791 Sealant' by Dow Corning Inc.
- .2 'Spectrum 3' by Tremco Ltd.

2.2 **ACCESSORIES**

.1 Primers: Type recommended by material manufacturers for various substrates, primers to prevent staining of adjacent surfaces encountered on project.

.2 Joint backing: ASTM C1330; Round, solid section, closed cell, skinned surface, soft polyethylene foam gasket stock, compatible with primer and sealant materials, 30 to 50% oversized, Shore A hardness of 20, tensile strength 140 to 200 kPa. Bond breaker type surface.

.3 Bond breaker: Type recommended by material manufacturers.

.4 Void filler around the window frames to be one part expanding polyurethane foam.

.5 Cleaning agents: As recommended by material manufacturer, non-staining, harmless to substrates and adjacent finished surfaces.

2.3 **MIXING**

.1 Follow manufacturers instructions on mixing, shelf and pot life.

3 Execution

3.1 **PREPARATION**

.1 Prepare joints to receive sealants to manufacturer's instructions. Ensure that joints are clean and dry and ferrous surfaces are free from rust and oil.

.2 Clean recesses to receive sealant, to be free of dirt, dust, loose material, oil, grease, form release agents and other substances detrimental to sealant's performance.
- .1 Remove lacquer or other protective coatings from metal surfaces, without damaging metal finish, using oil-free solvents. Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sand blasting.
- .2 Ensure recess is dry.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings. Remove incompatible coatings as required.

.3 Ensure that all materials in contact with sealant are compatible. Test substrate for adhesion.

.4 Depth of recess: Maintain depth to ½ joint width up to a maximum of 13 mm and not less than 6 mm at centre of joint. For greater depth, use joint backing under. Where

recess is less than specified depth, cut back surface of recess to specified recess depth.

.5 Install polyethylene backing rod in joints 6 mm or more in width. Roll backing rod into joint. Do not stretch or bend backing rod. Install bond breaker to back of recess.

.6 Prime sides of recess, in accordance with sealant manufacturer's instructions.

.7 Condition products for use in accordance with manufacturer’s recommendations.

3.2 INSTALLATION

.1 Apply sealant immediately after adjoining Work is in condition to receive such Work. Apply sealant in continuous bead using gun with correctly sized nozzle. Use sufficient pressure to evenly fill joint.

.2 Ensure sealant has full uniform contact with, and adhesion to, side surfaces of recess. Superficial painting with skin bead is not acceptable. Tool sealant to smooth surface, free from ridges, wrinkles, sags, air pockets, embedded impurities, dirt, stains or other defects.
- .1 At recesses in angular surfaces, finish sealant with flat profile, flush with face of material at each side.
- .2 At recesses in flush surfaces, finish compound with concave face, flush with face of material at each side.

.3 Make sealant bead uniform in colour.

.4 Cure sealants in accordance with sealant manufacturer's instructions. Do not cover up sealants until proper curing has taken place.

.5 Immediately remove excess compound or droppings which would set up or become difficult to remove from adjacent finished surfaces, using recommended cleaners, as work progresses. Do not use scrapers, chemicals or other tools which could damage finished surfaces. Remove defective sealant.

.6 Clean recesses and re-apply sealant.

.7 Remove masking tape immediately after joints have been sealed and tooled.

3.3 CLEANING

.1 Clean surfaces adjacent to joints, remove sealant smears or other soiling resulting from application of sealants. At metal surfaces, remove residue. Do not mar or damage finishes on materials adjacent to joints. Repair or replace marred or damaged materials.

3.4 SCHEDULE OF LOCATIONS

.1 Following sealant location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of Work of this Section. Generally seal following locations:
- .1 Concrete, masonry, wood and stone to metal.
- .2 Wood to masonry, concrete and stone.
- .3 Metal to metal.
- .4 All dissimilar materials.

.2 Sealant **Type 1 or Type 2**:
- .1 Interior joints between dissimilar materials.
- .2 Interior joints at perimeter of all built-in equipment.
- .3 Interior joints at perimeter of metal door and window frames.

.3 Sealant **Type 3**:
- .1 Interior non-movement joints 6mm or less for painting (painter's caulk).

.4 Sealant **Type 4**:
- .1 Interior joints where mildew resistance is required.
- .2 Interior joints at perimeter of all plumbing fixtures.
- .3 Interior joints between counter backsplash and wall surfaces.

.5 Sealant **Type 5:**
- .1 Glass to glass joints.
- .2 Glass to metal joints.
- .3 Metal to metal curtain wall joints.
- .4 Interior face of metal panel joints.

.6 Sealant **Type 6:**
- .1 Perimeter of all gypsum board partitions where sound insulation is indicated.
- .2 All vapour barrier seams and seals.

.7 Sealant **Type 7:**
- .1 Exterior joints between dissimilar building veneer materials.
- .2 Exterior control joints in building veneers.
- .3 Exterior joints at perimeter of all door and window frames.
- .4 Exterior joints in metal panel systems.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for metal door and frame work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 ASTM A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

.3 ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.4 CAN4/ULC-S104M, Standard Method for Fire Test of Door Assemblies.

.5 CAN4/ULC-S105M, Standard Specification for Fire Door Frames, Meeting the Performance Required by CAN4/ULC-S104M.

.6 CAN/CGSB-1.198, Cementitious Primer, (for Galvanized Surfaces).

.7 CGSB 41-GP-19Ma, Rigid Vinyl Extrusions for Windows and Doors.

.8 CAN/ULC-S702, Thermal Insulation, Mineral Fibre for Buildings.

.9 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.

.10 CSA W59-M, Welded Steel Construction (Metal Arc Welding).

.11 CSDMA, Canadian Steel Door Manufacturer’s Association.

.12 NFPA 80, Standard for Fire Doors and Other Opening Protectives.

.13 NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

1.3 **DESIGN REQUIREMENTS**

.1 Design exterior frame assemblies to accommodate expansion and contraction when subjected to minimum and maximum surface temperature of -35°C to 35°C.

.2 Maximum deflection for exterior metal doors under wind load of 1.2 kPa not to exceed 1/175th of span.

1.4 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating door and frame construction.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 for each type of door and frame indicating:
  - .1 Thickness and type of steel.
  - .2 Thickness and type of core.
  - .3 Thickness and type of steel stiffeners and location of them within the door.
  - .4 Thickness and type of metal facing on edges of door and method of fastening.
  - .5 Location of mortises, reinforcement, anchorages, joining, welding, sleeving, exposed fasteners, openings and arrangement for hardware.
- .2 Include schedule identifying each unit with door marks and numbers relating to numbering on Contract Drawings and in door schedule. Indicate doors and frames to be fire rated.

1.5 **QUALITY ASSURANCE**

.1 Perform work in accordance with requirements by a member of the Canadian Steel Door Manufacturer's Association (CSDMA).

.2 Label and list fire rated doors and frames by an organization acceptable to authorities having jurisdiction and accredited by the Standards Council of Canada in conformance with CAN4/ULC-S104M and CAN4/ULC-S105M for ratings indicated, Labelling shall be in accordance with NFPA 80.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Baron Metal Industries Inc.

.2 Daybar Industries Limited

.3 Fleming Doors Products.

.4 Steelcraft.

.5 Vision Hollow Metal Limited.

2.2 **MATERIALS**

.1 General: All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.

.2 Steel: ASTM A924/A924M, Class 1; Commercial grade steel, hot dip galvanized to ASTM A653/A653M, ZF120 galvanized coating.

.3 Minimum base steel thickness:

.1	Frames	1.6 mm
.2	Typical doors	1.6 mm
.3	Interior stiffeners	0.9 mm
.4	Lock/strike reinforcements	1.6 mm
.5	Hinge reinforcements	2.7 mm
.6	All other reinforcement	1.6 mm
.7	Top and bottom channels	1.2 mm
.8	Glazing stops	0.9 mm
.9	Guard boxes	0.9 mm
.10	Jamb spreaders	0.9 mm

.4 Top caps and thermal breaks: CGSB 41-GP-19Ma; Rigid PVC extrusions.

.5 Primer: CAN/CGSB 1.198.

.6 Core material:
- .1 Interior doors: Mineral fibre insulation with a minimum face density of 24 kg/m^3 (1.5 lbs/ft^3).
- .2 Exterior doors: Rigid poly/isocyanurate, closed cell insulation, 32 kg/m^3 (2.0 lbs/ft^3) , thermal value: RSI 1.9.
- .3 Fire rated doors: Mineral fibre insulation to CAN/ULC S702, Type 1A; 24 kg/m^3 (1.5 lbs/ft^3).

.7 Screws: Stainless steel screws with countersunk flat head.

.8 Door silencers: Type 6-180, black neoprene.

.9 Frame anchors:
- .1 Frames in masonry: 1.2 mm minimum, adjustable T-strap jamb anchors.
- .2 Frames in steel stud partitions: 0.9 mm minimum steel anchors of suitable design securely welded inside each jamb.
- .3 Labeled frames: In accordance with ULC requirements.

.10 Floor anchors: 1.6 mm minimum adjustable floor clip angles with 2 holes for anchorage to floor.

.11 Labels for fire doors and door frame: Brass plate, riveted to door and door frame.

.12 Glass and glazing: In accordance with Section 08 80 00.

2.3 FABRICATION

.1 General
- .1 Fabricate doors and frames in accordance with reviewed shop drawings.

.2 Welding: CSA W59-M to produce a finished unit with no visible seams or joints, square, true and free of distortion.
.3 Welding: Continuous unless specified otherwise. Execute welding by a firm fully acceptable to the Canadian Welding Bureau to requirements of CSA W47.1.
.4 Form profiles accurately to details shown on Contract Drawings.
.5 Ream and remove burrs from drilled and punched holes.
.6 Grind welded corners and joints to a flat plane and fill with metallic filler and sand to a uniform smooth finish. Apply one coat of primer.
.7 Provide weather strip for exterior doors in accordance with Section 08 70 00 and door manufacturer.

.2 Frames, windows, and screens:
.1 Fabricate frames of welded construction. Cut mitres and joints accurately and weld continuously on inside of frame profile. Exterior frames to be thermally broken.
.2 Construct large frame sections with provision for on Site assembly to suit Site conditions.
.3 Blank, reinforce, drill and tap frames for mortised, templated hardware. Protect mortised cut-outs with guard boxes.
.4 Reinforce frames where required for surface mounted hardware.
.5 Reinforce frames over 1200 mm wide with roll formed steel channels or hollow structural sections specified in Section 05 50 00 and as indicated on drawings.
.6 Furnish exterior door frames with a continuously welded integral steel weather drip at head of frame.
.7 Prepare each door opening for single stud rubber door silencers, 3 for single door openings located in strike jamb, and 2 for double door openings located in head.
.8 Install 2 channel or angle spreaders per frame, to ensure correct frame alignment. Install stiffener plates or spreaders between frame trim where required, to prevent bending of trim and to maintain alignment when setting in place.
.9 Form channel glazing stops minimum 16 mm height, accurately cut, mitred, fitted and fastened to frame sections with stainless steel counter-sunk, flat head screws spaced at maximum 450 mm throughout and 50 mm from each end.
.10 Provide the following requirements for electrified frame applications:
.1 Low voltage wire conduit for required electrified hardware devices.
.2 Junction boxes for all frame mounted electrified hardware devices, complete with required connectors to in frame low voltage wire conduit.

.3 Anchorage:
.1 Anchor units to floor and wall construction. Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb, minimum number of anchors for each jamb:
.1 Frames up to 2285 mm 3 anchors.
.2 Frames from 2285 mm to 2440 mm 4 anchors.

.2 Where frames are to be set in masonry or concrete, supply adjustable anchors to trade installing frame.

.3 Fabricate frames for installation in steel stud partitions with steel anchors of suitable design, minimum number of anchors for each jamb :

.1	Frames up to 2285 mm height	4 anchors.
.2	Frames 2285 mm to 2440 mm	5 anchors.

.4 General Door Requirements:

.1 Hollow steel construction, flush swing type, of sizes to conform to details, schedules and reviewed shop drawings with provisions for cut-outs for glass and grilles and reinforced to receive hardware fastenings.

.2 Blank, reinforce, drill and tap doors for mortised, templated hardware. Where required, reinforce doors for surface mounted hardware and door closers.

.3 Reinforce oversized doors with steel channels and plates specified in Section 05 50 00 and as indicated on drawings.

.4 Where openings are required, form integral cut-outs with framing, glass stop moldings and division bars.

.5 Install grilles to fit tight and secure into openings.

.6 Bevel both stiles of single doors 1 in 16.

.7 Provide the following requirements for electrified door applications:

.1 In door low voltage wire raceways.

.2 Steel astragals for hollow metal doors.

.3 Reinforcement for all door mounted electrified hardware devices as required and as indicated on Contract Drawings.

.5 Interior Doors:

.1 Supply and install inverted, recessed, mechanically interlocked with tack welded channels at top and bottom of doors.

.2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints mechanically interlocked and tack welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.

.3 Fill hollow space within door and vertical stiffeners from top to bottom with mineral fibre batt insulation.

.6 Exterior Doors:

.1 Supply and install inverted, recessed, mechanically interlocked with tack welded channels at top and bottom of doors.

.2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints mechanically interlocked and tack welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure no filler is used in joints.

.3 Fill void between door faces with polyisocyanurate insulation as specified, thermally bonded to door skins.

.7 Fire Rated Doors:

.1 Supply and install inverted, recessed, spot welded channels at top and bottom of doors. Supply and install steel flush top caps on exterior doors.

.2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints mechanically interlocked and tack welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.

.3 Fabricate doors to achieve fire rating as indicated on drawings and in accordance with ULC. Provide ULC label on door at hinged edge midway between top hinge and head of door.

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 of this Section means acceptance of existing conditions.

3.2 **HOLLOW METAL DOOR, AND FRAME INSTALLATION**

.1 Install hollow metal doors, frames, windows, and screens in accordance with reviewed shop drawings, manufacturer's written instructions and to meet CSDMA requirements.

.2 Install hollow metal doors, frames, windows, and screens plumb, square, level, secure, and at correct elevation.

.3 Install doors clear of floor finishes, and with the correct rebate opening for the door installation. Install door silencers.

.4 Secure anchorages and connections to adjacent construction. Brace frames rigidly in position while building-in. Remove temporary steel shipping jamb spreaders. Install wood spreaders at third points of frame rebate height to maintain frame width. Supply and install vertical supports as indicated on drawings for openings over 1200 mm in width. Remove wood spreaders after frames have been built-in.

.5 Allow for structural deflection and prevent structural loads from being transmitted to hollow metal frames.

.6 Touch-up areas where galvanized coating has been removed or damaged with primer.

.7 Fire rated doors: Install fire rated doors and frames in accordance with requirements of NFPA 80.

3.3 **ADJUSTING AND CLEANING**

.1 Adjust doors for smooth and balanced door movement.

.2 Clean doors, frames, windows and screens.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for four fold doors Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A36/A36M, Specification for Carbon Structural Steel.

1.3 **DESIGN REQUIREMENTS**

.1 Design folding door to withstand a windload condition of 20 lbs./sq. ft. (88 mph) at standard pressure and temperature.

.2 Folding door shall not exceed a maximum allowable deflection of 1/120 of the span.

1.4 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard(s), Product characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating elevations, sections, details, required clearances, materials, operating components, dimensions, gauges, and finishes.

.3 Closeout submittals: Submit operation, maintenance, cleaning instructions for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.5 **QUALITY ASSURANCE**

.1 Furnish each folding door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components. Furnish folding doors by one manufacturer for the entire project.

.2 Inserts and Anchorages: Furnish fasteners and spacers as required to facilitate installation. If special requirements are necessary, coordinate those requirements with the general Contractor.

1.6 **WARRANTY**

.1 Manufacturer shall warrant all folding doors against defects in material and workmanship for 3 years from date of acceptance.

2 Products

2.1 **ACCEPTABLE PRODUCTS AND MANUFACTURERS**

.1 'Model FF300 Glazed Four-Fold Doors' by Door Engineering.

2.2 **MATERIALS**

.1 Structural Steel: ASTM A36/A36M.

.2 Steel Sheets: Steel sheets of commercial quality, complying with ASTM A366/A366M cold-rolled steel sheet, or A569/A569M hot-rolled steel sheet.

.3 Hardware: Manufacturer's standard components.

.4 Fasteners: As recommended by door manufacturer.

.5 Door panels and framing: Provide minimum 14-gauge structural steel tube framing with minimum 14-gauge steel sheet on exterior and interior faces. Sheeting shall be formed on vertical edges with no visible welds on panel faces. All frames and framing members shall be true to dimension and square in all directions, no door shall be bowed or warped. Door shall not be out of line, vertically or horizontally. Exposed welds shall be ground smooth and flush. Fabricate door size as indicated on drawings.

.6 Door finish:
- .1 Fire Station Apparatus Bay: Custom powder coated to match PPG Duranar Sunstorm Coating 'Silverstorm - UC106685F'.
- .2 Training Apparatus Bay: Satin nickel finish.

.7 Surface Mounted Tube Frame: Supply pre-hung tube frame system designed to anchor to masonry wall construction or weld to steel structure. All hinges, track supports and operator supports shall be factory attached.

.8 Operating Hardware: Hardware shall include guide tracks and brackets, trolleys, center guides, not less than three pairs of jamb and fold hinges per opening and all bolts, nuts, fasteners, etc. necessary for complete installation and operation. Jamb hinges shall be dual shear and have two thrust bearings and two needle bearings. Jamb hinges shall be gusseted. Fold hinges shall be dual shear with two thrust bearings. All bearings shall be completely concealed within the hinge barrel. All hinge pins shall be minimum 19 mm diameter hardened steel.

.9 Weather stripping: Cloth-inserted neoprene bulb installed weather-tight. Weather stripping shall be retained continuously.

.10 Vision Panels: 6 mm clear tempered glazing; ' Energy Advantage' by Pilkington with low emissivity coating on surface #2, of the size, shape and location as noted on the drawings. 25 mm total insulated glass unit thickness.

2.3 **OPERATORS**

.1 Each Four-Fold door shall be operated by an overhead mounted electro-mechanical drive unit designed for high cycle operation. Operator consists of an electric motor, gear reducer, and rotating drive arm. Door shall be operated in accordance with Manufacturer's written instructions.

.2 Electric Controls: Controls shall be furnished by the door manufacturer and shall be complete for each door and built in accordance with the latest NEMA standards.

.3 Operation (interior): Remote pushbutton stations, surface mounted, in location shown, with "OPEN-STOP-CLOSE" designations on pushbuttons in English.

.4 Radio Control: Portable transmitter to signal operator to open, close or stop door.

.5 Photo sensors and timer: UL approved, self monitoring operator to open door when object is sensed and a timer-to-close function to close door at a programmable time from 5 seconds to 1 hour.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of steel hanger system, installed by Section 05 50 00, and other Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Install door and operating equipment complete with necessary hardware, jamb and head mould strips, anchors, inserts, hangers and equipment supports in accordance with final shop drawings, manufacturer's product data and as specified herein.
   .1 Secure guides to walls, plumb, level and true to line. Anchor guides at spacings indicated on approved shop drawings.
   .2 Provide additional support as necessary for attachment of guides, brackets and door and operator mechanisms to interfacing surfaces.

.2 Connect and adjust electrical components and operating hardware accordingly.

.3 Touch-up paint on frame and other painted surfaces in accordance with painting Section 09 91 00.

.4 Upon completion of installation, including work by other trades, lubricate, test and adjust doors to operate in accordance with manufacturer's product data. Final adjustments shall be made by manufacturer's authorized representative.

.5 Protect finished installations until date of Substantial Completion. Repair damage to door panel, hardware and operators.

3.3 **CLEANING**

.1 Upon completion of work of this section, remove strippable coatings, clean, materials, adjust operations and lubricate as required to obtain optimum performance.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for electrically operated glazed sectional overhead door Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

.2 ANSI, H35.1M Alloy and Temper Designation Systems for Aluminum (Metric).

.3 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.4 ASTM B209M, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.5 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standards for Electrical Installations.

.6 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.

.7 CAN/CSA G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles.

.8 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

.1 Design door assembly for climatic design data for location of work and to withstand wind loads in closed position of 1 kPa positive and 0.6 kPa negative. Maximum deflection under full design load to be 1/240 of opening width.

.2 Calculate properties of steel sections and allowable stresses used in determination of structural performance in accordance with CSA S136.1-M.

.3 Design door assembly to withstand minimum 100,000 cycles per annum, and 20 years total life cycle.

.4 Design electrical components for doors in accordance with CSA C22.1 and the Ontario Hydro Electrical Safety Code.

1.4 SUBMITTALS

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standards, characteristics, limitations, and trouble-shooting protocol.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Elevations, materials, sections and details, operating components, dimensions, gauges, glazing, hardware, accessories, finishes, and service rating.
  - .2 Complete electrical wiring diagrams including electrical schematics and sequence of operation.
  - .3 Complete engineering design data to confirm that door meets design criteria specified.

.3 Closeout submittals:
- .1 Submit following for each Product for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00:
  - .1 Identification: Manufacturing name, type, year, and serial number.
  - .2 Performance criteria and maintenance data.
  - .3 Operating instructions and precautions.
  - .4 Safety precautions.
  - .5 Component parts availability including names and addresses of spare part suppliers.
  - .6 Lubrication schedule indicating lubrication points and type of lubricant recommended.

1.5 QUALITY ASSURANCE

.1 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in Work of comparable complexity and scope, to perform the following services as part of the Work of this Section :
- .1 Design overhead doors to resist live, dead, lateral, wind, or seismic loads.
- .2 Review, stamp, and sign shop drawings.

1.6 EXTENDED WARRANTY

.1 Submit a extended warranty for Work of this Section in accordance with the Conditions of the Contract, except that warranty period is extended to 3 years.
- .1 Warrant against failure to meet design criteria and specified requirements.
- .2 Coverage: Complete replacement including affected adjacent Work.

2 Products

2.1 **ACCEPTABLE PRODUCTS AND MANUFACTURERS**

.1 Model Insulated (C175) Sectional Overhead Doors with Aluminum framed Full View Panels by Service Door Industries.

2.2 **MATERIALS**

.1 Aluminum extrusions: ASTM B211 and ANSI H35.1 AA6063 alloy, T6 temper.

.2 Aluminum sheet: ASTM B209 and ANSI H35.1 AA1100 aluminum alloy, H14 temper, minimum 1.0 mm aluminum sheet.

.3 Steel angles, shapes, plates, and similar items: CAN/CSA-G40.20/G40.21-M, Grade 350W.

.4 Galvanized steel sheet: commercial quality to ASTM A653/A653M with Z275 zinc coating.

.5 Insulated sections: Structural quality hot-dipped galvanized steel with polyurethane core sandwich type construction, thermal break and to incorporate the use of two continuous replaceable factory installed gaskets. Sections shall have a minimum thermal insulating value of R16 (RSI 2.81).

.6 Insulation: Cavity shall be filled with continuous process, formed-in-place, CFC and HCFC free rigid polyurethane core, interior and exterior skins shall feature thermal break.

.7 Glazing: 12.7 mm thick insulated glass unit consisting of two panes of 3 mm thick tempered glass with 6.7 mm thick air space, warm edge spacers and Low E coating to 2nd surface.

.8 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. Dual durometer vinyl jamb weather seal, bolted to the continuous adjustable mounting angle (ADCA).

.9 Trusses: Provide adequate number of galvanized steel reinforcing trusses to meet the wind loading.

2.3 **STANDARD OPERATING HARDWARE**

.1 Track: Lift hardware as indicated on drawings with 75 mm size minimum 2.3 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: 133 mm diameter die cast aluminum.
- .2 Shaft: 40 mm diameter solid steel.

.4 Top roller carrier: Galvanized steel minimum 2.3 mm thick, adjustable.

.5 Rollers: Full floating, grease packed hardened steel, ball bearing minimum 75 mm diameter, stamped tire.

.6 Roller brackets: Adjustable, galvanized steel, minimum 2.5 mm thick.

.7 Hinges: standard duty industrial 2.3 mm thick galvanized steel.

.8 Cable: minimum 4 mm diameter multi-strand galvanized steel aircraft cable with a safety factor of 8:1.

.9 Lock: manufacturer's standard interior mounted slide lock.

2.4 SPRINGLESS SAFE-DRIVE OPERATING SYSTEM

.1 Track: Lift hardware as indicated on drawings with 80 mm size minimum 2.75 mm core thickness galvanized steel track.

.2 Track Hangers: 32 mm x 32 mm x 2 mm galvanized steel angles.

.3 Vertical track mounting: Adjustable Continuous Track Angle (ADCA) bolted type, field adjustable, sloped to ensure weather tight seal, shall be fabricated from 2.4 mm commercially galvanized steel,

.4 Rollers: UHMW nylon rollers, 76 mm diameter, with sealed ball bearings, 11 mm diameter roller axles and both inner and outer ball races of hardened steel..

.5 Roller brackets: Fabricated from 3.1 mm zinc plated steel.

.6 Hinges: standard duty industrial 2.75 mm thick zinc plated steel.

.7 Track Guards: Continuous 4.5 mm x 1524 mm high, chamfered 45 degree at top, gray prime finish.

.8 Bumper springs shall be installed at the end of each horizontal track to stop door over travel.

2.5 ELECTRICAL

.1 Electrical jack shaft side mounted type operator for standard operating doors and direct drive type electric operator, shaft mounted for springless safe-drive operating doors. Operator to include motors, speed reducers with all gears running in oil, sheaves, racks, levers, cables and brake, disconnect switches, reversing starters, controls, and all conduit and wiring to make all connections required to complete the Work.

.2 Provide operator with floor level disconnect device to allow for manual operation in event of power failure. Equip operator with electrical interlock switch to disconnect power to operator when in manual operation and Built-in chain hoist for manual operation in event of power failure.

.3 Electrical motors, controller units, remote pushbutton stations, relays and other electrical components: to CSA approval with CSA enclosure type 1.

.4 Power supply: 120 V, 3 phase, 60 Hz.

.5 Motor: Minimum 0.375 kW to maximum 0.560 kW to suite design.

.6 Operation: Remote pushbutton stations, surface mounted, in location shown, with "OPEN-STOP-CLOSE" designations on pushbuttons in English.

.7 Exterior push buttons: Mushroom style exterior button to close door, interlinked with card reading system. Provide one per door, surface mounted, in location shown.

.8 Radio Control: Portable transmitter to signal operator to open, close or stop door.

.9 Vehicle Detection and Sensing Unit

- .1 System to consist of detector unit working in conjunction with sensing loop to activate door when vehicle enters or exits.
- .2 Vehicle detector: Manufacturers standard unit for use in temperature range of -40°C to 71°C.
- .3 System to automatically self-tune after initial setting.
- .4 Include protection against interference or damage by lightning or other electrical influence. Minimum protection to include loop fuse, zener diode over-voltage protection, neon flash over protection and line filter.

.10 Safety switch: 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.

.11 Door speed: Minimum 300 mm per second.

.12 Control transformer: for 24 V AC control voltage.

2.6 FABRICATION

.1 Verify dimensions of existing Work before commencing fabrications and report discrepancies to Consultant.

.2 Fabricate Work in accordance with Contract Drawings and reviewed shop drawings. Fabricate, fit and assemble Work in shop where possible.

.3 Fabricate Work free from defects impairing function, appearance, strength and durability.

.4 Join stiles and rails with self tapping screws. Reinforce doors as required to meet design criteria.

.5 Panels and glazing to be encased in vinyl channels and held in place with a snap in retainer.

2.7 **FINISHES**

.1 Extrusion and sheet finish:
- .1 Fire Station Apparatus Bay: Custom powder coated to match PPG Duranar Sunstorm Coating ‘Silverstorm - UC106685F’.
- .2 Training Apparatus Bay: Satin nickel finish.

.2 Steel: Hot dip galvanized in accordance with CAN/CSA G164-M.

3 Execution

3.1 **INSTALLATION**

.1 Install doors in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Use anchorage devices to securely fasten unit assembly to wall construction and building and building framing without distortion or stress.

.3 Fit and align assembly including hardware; level and plumb, to provide smooth operation. Install door to fit tight at all edges of jambs and heads of frames.

.4 Install operator including electrical motors, controller units, pushbutton stations, vehicle sensing unit, remote operators, relays and other electrical equipment required for door operation in accordance with CSA C22.1 and Ontario Hydro Electrical Safety Code.

.5 Coordinate the installation of a magnetic loop with Division 26.

.6 Lubricate and adjust door operating components to ensure smooth opening and closing of doors.

.7 Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 92 00.

.8 Touch-up doors and hardware after installation to the satisfaction of the Consultant.

.9 Adjust weatherstripping to form a weathertight seal.

.10 Apply isolation coating at 0.8 mm dry film thickness to prevent corrosive or electrolytic action between dissimilar materials.

3.2 ERECTION TOLERANCES

.1 Maintain dimensional tolerances and alignment with adjacent work and as follows:
- .1 Maximum variation and alignment from plum: 1.5 mm.
- .2 Maximum variation from level: 1.5 mm.
- .3 Longitudinal or diagonal warp: Plus or minus 3 mm per 3 m straight edge.

3.3 FIELD QUALITY CONTROL

.1 Testing: Test operate door and demonstrate the operation of same to the satisfaction of the Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for sliding automatic door work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 611, Voluntary Standards for Anodized Architectural Aluminum.

.2 ANSI H35.1M Alloy and Temper Designation Systems for Aluminum (Metric).

.3 ASTM C920, Specification for Elastomeric Joint Sealants.

.4 ASTM E283, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

.5 ASTM E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.

.6 CAN/CGSB-1.108-M, Bituminous Solvent Type Paint.

.7 CAN/CGSB-12.1-M, Tempered or Laminated Safety Glass.

.8 CAN/CGSB-12.8-M, Insulating Glass Units.

.9 CAN/CGSB-69.26, Power-Operated Pedestrian Doors.

1.3 **DESIGN REQUIREMENTS**

.1 Design sliding door system in accordance with following Climatic Design Data for Brampton contained in Ontario Building Code (OBC):
  .1 Design Temperature: January 1%, July 2 1/2% .
  .2 Wind (Hourly Wind Pressures): 1 in 50 year occurrence.
  .3 Earthquake: Seismic Data as listed.

.2 Design complete aluminum entrance door system, including glazing, to meet the following performance criteria:
  .1 U-factor: Maximum to follow.
  .2 SHGC: Maximum to follow.

.3 Restrict air infiltration/exfiltration, through sliding door system to 3.05×10^{-4} $m^3/s/m^2$ at reference pressure differential of 75 Pa, when measured in accordance with ASTM E283.

.4 Design and detail controlled drainage path to actively discharge water, which enters into, or forms within, sliding door system to exterior; design to prevent accumulation or storage of water within sliding door system, and to prevent water from entering interior. No water leakage permitted when tested in accordance with ASTM E331.

.5 Design and detail air and vapour retarder, insulation and rainscreen Products and assemblies into a continuous and integrated envelope. Optimize design to align envelope layers and to minimize thermal bridges.

.6 Design sliding door system to accommodate following without producing detrimental effect on sliding door system or its components:
- .1 40 degrees C range of cyclic, daily thermal swing for component expansion and contraction.
- .2 Dynamic, cyclic loading and release of loads such as wind loads.
- .3 Movement of supporting structure such as live, dead load, and creep deflections, seismic load and sway displacement and similar items.

.7 Design to prevent excessive deflection and permanent or progressive glazing displacement. Restrict horizontal and vertical mullion deflection to L/175 maximum (under uniformly distributed positive load), and do not exceed 10 mm total, regardless of span.

.8 Design, fabricate, and supply anchorage inserts for installation as part of other parts of the work. Design anchorage assemblies to accommodate construction and installation tolerances.

.9 Design sliding door system to accommodate 19 mm vertical deflection in supporting structure.

.10 Design automatic door equipment to accommodate traffic loading of 100,000 cycles.

.11 Design sliding automatic doors system with power and control voltage electrical requirements of single phase, 120V, 60Hz.

.12 Safety design criteria:
- .1 Design to prevent initiation of close cycle when failure of threshold presence detectors occurs.
- .2 Maximum closing force: 133 N factory set.

.13 System safety features:
- .1 Emergency exit break-away: Design sliding door break-away hardware on active leafs only, in direction of egress, under 90 N factory set, horizontal force field adjustable.
- .2 Motion/presence detectors: Design to detect moving (approaching or departing) and motionless people, and moving objects, both sides of sliding automatic door.
- .3 Threshold presence detector: Design to prevent sliding doors from closing when door opening is occupied.
- .4 Back-up system: 3 photocell detectors across doorway opening.

.5 Detection systems failure defaults: Default to hold-open position in case of system's failure.

.14 Sequence of operation (normal): Program following operating sequences for On key switch position.
- .1 Motion detector activation initiates door opening cycle, threshold presence detectors are activated, and timer is re-set.
- .2 After preset time has elapsed, door close cycle is initiated, threshold detectors remain activated till fully closed, and motion detectors, (both sides), continue to monitor for movement toward door.
- .3 If sliding door encounters resistance or obstruction while closing, door returns to fully open position and re-activates timer leading to closing cycle.
- .4 Door security system remains inactive

.15 Program following operating sequences for Exit Only key switch position:
- .1 Sequences identical to On position, except pedestrian entrancing is disallowed.

.16 Program following operating sequences for Maintenance key switch position:
- .1 Sliding door becomes inoperative (activation is not possible) and sliding door leaves can slide freely.
- .2 Door security system remains inactive.

.17 Program following operating sequences for Off key switch position:
- .1 Sliding door panels close when the motion and threshold detectors report door is clear, and remain in closed position to facilitate manual locking. Detectors are de-energized.
- .2 Door security system includes sliding automatic door.

1.4 SUBMITTALS

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Plans, sections, and details.
  - .2 Products and glazing types.
  - .3 Finishes.
  - .4 Anchorage inserts, system installation tolerances
  - .5 Section and hardware reinforcement, anchorage, assembly fixings
  - .6 Detailing, locations, and allowances for movement, expansion, contraction.
  - .7 Path of cavity drainage and air pressure equalization.
  - .8 Relationship of doors, frames, track, hardware and operating components to adjacent construction. Include detailed descriptions and catalogue cuts of specified door controls.
- .2 Submit complete electrical wiring diagrams including electrical schematics and sequence of operation for doors.
- .3 Submit complete design calculations for the doors to demonstrate conformance with design requirements.
- .4 Calculations or modelling confirming sliding automatic doors conform to specified performance and energy requirements.

.2 Samples:
.1 Submit following samples in accordance with Section 01 30 00:
.1 Two 300 mm long sliding door extrusion .
.2 Two 300 mm square insulating glass unit.
.3 Two 300 mm square corner samples of each type door and frame.

.3 Certificates:
.1 Submit CSA, ULC, or Ontario Hydro approvals for sliding automatic door systems.

.4 Close-out submittals:
.1 Submit following for each Product, incorporated into Operations and Maintenance Manual in accordance with Section 01 78 00.
.1 Printed operation instructions and maintenance data for doors with as-built straight line wiring diagrams illustrating electrical connections and control wiring.
.2 Submit lubrication chart indicating lubrication points and type of lubricant recommended for equipment.

.5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 **QUALITY ASSURANCE**

.1 Perform work of this Section by a company which supplies and installs work of this Section. Execute installation by manufacturer's trained and certified installation specialists.

1.6 **EXTENDED WARRANTY**

.1 Submit an extended warranty for sliding automatic door work In accordance with General Conditions, except that warranty period is extended to 5 years.
.1 Warrant that sliding automatic door systems will remain fully operational and functional, assuming normal wear and tear and maintenance.
.2 Coverage: complete replacement including affected adjacent work.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS AND SYSTEMS:**

.1 All materials under work of this Section, including but not limited to, sealants and coatings are to have low VOC content limits.

.2 Acceptable manufacturers and systems include:
.1 OHC Unislide by Besam.
.2 Series 2000 by Horton Automatics.
.3 Dura-Glide, Series 2000 by Stanley Ltd.

.3 Hardware:
- .1 Complete perimeter weather stripping system.
- .2 Back-to-back cylinder cam lock between meeting stiles of sliding doors.
- .3 On - Exit only - Maintenance - Off, four position, key switch located on the door stile of each door.

.4 Aluminum extrusions: ANSI H35.1 AA6063, T5 temper alloy.
- .1 Finish: Clear anodized to AAMA 611 per Aluminum Association Designation System for Aluminum Finishes. AA-M12C23A41.

.5 Tempered/laminated, safety glass: CAN/CGSB-12.1-M, Type 1, Class B.; Laminated glass consisting of two 3 mm thick tempered glass panes laminated together, laminating film thickness: 1.52 mm.

.6 Insulating glass units: CAN/CGSB-12.8-M; 25 mm overall thickness. Tempered/laminated inside, tempered/laminated outside .

.7 Temporary glass presence markers: Easily removable, non-residue depositing.

.8 Permanent warning decal: 150 mm diameter, self adhesive vinyl, red colour decal with white lettering reading CAUTION SLIDING DOOR.

.9 Glazing tape: Preformed and pre-shimmed tape, paper release, colour as selected by Consultant.

.10 Setting blocks: Neoprene, 80-90 Shore A Durometer hardness, 100 mm long x 6 mm high x rebate width.

.11 Motion/presence detector:
- .1 K-band microwave, for two way traffic, motion detectors and active infrared presence sensors, designed to control the opening, hold open, and closing cycles of sliding automatic doors, with fully adjustable detection pattern and sensitivity adjustments in accordance with CAN/CGSB-69.26, in high impact, weather tight housing:
  - .1 Eye-Cue Besam by Enex Door Automation Inc.
  - .2 Apex by Horton Automatics
  - .3 Stan-Guard Threshold Sensor by Stanley Ltd.
- .2 Fabricate detectors which are capable of distinguishing false impulse events, including rain, snow, and which are unaffected by temperature changes, ambient light, or excessive traffic flow.

.12 Back-up system: Three photocell presence detectors concealed in sidelight stiles and located at 150 mm, 610 mm, and 1500 mm A.F.F across threshold.

.13 Anchors, clips, blocking, and angles: AISI Type 304 stainless steel, 2B mill finish.

.14 Screws, bolts and other fasteners: AISI Stainless Steel Type 304.

.15 Isolation coating: CAN/CGSB-1.108-M; Bitumastic coating, acid and alkali resistant material.

.16 Foam insulation: One component polyurethane foam for installation within closures and fillers; Enerfoam by DuPont de Nemours Inc.

.17 Frame sealant: Type as recommended by the sliding automatic door manufacturer.

.18 Lubricant: Type as recommended by manufacturer.

.19 Conduit: In accordance with Division 26 for rigid and flexible conduit and accessories.

.20 Wiring: In accordance with Division 26 .

.21 Airseal transition membrane: 'Blueskin SA' by Bakor, 'Sopraseal Stick 1100' by Soprema Inc. or 'Air-Shield by W. R. Meadows. Membrane to come complete with applicable primer.

.22 Joint backing: Product as recommended by sealant manufacturer.

.23 Sliding door sealant: ASTM C920, Type S, Grade NS, Class 35; One part silicone, neutral cure sealant, medium modulus; 'Dowsil Contractors Weatherproofing Sealant (CWS)' by Dow Consumer Solutions or 'Tremsil 400' by Tremco. Colour as later selected by Consultant. Primer as recommended by manufacturer.

2.2 **FABRICATION**

.1 Verify dimensions of existing work before commencing fabrication and report discrepancies to Consultant. Commencement of work means acceptance of existing conditions.

.2 Fabricate sections true to detail, free from defects impairing appearance, strength and durability. Fabricate extrusions with sharp, well defined corners.

.3 Fabricate, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints. Fabricate frame sealant at joints for weatherproof seams.

.4 Fabricate to conceal anchors and attachments from view. Fabricate concealed reinforcement in accordance with design requirements.

.5 Do not expose manufacturer's identification labels on sliding automatic door assemblies.

.6 Fit and mitre corners and joints accurately fitted and securely jointed together. Apply back-up sealants on the inside of aluminum frame joints.

.7 Fabricate doors and frames complete with internal reinforcements, cutouts, recesses.

.8 Supply and install transom framing complete with glazing.

.9 After fabrication, apply protective strippable coating to prefinished aluminum surfaces. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.

3 Execution

3.1 **EXAMINATION**

.1 Verify conditions and dimensions of previously installed Work upon which work of this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Install sliding door system in accordance with reviewed shop drawings and manufacturer's instructions.

.2 Install work of this Section securely, in correct location, level, square, plumb, at correct elevations, free of warp or twist.

.3 Apply isolation coating at 0.8 mm dry film thickness to prevent corrosive or electrolytic action between dissimilar materials such as aluminum to concrete, masonry, galvanized steel and similar conditions.

.4 Install flashings, closures, and trim pieces.

.5 Fill voids between aluminum framing and adjacent construction with foam insulation.

.6 Supply and install sliding automatic door systems complete with glazing and accessories.

.7 Install glass presence markers, in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

.8 Install manufacturer's standard weatherstripping at door frame perimeter. Install weatherstripping throughout the full length and width of the doors at jambs and heads.

.9 Adjust operable parts for correct function.

.10 Remove damaged or unacceptable Products and assemblies from Site and replace to acceptance of Consultant.

.11 Install permanent warning decal onto upper lites of both sliding doors and fixed sidelights.

3.3 **ERECTION TOLERANCES**

.1 Maximum variation from plumb: 1.5 mm/3 m non-cumulative.

.2 Maximum misalignment of two adjoining members abutting in plane: 0.4 mm.

.3 Maximum perimeter sealant joint between sliding door system and adjacent construction: 13 mm.

3.4 GLAZING PERIMETER AIRSEAL

.1 Install glazing perimeter airseal at perimeter of each insulating glass unit to achieve an airseal from IG unit to sliding door frame. Do not obstruct path of cavity drainage and air pressure equalization.

3.5 AIRSEAL TRANSITION MEMBRANE

.1 Install primer and airseal transition membrane in accordance with manufacturer's instructions.

.2 Overlap airseal transition membrane 75 mm minimum and lap in direction of waterflow.

.3 Coordinate airseal transition to adjacent parts of Work.

3.6 ELECTRICAL WORK

.1 Install rigid steel conduit and wiring:
- .1 To nearest power supply junction boxes and make the connection.
- .2 For control and activation devices

.2 Install approach motion/presence detectors and adjust in accordance with sliding automatic door manufacturer's instructions.

3.7 JOINT BACKING AND SLIDING DOOR SEALANT

.1 Install joint backing and sliding door sealant at both sides of sliding automatic door frame perimeter for an air and weather tight installation.

3.8 FIELD QUALITY CONTROL

.1 Lubricate moving parts before test operations, include greasing/lubrication of sprockets, bearings, cables, and guides.

.2 Test operate sliding automatic doors and demonstrate operation to acceptance of Consultant.

3.9 CLEANING

.1 Remove strippable, protective coatings, temporary labels, and glass presence markers, clean frames and glazing free of residue.

.2 Clean and polish glass and metal surfaces, both interior and exterior.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, tool, equipment and services necessary for Aluminum work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 501, Methods of Test for Exterior Walls.

.2 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels - Series: Components, Coatings and Finishes.

.3 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.

.4 AAMA CW-DG-1, Aluminum Curtain Wall Design Guide Manual.

.5 AAMA/WDMA/CSA 101/I.S.2/A440, Standard Specification for Windows, Doors, and Unit Skylights.

.6 ANSI H35.1M, Alloy and Temper Designation Systems for Aluminum (Metric).

.7 ASTM A167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

.8 ASTM B209M, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.9 ASTM B221M, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles and Tubes.

.10 ASTM C920, Specification for Elastomeric Joint Sealants.

.11 ASTM E283, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

.12 ASTM E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

.13 ASTM E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.

.14 ASTM E783, Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.

.15 ASTM E1105, 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.

.16 ASTM F738M, Specification for Stainless Steel Metric Bolts, Screws, and Studs.

.17 CAN/CGSB 1.108-M, Bituminous Solvent Type Paint.

.18 CAN/ULC S702, Thermal Insulation, Mineral Fibre, for Buildings.

.19 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material Third Edition.

.20 NFRC 100, Procedure for Determining Fenestration Product U-factors.

.21 NFRC 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.

1.3 **DEFINITION(S)**

.1 Aluminum work: Shall mean aluminum curtainwall, windows, entrances, vestibules, doors, and framing mentioned in Part 2 of this Specification Section.

1.4 **DESIGN REQUIREMENTS**

.1 Design Aluminum work to meet requirements of AAMA/WDMA/CSA 101/I.S.2/A440, AAMA CW-DG-1, ASTM E283, ASTM E330, ASTM E331, NFRC 100, NFRC 200 and to meet performance and energy requirements specified herein and as required by authorities having jurisdiction.

.2 Design Aluminum work in accordance with following Climatic Design Data for Brampton contained in the Ontario Building Code:
- .1 Design temperature: January 1%, July 2 1/2% .
- .2 Hourly wind pressures: 1 in 50 year occurrence.
- .3 Seismic design: Class “C”.

.3 Design complete aluminum window systems, including glazing, to meet the following performance criteria:
- .1 U-factor: Maximum to follow.
- .2 SHGC: Maximum to follow.

.4 Design complete aluminum entrance door systems, including glazing, to meet the following performance criteria:
- .1 U-factor: Maximum to follow.
- .2 SHGC: Maximum to follow.

.5 Design Aluminum work to accommodate following without producing detrimental effect:
- .1 Cyclic 40°C daily thermal swing of components.

.2 Cyclic, dynamic loading and release of loads such as wind loads.
.3 13 mm vertical deflection in supporting structure and movement of supporting structure due to live, dead load, and creep or deflections, seismic load, sway displacement and similar items.

.6 Design to prevent accumulation of condensate on interior side of Aluminum work framing under the following service conditions:
.1 Interior summer temperature: 21°C.
.2 Interior winter temperature: 21°C.
.3 Exterior temperature: -20°C.
.4 Interior RH: 35%.

.7 Restrict air infiltration/exfiltration, through Aluminum work in accordance with ASTM E283 at pressure differential as indicated:
.1 Curtainwalls and entrance assemblies: 0.003 L/s m^2 at differential of 300 Pa.
.2 Doors (per door): 2.78 m^3/h m per linear metre of crack at differential of 75 Pa.

.8 Design and detail controlled drainage path to actively discharge water, which enters into or forms within Aluminum work, to exterior; prevent accumulation or storage of water within Aluminum work. Prevent water from entering interior when tested in accordance with ASTM E331 at a pressure differential of 700 Pa..

.9 Design and detail air barrier, vapour retarder, and rainscreen products and assemblies into continuous and integrated Aluminum work envelope. Optimize Aluminum work design to align envelope layers and to minimize thermal bridges.

.10 Prevent deflection and permanent or progressive glazing displacement. Restrict horizontal and vertical mullion deflection to less than L/175 and 19 mm maximum for heights under 4115 mm and L/240 and 25 mm maximum for heights over 4115 mm.

.11 When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span in accordance with ASTM E330.

.12 Design anchorage inserts for installation as part of other Sections of work. Design anchorage assemblies to accommodate construction and installation tolerances.

.13 Provide all reinforcing within aluminum members as required by design and OBC to provide structurally sound assembly. In any case, mullion size shall not be increased due to provision of reinforcing.

.14 Design Aluminum work and connections to substrate where the bottom of the Aluminum work extends to a point below 1070 mm above finished floor level and separates a floor level from an adjacent interconnected space to withstand the required guard and handrail loads in accordance with the OBC and applicable local regulations. When requested by Consultant, provide a letter signed and sealed by a Professional Engineer certifying that the Aluminum work conforms to the OBC requirements.

.15 Design operable windows within reach of occupants with limiting stops conforming to requirements of OBC.

1.5 SUBMITTALS

.1 Shop drawings:
- .1 Submit shop drawings for mock-ups and Aluminum Work in accordance with Section 01 30 00 indicating:
  - .1 Plans, sections, details, type of extrusions, profiles, finishes, panels, spandrels, operating components, doors, related flashings, closures, fillers, and end caps, and sealants.
  - .2 Products and glazing types.
  - .3 Calculations or modelling confirming Aluminum work conforms to specified performance and energy requirements.
  - .4 Structural integrity of Aluminum work, anchorage inserts, and system installation tolerances.
  - .5 Section and hardware reinforcement, anchorage, assembly fixings.
  - .6 Detailing, locations, and allowances for movement, expansion, contraction
  - .7 Air barrier and vapour retarder continuity and path of cavity drainage and air pressure equalization.
  - .8 Seismic anchors, supports and accessories for complete installation.

.2 Samples:
- .1 Submit two samples of following in accordance with Section 01 30 00.
  - .1 250 mm long samples of each type of extrusion and finish.
  - .2 250 x 200 mm samples of insulating glass unit.
  - .3 One complete corner detail of door frame, glazing, and finish for each door type.
  - .4 Each door hardware item for Consultant’s approval.
  - .5 250 x 200 mm sample of aluminum panel.
  - .6 200 x 200 mm sample of insect screen for operable windows for Consultant’s approval of fibreglass mesh.

.3 Reports:
- .1 Submit substantiating engineering data, and independent test results of pre-tested, Aluminum work to substantiate compliance with the design criteria including air leakage and water penetration conforming to ASTM E283 and ASTM E331.

.2 Engineering data demonstrating compliance with test procedures outlined in AAMA 501 including as a minimum air leakage resistance, static pressure water penetration resistance, dynamic pressure water penetration resistance, wind load resistance, vertical live load deflection movement and lateral (horizontal) movement, and condensation resistance.

.3 Submit documentation to substantiate ten years of experience in Aluminum work manufacture and installation of similar size and nature.

.4 Close-out submittals: Submit Aluminum work data for incorporation into the Operations and Maintenance Manual as part of Section 01 78 00.

.5 Extended warranties: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.6 **QUALITY ASSURANCE**

.1 Retain a Professional Engineer, licensed in Province of Ontario, with experience in Aluminum work of comparable complexity and scope to perform the following services as part of the work of this Section:

.1 Design of Aluminum work.

.2 Design of anchors, supports and accessories to meet seismic requirements.

.3 Review, stamp, and sign shop drawings.

.4 Conduct on-Site inspections and prepare and submit inspection reports. Number and frequency of inspection to be sufficient to satisfy Engineer that Window Wall Work is being fabricated and installed in accordance with reviewed shop drawings and design intent.

.2 Shop mock-up:

.1 Provide one, full scale mock-up in shop of Aluminum work for shop testing, including air leakage, water penetration, and deflection in accordance with AAMA/WDMA/CSA 101/I.S.2/A440,, AAMA 501, ASTM E283, ASTM E330, and ASTM E331. If a test fails, additional testing may be required by Consultant to ensure performance of Aluminum Work at no additional cost to Owner.

.2 Demonstrate conformance to specified design requirements.

.3 Mock-up shall show full range of Products, finishes, textures, quality of fabrication, and workmanship including, but not limited to, framing members, glazing units, anchorage, opening units, doors and transitions to adjoining assemblies and materials.

.3 Site mock-up:

.1 Provide one full scale in-situ mock-up for testing of air and water infiltration to AAMA 501, ASTM E783 and ASTM E1105 to the satisfaction of an Consultant. If a test fails, additional testing may be required by Consultant to ensure performance of Aluminum Work at no additional cost to Owner.

.2 Deliver and erect one, full scale mock-up of Aluminum work assembly, in location acceptable to Consultant.

.3 Demonstrate conformance to specified design requirements.

.4 Demonstrate installation procedures, finished look and quality of workmanship including, but not limited to, framing members, glazing units, anchorage, opening units, doors and transitions to adjoining assemblies and materials.

.5 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.4 Pre-installation meetings:

.1 Mock-ups: Prior to installation of mock-ups, arrange meeting at the shop and on Site to be attended by Consultant, Contractor, and window wall Engineer and site superintendent to inspect substrates, and to review installation procedures 48 hours in advance of installation.

.2 Site: Prior to installation of window wall, arrange meeting at the Site to be attended by Consultant, Contractor, and window wall Engineer and site superintendent to inspect substrates, and to review installation procedures 2 weeks in advance of installation.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle Aluminum Work in accordance with AAMA CW-10 and manufacturer's written recommendations.

.2 Protect aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.

1.8 EXTENDED WARRANTY

.1 Aluminum work: Submit an extended warranty for Aluminum work in accordance with General Conditions, except that warranty period is extended to 5 years.

.1 Warrant against failure to meet the design criteria and requirements such as interior leakage, frame condensation.

.2 Coverage: Labour and materials to repair or replace Aluminum Work as required to correct deficient work and meet specified requirements including affected adjacent work.

.2 Glazing:

.1 Provide a 10 year warranty, commencing from date of Substantial Performance, against defects in the insulating glass units and warrant them to be free from material obstruction of vision as a result of dust or film formation on the internal glass surfaces by any cause, under normal design conditions. Warrant the following:

.1 The insulating glass units shall be free from condensation, fogging material obstruction of vision as a result of dust or film formation on the internal glass surfaces by any cause under design conditions.

.2 The insulating glass units shall not change their mechanical design properties and shall not in any way deteriorate, degrade, delaminate or change their visual appearance.

.3 The glass units will not break due to thermal shock and temperature differential due to inherent glass faults, other than extrinsic glass breakage.

.4 Internal fogging shall be deemed to occur when light transmission of the glass is reduced by 5% in any 50 mm x 50 mm area.

.5 Failure will be deemed to occur when the internal dew point exceeds -40oC in a 21oC ambient temperature (when tested in accordance with ASTM E576).

.2 Warrant that glazing work is water and weather tight and free from distortion; that glazing materials will not deteriorate from exposure to the atmosphere and weather, will not be displaced, and will be free from permanent deformation under load; and that glass and insulating glass units will not be broken, cracked or scratched by causes resulting from defects in material, workmanship or design of glazing installation.

.3 Cracked or scratched glass, shrinking, cracking, staining, hardening, sagging of glazing materials; loosening or rattling of glass; and leaking of glazed joints will be considered defective work.

.4 Warranty shall provide for the removal of defective Products, replacement with new Products conforming to the specifications, and restoration of work damaged by removal and replacement including labour and installation costs.

3. Manufacturer's finish Warranty: Provide manufacturer's written warranty naming Owner as beneficiary and covering finish degradation or failure of factory-applied exterior fluoropolymer finish on Aluminum work within the warranty period; warrant finish per AAMA 2605 for colour fade less than 5 units, maximum chalk rating of 8, and greater than 30% gloss retention. Warranty period for finish: 5 years from date Work is certified as substantially performed.

2 Products

2.1 ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)

.1 All Aluminum work systems and components are to be provided by a single manufacturer to ensure a single source of responsibility for the Work of this Section.

.2 Curtain wall: ‘HP3252 Series’ by CRL / U.S. Aluminum or approved alternative Oldcastle Building Envelope. Reinforcing in curtain wall mullions as required to maintain mullion size as detailed.

.3 Exterior entrance system:

.1 Aluminum entrance framing: In accordance with 2.1.1, Curtainwall.

.2 Aluminum doors: ‘ThermaPorte 7700’ by Alumicor Limited, ‘Insulclad Doors' by Kawneer Company Canada Limited or approved alternative by US Aluminum (C.R. Lawrence).

.4 Interior vestibule framing:
- .1 Aluminum entrance framing: '1800 Series' by Alumicor Limited or 'Trifab VG 451' by Kawneer Company Canada Limited or approved alternative by US Aluminum (C.R. Lawrence).
- .2 Aluminum doors: 'Canadiana' by Alumicor Limited, 'Standard Entrances' by Kawneer Company Canada Limited or approved alternative by US Aluminum (C.R. Lawrence).

2.2 MATERIALS

.1 All materials under work of this Section, including but not limited to, sealants are to have low VOC content limits.

.2 Aluminum extrusions and channels: ASTM B221 and ANSI H35.1 AA6063 alloy, T6 temper.
- .1 Profile and dimensions: Refer to Contract Drawings.
- .2 Thermal breaks in frame members: Vertically aligned with glazing.

.3 Aluminum sheet: ASTM B209 and ANSI H35.1 AA1100 aluminum alloy, H14 temper, minimum 2.38 mm thickness for all sheet widths.

.4 Reinforcements and anchors: ASTM A167, Type 304 to AISI No. 2B finish. Size as shown.

.5 Glass and glazing materials: As specified in Section 08 80 00.

.6 Spandrel panel, airseal backpan: ASTM A653/A653M; 0.9 mm thick, Z275 galvanized steel sheet.

.7 Airseal and Aluminum Work sealant: ASTM C920, Type S, Grade NS, Class 100/50; One-part, low-modulus, moisture-curing, silicone. 'Dow Corning 790' by Dow Corning; 'Spectrem 1' by Tremco. Verify compatibility with insulating glass unit manufacturer's secondary sealant. Colour as selected by Consultant. Primer as recommended by manufacturer.

.8 Frame sealant: Type as recommended by the Aluminum work manufacturer.

.9 Joint backing: Closed cell foam polyethylene rod, outsized minimum 30-50% larger than joint width and compatible with joint sealant. Product as recommended by sealant manufacturer.

.10 Airseal transition membrane: To match products provided under Section 07 26 00 - Air/Vapour Barriers.

.11 Anchors, clips, and angles: Extruded aluminum or stainless steel.

.12 Shims and blocking for frame: Rigid plastic, wood is not permitted.

.13 Flashings, closures and trim: 1.0 mm minimum aluminum sheet, finish to match Aluminum Work extrusion finish.

.14 Screws, bolts and other fasteners: ASTM F738M; Stainless Steel Type 304.

.15 Seismic anchors, supports and accessories: In accordance with reviewed shop drawings.

.16 Isolation coating: CAN/CGSB-1.108-M; Bitumastic coating, acid and alkali resistant material.

.17 Spandrel panel insulation: CAN/ULC S702; minimum 56 kg/m^3, unfaced, semi-rigid mineral wool.
- .1 'Thermafiber FireSpan' by Owens-Corning.
- .2 'CurtainRock' by Rockwool Inc.
- .3 Thickness: As required to fill void.
- .4 Insulation fasteners: Stik-Clip with retaining washer.

.18 Foam Insulation: One component polyurethane foam-in-place moisture cured caulking sealant insulation, 16 kg per m3 to 32 kg per m3 density; injected from prepackaged pressurized containers for installation within closures and fillers; foam shall be CFC free. Enerfoam by Dow Chemical Canada Inc. or approved alternative.

.19 Window hardware: Manufacturer's standard heavy duty corrosion resistant hardware.

.20 Door hardware: Supplied by others, installed by this Section.

.21 Weatherstripping: Durable, non-absorbing material resistant to deterioration by aging and weathering. Weather stripping shall provide complete air-tight seal at jambs and head of opening. Adapt weatherstripping as required to maintain required performance and provide any/all necessary accessories.

2.3 FABRICATION

.1 Fabricate sections true to detail, free from defects impairing appearance, strength and durability. Fabricate extrusions with sharp, well defined corners.

.2 Fabricate Aluminum work in accordance with reviewed shop drawings and manufacturer's written instructions.

.3 Fabricate, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints. Apply frame sealant at joints to provide continuity of water and air barrier.

.4 Conceal anchors, reinforcement and attachments from view. Fabricate reinforcement in accordance with design requirements.

.5 Do not expose manufacturer's identification labels on aluminum assemblies.

.6 Fabricate continuous sill flashings with intermediate anchor clips, and joint reinforcing, form to profile shown. Fabricate filler and closure pieces as necessary for a complete and weather tight installation.

.7 Certify aluminum windows as complying with the AAMA/WDMA/CSA 101/I.S.2/A440 design criteria and requirements using an easily removable label located on the inside face of glazing.

.8 Fabricate doors and frames complete with internal reinforcements, cut-outs, and recesses to accommodate finish hardware. Reinforce cut-outs to assure adequate strength.

.9 Fabricate Aluminum work closures and trim from aluminum sheet. Form to profile shown. Make weathertight.

.10 Double weatherstrip windows and doors. Install weatherstripping in specially extruded ports and secure to prevent shrinkage or movement.

.11 Fabricate glazing recess with drainage to exterior.

2.4 ALUMINUM DOORS

.1 Fabricate doors of welded construction.

.2 Glazing stop: Aluminum, square, snap-on type, designed for glazing system.

2.5 INSULATED PANELS AND SPANDREL PANELS

.1 Fabricate insulated panel and spandrel panel inner facing of galvanized sheet to form an airseal backpan. Wrap edges with galvanized sheet, enabling installation and minor movement of perimeter seal.

.2 Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

.3 Provide integral reinforcing and stiffeners as required to reinforce panel against deflection caused by wind and suction loads.

.4 Place continuous layer of insulation to airseal backpan with adhesive and impale clips and fasteners. Ensure there are not gaps between the insulation and airseal backpan.

.5 Provide spacers as necessary to separate dissimilar metals.

.6 Ventilate and pressure equalize the air space outside the exterior surface of the insulation, to the exterior.

.7 Arrange fasteners and attachments to ensure concealment from view.

.8 Glass panels: Consists of 6 mm thick spandrel glass to the exterior with insulated backpan to the inside. Insulation shall be in thickness as indicated on Contract Drawings thick, retained with stick clips. Seal all joints in shop with high grade butyl sealant, including perimeter seal at backpan. Colour to later selection by Consultant.

.9 Metal panels: Consists of an exterior prefinished flush aluminum panel with panel stiffeners as required, to match colour of window framing, with insulation core in thickness as indicated on Contract Drawings and galvanized sheet back-pan.

2.6 **FINISH**

.1 Extrusion finish: Four coat finish with barrier coat 'Duranar XL' by PPG in accordance with AAMA 2605. Colour:‘Silverstorm - UC106685F’.

.2 Mullion cap finish: Four coat finish with barrier coat 'Duranar XL' by PPG in accordance with AAMA 2605. Colour: ‘Silverstorm - UC106685F’.

.3 Doors: Four coat finish with barrier coat 'Duranar XL' by PPG in accordance with AAMA 2605. Colour:‘Silverstorm - UC106685F’.

.4 Panel and sheet finish: As indicated on drawings to match adjacent extrusion finish.

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**

.1 Install Aluminum Work in accordance with reviewed shop drawings, manufacturer's written instructions, and CAN/CSA-A440-M/A440.1-M.

.2 Install Work of this Section securely, in correct location, level, square, plumb, at proper elevations, free of warp or twist.

.3 Apply isolation coating at 0.8 mm dry film thickness to prevent corrosive or electrolytic action between dissimilar materials such as aluminum to concrete, masonry, galvanized steel and similar conditions.

.4 Install flashings, closures, and trim pieces.

.5 Fill voids between aluminum framing and adjacent construction with foam insulation.

.6 Install sills in maximum lengths possible. For sills over 1200 mm in length, maintain 3 mm to 6 mm space at each end.

.7 Refer to Contract Drawings for glazing type locations. Install glazing in accordance with Section 08 80 00.

.8 Spandrel panels:
- .1 Set back pans to framing, apply sealant to cover screw heads to maintain air tight seal between back pans and framing.
- .2 Adhere stick clips to metal back pans at 300 mm o.c. both ways. Apply insulation adhesive over entire surface of barrier and around clips held with adhesive.
- .3 Cut insulation slightly over-size and press insulation boards firmly to barrier impaling them on clips without bending clips. Butt insulation boards tightly. install retainers to clips.

.9 Install aluminum door weatherstripping at door frame perimeter. Install weatherstripping throughout entire length and width of doors at jambs and heads.

.10 Install doors and hardware to manufacturers' written instructions. Clean and adjust hardware for correct performance.

.11 Install hardware in accordance with hardware templates.

.12 Adjust fixed and operable hardware for correct clearances and function.

.13 Remove damaged or unacceptable Products and assemblies from Site and replace to Consultant's acceptance.

.14 Install glass presence markers, in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

3.3 ERECTION TOLERANCES

.1 Tolerances: Non-cumulative.
- .1 Maximum variation from plumb: 1.5 mm/3 m non-cumulative or 12 mm/30 m, whichever is less.
- .2 Maximum misalignment of two adjoining members abutting in plane: 0.8 mm.
- .3 Vertical and horizontal positions: +/- 3 mm.
- .4 Racking of face: 6 mm, nil in elevation.
- .5 Operable components: Consistent with smooth operation and weatherproof performance.
- .6 Maximum perimeter sealant joint between Aluminum Work and adjacent construction: 13 mm.

3.4 GLAZING PERIMETER AIRSEAL

.1 Install glazing perimeter airseal at entire perimeter of each insulating glass unit to achieve an airseal from insulating glass unit to curtain wall frame. Do not obstruct path of cavity drainage and air pressure equalization.

.2 Perform sealant work in accordance with manufacturer’s written requirements.

3.5 AIRSEAL TRANSITION MEMBRANE

.1 Install primer and airseal transition membrane in accordance with manufacturer's instructions. Install airseal transition membrane into extrusion reglet as indicated on drawings. If there is no extrusion reglet, mechanically fasten airseal transition membrane to frame with batten bar fastened at 150 mm o.c.

.2 Overlap airseal transition membrane 75 mm minimum and lap in direction of waterflow.

.3 Coordinate airseal transition to adjacent parts of Work.

3.6 JOINT BACKING AND ALUMINUM WORK SEALANT

.1 Prepare substrate surface and mask as recommended by sealant manufacturer.

.2 Install joint backing and sealant at Aluminum Work and perimeter joints for weather tight installation in accordance with sealant manufacturer's instructions. Tool sealant. Remove excess sealant.

.3 Seal joints between windows and window sills with sealant. Bed sill expansion joint cover plates and drip deflectors in sealant. Seal between sill upstand and window-frame. Seal butt joints in continuous sills.

3.7 ADJUSTING

.1 Adjust operable units to move smoothly, with proper tension, throughout their full range of motion and to fit tightly when closed and locked.

.2 Lubricate hardware in accordance with manufacturer's instructions.

.3 Ensure that weatherstripping makes weathertight contact and does not cause binding to affect closing and locking.

3.8 CLEANING

.1 Maintain Aluminum Work, inside and outside, in clean condition throughout construction period.

.2 Remove labels, protective material, and glass presence markers from prefinished surfaces.

.3 Remove CAN/CSA-A440-M/A440.1-M certification labeling when directed by Consultant, in writing.

.4 Wash Aluminum Work with solution of mild detergent in warm water, with particular attention to recesses and corners. Wipe surfaces clean and dry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for finish hardware work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 BHMA, Builders Hardware Manufacturing Association.

.2 NFPA 80, Standard for Fire Doors and Other Opening Protectives.

1.3 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating compliance with reference standards, transportation, storage, handling and installation requirements.

.2 Shop Drawings:
- .1 Submit Shop Drawings and 3 complete hardware lists in accordance with Section 01 30 00 indicating:
  - .1 Door locations, sizes, hardware manufacturer's catalogue numbers, finish symbols and quantities required.
  - .2 Locations and mounting heights of each type of hardware.
- .2 Supply templates and required information to door and frame manufacturer to enable accurate sizes, locations of cut-outs and reinforcement for hardware.
- .3 Submit templates to required trade to arrange for provisions for accurate setting and fitting of hardware.

.3 Samples:
- .1 Submit 2 samples in accordance with Section 01 30 00 of each item that is different from hardware specified and include manufacturer's parts lists and installation instructions.
- .2 Submit hardware component samples illustrating style, colour and finish. Tag samples identifying applicable Specification article number, brand name and number, finish, building location, date and catalogue number.
- .3 Do not order hardware until samples have been accepted. Submit new samples to replace rejected samples. Supply hardware and finishes identical to each accepted sample.

.4 Closeout submittals:
- .1 Submit the following in accordance with Section 01 78 00 for each Product for incorporation into Operation and Maintenance Manual:
  - .1 Maintenance data.
  - .2 Operating instructions and safety precautions.
  - .3 Parts list with name and address of supplier.
  - .4 Lubrication schedule and type of lubricant recommended.
  - .5 Keys, tools and special devices.
  - .6 Inspection procedures related to preventive maintenance.

1.4 **QUALITY ASSURANCE**

.1 General:
- .1 Manufacturers: Companies specializing in manufacturing door hardware and registered with BHMA.
- .2 Hardware supplier: Company specializing in supplying commercial door hardware and acceptable to manufacturer.

.2 Certifications:
- .1 Employ an Architectural Hardware Consultant to prepare hardware schedule and inspect completed installation and certify that hardware has been installed in accordance with manufacturer's printed instructions, Authorities having Jurisdiction and as specified.
- .2 Submit manufacturer's certificate that finish hardware and fire rated hardware meets specified requirements.

1.5 **DELIVERY, STORAGE, AND HANDLING**

.1 Be responsible for packaging of hardware, on a set by set basis. As material is received from various manufacturers identify it to correspond to Hardware List symbols.

.2 Label packages legibly, indicating manufacturer's number, types, sizes, opening number and Hardware List reference number. Wrap hardware and include in package, screws, bolts and fastening necessary for correct installation. If hardware package is not complete, pay additional charges incurred by installer.

.3 Deliver hardware to Site packaged, labelled and cross-referenced to hardware list for each item and its scheduled installation location.

.4 Accept Products of this Section on Site and ensure that each item is undamaged.

.5 Catalogue and store hardware in secure area.

2 Products

2.1 **GENERAL**

.1 Aluminum door hardware: Supplied and installed under the work of Section 08 44 00.

.2 Carefully check and verify Hardware List against Contract Drawings to ensure that hardware listed can be used as specified. Inform Consultant of concerns regarding quality, quantity, operation or function of hardware selected:
- .1 Verify hand of doors, examine details on Contract Drawings and at Site to ensure hardware supplied can be correctly installed and is correct for work as constructed.

.2 Select hardware in accordance with applicable codes and regulations and to approval of local Fire Marshal.

.3 Replace and pay for defective hardware including hardware which was incorrectly selected, and remedial and installation costs.

.3 Ensure that hardware selected will function correctly, meets Contract requirements and Ontario Building Code and authorities having jurisdiction.

.4 Ensure that each hardware item is of same type, design and by same manufacturer.

.5 Manufacturer's names or trade marks are not permitted on exposed surfaces of hardware.

.6 Include in packing slip a list of parts, name of supplier and door number in which lock is to be installed.

.7 Hardware for fire rated and labelled door and frame assemblies: ULC listed or as accepted by authorities having jurisdiction.

.8 Fire rated assemblies:

.1 Hardware: Selected and installed in accordance with applicable codes and regulations, NFPA-80 and to approval of Ontario Fire Marshal.

.2 Fire rated doors: ULC labelled hardware. Submit written certification of conformance to ULC requirements for each type of hardware prior to delivery.

.3 Locksets and latchsets on fire rated doors: 19 mm throw minimum.

2.2 ACCESSORIES

.1 Items to be attached to masonry or concrete with expandable shields, lag screws, bolts or other fastening devices as required. Exposed screws: Stainless steel, Phillips or Robertson heads.

2.3 FINISHES

.1 Metal finishes: Free from defects, clean, unstained and of a uniform colour for each type of finish required. Exposed surfaces and anchors: Specified finish symbol of item.

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 of this Section means acceptance of existing conditions.

3.2 INSTALLATION

.1 Install hardware in accordance with reviewed Shop Drawings, manufacturer's installation instructions, and applicable Codes and regulations.

.2 Install hardware in accordance with hardware templates.

.3 Adjust fixed and operable hardware for correct clearances and function.

.4 Mount hardware measured from finished floor to centre of hardware, unless indicated otherwise or required by Code:

- .1 Top hinge: 250 mm from head of door to top.
- .2 Bottom hinge: 265 mm from finished floor to bottom of hinge.
- .3 Intermediate hinge: Equal distance between top and bottom hinge.
- .4 Locksets, latchsets: 1000 mm.
- .5 Panic device crossbar: 1000 mm.
- .6 Push plates: 1100 mm to bottom of plates.
- .7 Guard bars: 1100 mm.
- .8 Door pulls: 1100 mm to bottom of pulls.
- .9 Blank strike: 1450 mm.
- .10 Blank fronts: 1450 mm.

.5 Include for supply and installation of wiring for electric strikes from electrical junction box to electric strike hardware.

.6 Locate door stops to contact doors 75 mm from latch edge.

.7 Install hardware and trim square and plumb to doors.

.8 Replace wrappings for hardware provided by manufacturer after installation.

.9 Safeguard keys to keep them out of unauthorized hands, tag them with door number, and deliver them to person designated by Consultant at building completion.

3.3 FIELD QUALITY CONTROL

.1 Have hardware inspected after installation by hardware supplier's representative, obtain certification in writing that hardware has been supplied and installed in accordance with Specifications and hardware manufacturer's instructions and is functioning correctly.

.2 Inspect fire rated openings to ensure they are installed in compliance with NFPA 80 requirements and Authorities having Jurisdiction.

.3 Test access control system and electrified hardware devices for proper operation. Verify electric door release hardware operates properly upon activation of fire alarm system.

3.4 ADJUSTING

.1 Verify under work of this Section, that installed hardware functions properly.

.2 Adjust hardware so that latches and locks operate smoothly and without binding, and closers act positively with the least possible resistance in use. Lubricate hardware if required by manufacturer's instructions.

.3 Adjust doors with self closing devices or automatic closing devices for proper operation after the HVAC system is balanced and adjusted. Verify spring power of non sized door closers is properly adjusted.

3.5 CLEANING

.1 Remove wrappings at completion of the Project and clean hardware in accordance with manufacturer's instructions.

3.6 HARDWARE GROUPS/SCHEDULE

.1 Hardware groups/schedule: Refer to hardware groups/schedule appended to this Section.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, tool, equipment and services necessary for automatic door equipment work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ANSI/BHMA A156.19, Power Assist and Low-Energy Power-Operated Doors.

1.3 **DESIGN REQUIREMENTS**

.1 Design handicap door system comprising of low energy power operator with optional push and go door system as defined in ANSI/BHMA A156.19.

.2 Design system operator to activate if one push button from either side of door is pushed. Actuated door shall open slowly to back check (80°) in 3 to 6 seconds and to full open position in 4 to 7 seconds. Door shall remain open for period set to suit requirements (period of 5 to 30 seconds). After time delay door shall close by spring in door operator from 90° to 10° in 3 to 6 seconds from 10° to fully closed in 1-1/2 to 2 seconds.

1.4 **SUBMITTALS**

.1 Product data: Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, trouble-shooting protocol, transportation, storage, handling and installation requirements.

.2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating all connections, attachments, reinforcing, anchorage and location of exposed fastenings.

.3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 **EXTENDED WARRANTY**

.1 Submit a extended warranty for automatic door equipment in accordance with General Conditions, except that warranty period is extended to 2 years.
  .1 Warrant against failure to meet design criteria and requirements.
  .2 Coverage: Complete replacement including affected adjacent Work.

2 Products

2.1 **ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)**

.1 Heavy Duty Door Operator: Design is based on self contained, low pressure electro-hydraulic power. Operator to be as manufactured by one of the following:
- .1 PowerSwing by Assa Abloy Entrance Systems Canada (Besam).
- .2 Magic Force by Stanley Canada Inc.
- .3 Or approved alternative by Allegion.

.2 Door operating equipment shall be complete with electro mechanical motor gear box. Provide 3 position (off-on) switch. System shall operate between -30 deg C and 50 deg C.

2.2 **REQUIREMENTS**

.1 Functional Requirements:
- .1 Equipment shall be designed to operate swing doors up to weight of 100 kg.
- .2 Opening Speed:
  - .1 Door shall be field adjusted to back check as required in Table 1 of ANSI/BHMA A156.19.
  - .2 Opening speed to fully open shall be 4 seconds or longer.

.2 Hold Open: Door shall be field adjusted to remain fully open for not less then 5 seconds or more than 30 seconds.

.3 Closing Speed:
- .1 Doors shall be field adjusted to close 90° to 10° in 3 seconds or longer as required in Table 1 of ANSI/BHMA A156.19.
- .2 Doors shall close from 10° to fully closed in not less than 1.5 seconds.
- .3 Force required to prevent door from opening or closing shall not exceed 7 kg applied 25 mm from latch edge of door at any point in opening or closing cycle.
- .4 During power failure, doors shall open with manual pressure not exceeding 11.3 kg at point 25 mm from latch edge of door.
- .5 Doors shall be equipped with signs visible from either side, instructing user as to operation and function of door.

.4 Requirements:
- .1 Provide header complete with full housing, finish shall match door frame finish.
- .2 Locations of automatic door operators to conform to requirements of the Ontario Building Code (OBC).
- .3 Operator shall be activated by 150 mm diameter stainless steel push button switches on either sides as indicated.
- .4 Switches shall bear universal handicap logo visible to all types of traffic.

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**

.1 Install automatic door operators, controls and accessories for doors indicated in accordance with reviewed shop drawings and manufacturer written instructions.

.2 Installation of automatic door operators to be in accordance with requirements of the Ontario Building Code (OBC).

.3 Doors shall operate manually as though equipped with manual door closers, without damage to automatic door components, in event of power failure or in event of power termination.

.4 Co-ordinate this work with Section 08 44 00.

.5 Power supply to each door operator and wiring shall be provided by Division 26 - Electrical. Make connections at operators and at control panel and supply and install each electrical work between operators and activating controls. Comply with requirements of Division 26 - Electrical. All wiring shall be concealed and where exposed shall be run in conduit. Location of exposed wiring shall be subject to Consultant's approval.

3.3 **ADJUSTMENT AND CLEANING**

.1 Test and adjust operators and controls smooth and proper operation.

.2 Upon completion of Work of this Section, remove from Site all debris, equipment and excess material resulting from Work of this Section.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment, tools, and services necessary for glass and glazing work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.

.2 ASTM C1376, Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.

.3 ASTM C1503, Standard Specification for Silvered Flat Glass Mirror.

.4 ASTM D2240, Test Method for Rubber Property - Durometer Hardness.

.5 ASTM E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.

.6 CAN/CGSB-12.1-M, Tempered or Laminated Safety Glass.

.7 CAN/CGSB-12.8, Insulating Glass Units.

.8 Glass Association of North America (GANA) Glazing Manual.

.9 NFPA 80, Standard for Fire Doors and Other Opening Protectives.

1.3 **DESIGN REQUIREMENTS**

.1 Glass design:
- .1 Design glass using a probability of breakage of 8 lites per 1000 at the first application of design load.
- .2 Perform stress analysis. Design units to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .3 Perform a thermal stress analysis on each glass unit with Low-E coating and provide heat strengthening and/or tempered units as necessary to prevent thermal breakage.
- .4 Perform a thermal stress analysis on each insulating thermal unit and provide heat strengthening and/or tempered units as necessary to prevent thermal breakage.
- .5 Where required, design glazing units so as not to allow thermal stress fracture due to heat build-up behind insulating units.
- .6 Roller wave:
  - .1 Heat treated flat glass to be by horizontal (roller hearth) process with inherent roller wave distortion parallel to the bottom edge of the glass as installed.

.2 Maximum peak to valley roller wave 0.08 mm in the central area and 0.20 mm within 267 mm of the leading and trailing edge or 100 millidiopter over 95% of the glass surface.
.3 Maximum bow and warp 0.79 mm per 300 mm.
.4 Roll distortion is to run parallel to the width dimension when installed in the building.

.7 Coordinate with applicable Sections as required to meet intended energy and performance requirements for insulating glass units.

.2 Limit glass deflection to flexural limit of glass with full recovery of glazing materials.

.3 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.

1.4 SUBMITTALS

.1 Shop drawings:
.1 Submit shop drawings in accordance with Section 01 30 00 indicating as a minimum:
.1 Fabrication and erection of glazing elements indicating materials, thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

.2 Samples:
.1 Submit following samples in accordance with Section 01 30 00.
.2 Submit one sample of each type of glass.
.1 300 x 300 mm of each type of insulating glass unit, complete with each different Low-E coating.
.2 300 x 300 mm of tempered glass.
.3 300 x 300 mm of laminated glass.
.4 300 x 300 mm of each colour of spandrel glass.
.5 300 x 300 mm of mirror.
.6 300 x 300 mm of glass film.

.3 Certificates:
.1 Submit manufacturer's certification that glass and glazing materials are compatible.

.4 IGMAC Compliance Audit: Submit in accordance with Section 01 30 00, a written certification of successful completion of a Compliance Audit within the last six months.

.5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 **QUALITY ASSURANCE**

.1 Insulating glass unit fabricators shall be a certified member of the Fenestration and Glazing Industry Alliance (FGIA). FGIA members must participate in the certification program and shall have successfully passed a Compliance Audit within the last six months.

.2 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of glazing units of a similar size and nature.

1.6 **SITE CONDITIONS**

.1 Glaze with compounds, sealants, or tapes only when glazing surfaces are at temperatures over 4°C, and when positive that no moisture is accumulating on them from rain, mist, or condensation.

.2 When temperature of glazing surfaces is below 4°C, obtain from Consultant and material manufacturer approval of glazing methods and protective measures which will be used during glazing operations.

1.7 **EXTENDED WARRANTY**

.1 In accordance with Section 08 44 00.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Glass manufacturers:
- .1 AGC Flat Glass.
- .2 Cardinal Glass Industries.
- .3 Guardian Industries.
- .4 Viracon Inc.
- .5 Vitro Architectural Glass (formerly PPG Industries Ltd.)

2.2 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers, coatings, sealers, sealants, adhesives and cleaners are to have low VOC content limits.
- .2 All coatings of a similar type shall be applied in a single production run to ensure colour match.
- .3 Edges of glass shall be free from spalls, flake chips or rough chips which would be either visible or compromise the adhesion of the exterior weather seal or reduce the strength of glass when subjected to temperature differentials.

.2 Tempered glass **(TGL)**: CAN/CGSB-12.1-M, Type 2, Class B, Category II, clear, minimum 6 mm thick.

.3 Fire rated glass **(FRGL)**: 20 min. to 3 hr. fire rating tested to ULC CAN4 S104-M and ULC CAN4 S106-M, 5 mm thick or as otherwise noted on Door Schedule with appropriate labelling stating fire rating and approval, clear polished glass. Firelite Plus by Nippon Electric Glass Company Ltd. or approved alternative.

.4 Laminated glass **(LGL)**: to CAN/CGSB-12.1, Category II, consisting of top layer of 3 mm thick clear tempered glass, 0.8 mm thick clear PVB interlayer, and bottom layer of 3 mm thick clear tempered glass. Heat strengthening and/or tempered laminated glass as necessary to prevent thermal breakage.

.5 Spandrel glass **(SGL)**: ASTM C1048, Condition B, 6 mm thick tempered glass, with water-based silicone emulsion coating applied to backside, 'Opaci-Coat 300' by ICD High Performance Coatings or approved alternative. Colour: To the later selection of the Consultant.

.6 Heat strengthened glass **(HSGL)**: CAN/CGSB-12.3-M; clear float glass, glazing quality, heat strengthened in accordance with ASTM C 1048, Kind HS, 17.5 mm thick unless indicated otherwise.

.7 Silvered mirror glass **(MGL)**:
- .1 to ASTM C1503, 6 mm thick, laminated safety mirror glass fabricated with polished plate or float glass. Mirror backing shall be resistant to sulphur and hydrogen sulphide fumes. Polish and round all corners of mirrors.
- .2 Mirror attachment accessories:
  - .1 Mirror adhesive: Chemically compatible with mirror coating and wall substrate.
  - .2 Mirror frames: Stainless steel.
  - .3 Stainless steel clips.

.8 Insulating glass units:
- .1 To CAN/CGSB-12.8-M, ASTM E2190 and IGMA requirements utilizing approved stainless steel edge spacer. Dual seal with a PIB primary seal and silicone secondary seal.
- .2 To comply with IGMA labelling requirements to be considered certified. Materials, excluding the glass, shall be from the same manufacturer as those employed for the certification of the insulating glass units.

.9 Argon gas: 100% pure. Argon gas to be used to fill air space at all insulated glass units.

.10 Low-E coating (Soft coat): ASTM C1376, high performance sputtered low-E coating. Provide insulating glass units with low-E coating edge deletion and low-E coating. Apply low-E coating to second surface unless otherwise indicated. 'EnergySelect 36' by AGC Flat Glass, 'Cardinal LoE-272' by Cardinal Glass Industries or 'SN 68' by Guardian Industries.

.11 Glazing and rebate primers, sealants, sealers, and cleaners: Compatible with each other. Type as recommended by sealant, spline, and glass manufacturer.

.12 Glazing sealant: Silicone sealant as recommended by glazing manufacturer. Verify compatibility with insulating glass unit secondary sealant.

.13 Heel & toe bead: Silicone sealant as recommended by glazing manufacturer.

.14 Glazing gasket: 'Visionstrip' or Polyshim II' by Tremco Ltd., glazing seal, size as recommended by manufacturer.

.15 Glazing tape: 'Polyshim II' glazing tape EPDM shim.

.16 Glazing splines: EPDM or neoprene, extruded shape to suit glazing channel retaining slot, colour as selected.

.17 Setting blocks (regular): EPDM, 80 - 90 Shore A durometer hardness to ASTM D2240, sized to suit glazing method, glass unit weight and area.

.18 Edge blocks: EPDM, 60-70 Shore A Durometer hardness, self adhesive on face, sized with 3 mm clearance from glass edge and spanning glass thickness(es).

.19 Glass presence markers: Easily removable, non-residue depositing.

.20 Screws, bolts and fasteners: Type 304 stainless steel.

2.3 GLAZING AND FILM SCHEDULE

.1 General: Glass types shall be as indicated on Drawings and below unless otherwise required due to thermal stress analysis.

.2 GL-1 (IG units): 6 mm clear tempered glass interior lite, argon filled air space, 6 mm clear tempered glass exterior lite with low-E coating on surface #2. Standard throughout unless noted otherwise. 25 mm overall thickness.

.3 GL-2: 7 mm clear laminated safety glass interior lite, argon filled air space, 6 mm clear tempered glass exterior lite with low-E coating on surface #2. Standard throughout unless noted otherwise. 25 mm overall thickness.

.4 GL-3: 6 mm thick spandrel glass with galvanized metal back-pan filled with semi-rigid insulation.

.5 GL-4: 6 mm clear tempered glass.

2.4 FABRICATION

.1 Verify glazing dimensions on Site.

.2 Clearly label each glass lite with maker's name and glass type. Ensure labels are easily removable, non-residue depositing type. Do not remove labels until after Work is accepted by Consultant.

.3 Fabricate glazing not less than 3 mm smaller than rebate size in either dimension; allow for edge spacers, shims, and setting blocks as necessary.

.4 Work shall have smooth finished surfaces free from distortion and defects detrimental to appearance and performance.

.5 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.

.6 Grind and polish a 1.5 mm arris to both edges of exposed glazing at locations where glazing is not encapsulated in framing and where edges are exposed to occupants.

.7 Fabricate argon filled thermal units with air space filled minimum 90% with argon gas.

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 of this Section means acceptance of existing conditions.

.2 Verify that openings for glazing are correctly sized and within tolerance.

.3 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

.4 Laminated glass edges shall be completely covered by tape to protect against sealants and water if required by manufacturer.

3.2 PREPARATION

.1 Clean contact surfaces with solvent and wipe dry.

.2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.

.3 Prime surfaces scheduled to receive sealant.

3.3 INSTALLATION

.1 Provide glazing in accordance with FGIA recommendations. Provide continuous contact between glazing tapes and gasket to the glazing.

.2 Install glazing to the work of Sections 05 50 00, 06 20 00, 08 11 13, 08 35 00, 08 39 18, 08 42 29 and 08 44 00.

.3 Provide neat, straight sight lines. Trim excess glazing tape flush with top of stops and fixed leg of frames.

.4 Remove protective coatings, glazing stops, clean rebate and glass contact surfaces with solvent, wipe dry.

.5 Apply primer/sealer to contact surfaces, prior to glazing.

.6 Apply glazing tape as per manufacturer's instructions including recommended corner sealant.

.7 Use setting blocks at 1/4 points and spacers to centre glass unit in frame.

.8 Install glazing in accordance with reviewed shop drawings and manufacturer's written instructions. Install glazing with full contact and adhesion at perimeter. Maintain edge clearance recommended by glass manufacturer.

.9 Apply a continuous heel bead of sealant around perimeter of inboard lite of the sealed unit and the metal framing.

.10 Re-install glazing stops ensuring continuous contact and rattle-free installation. Do not distort glass. Trim tape protruding more than 2 mm above stop.

.11 Install glazing gasket in accordance with manufacturer's recommendations.

.12 Do not cut or abrade tempered, heat treated, or coated glass.

.13 Install glass presence markers in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

.14 Remove, dispose of, and replace broken, cut, abraded glass, and defective glass including but not limited to production dimples, roller wave or marks, tong marks, chips, cracks, etc.

.15 Exterior glass: Glaze units with gasket on exterior side and glazing tape on interior side. Seal gap between glazing and stop with sealant to depth equal to bite of frame. Apply cap head of sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

.16 Interior glass: Glaze interior glass using glazing gasket glazing tape.

.17 Glass film
- .1 Install glass film with adhesive, applied in accordance with film manufacturer's instructions.
- .2 Place without air bubbles, creases or visible distortion.
- .3 Fit tight to glass perimeter with razor cut edge.

.18 Mirrors:

.1 Install mirrors in one single piece in sizes indicated without joints.

.2 Set mirrors with adhesive and clips, applied in accordance with manufacturer's instructions.

.3 Where indicated, provide continuous metal trim along all mirror edges, with mitred corners and concealed fastenings.

3.4 CLEANING

.1 Immediately remove sealant and compound droppings from finished surfaces.

.2 Remove labels, protective material, and glass presence markers from prefinished surfaces.

.3 Clean glass surfaces with cleaning agents and methods in accordance with Manufacturer’s written instructions.

.4 Do not wash glass film for 30 days after installation.

.5 Do not use bristle brushes on glass film.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for gypsum board work.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 ASTM C475, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

.3 ASTM C645, Specification for Nonstructural Steel Framing Members.

.4 ASTM C754, Specification for Steel Framing Members to Receive Screw-Attached Gypsum Board.

.5 ASTM C834, Standard Specification for Latex Sealants.

.6 ASTM C840, Specification for Application and Finishing of Gypsum Board.

.7 ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

.8 ASTM C1396, Specification for Gypsum Board.

.9 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 **DESIGN REQUIREMENTS**

.1 Design gypsum board wall and ceiling systems with a maximum deflection of l/360.

.2 Design ceiling suspension system in accordance with manufacturer's printed directions and ASTM C754.

.3 Design ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

.4 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.

.5 Design suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures.

.6 Design subframing as necessary to accommodate, and to circumvent, conflicts and interferences where ducts or other equipment prevent the regular spacing of hangers.

.7 Design wall framing system and reinforce as necessary to accommodate and support items attached to and supported by wall framing system.

.8 Design wall framing system for wall assemblies with a height greater than 3000 mm and those assemblies incorporating non-standard gypsum board assemblies including, but not limited to, abuse resistant gypsum board, and large format tile. applications.

1.4 REGULATORY REQUIREMENTS

.1 Provide fire separations and fire protection exactly as specified in test design specification that validates the specified rating. Verify that work specified in other Sections, as a part of the entire assembly, meets applicable validating test design specification.

1.5 SUBMITTALS

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop Drawings:
- .1 Submit Shop Drawings in accordance with Section 01 30 00 indicating:
  - .1 Wall assemblies, suspension systems, adjacent construction, elevations, sections and details, dimensions, thickness, finishes and relationship to adjacent construction.
  - .2 Framing and blocking for items being supported of wall systems.
  - .3 Fire rated designs.

.3 Certifications: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

1.6 QUALITY ASSURANCE

.1 Qualifications: Execute the work of this Section by skilled, qualified, and experienced workers trained in the installation of the work of this Section.

.2 Retain a Professional Engineer, licensed in Province of Ontario, with experience in work of comparable complexity and scope, to perform following services as part of work of this Section:

.1 Design of wall systems with height greater than 3000 mm and at non-standard gypsum board assemblies including, but not limited to, assemblies incorporating abuse resistant gypsum board, and large format tile applications.
.2 Design of suspended gypsum board assemblies.
.3 Review, stamp, and sign Shop Drawings and design calculations.
.4 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed Shop Drawings.

1.7 **SITE CONDITIONS**

.1 Do not begin work of this Section until:
.1 Mechanical and electrical work above the ceiling is complete.
.2 Substrate and ambient temperature is above 15°C.
.3 Relative humidity is below 80 %.
.4 Ventilation is adequate to remove excess moisture.

.2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and 24 h after installation.

2 Products

2.1 **MATERIALS**

.1 General: All materials under work of this Section, including but not limited to, sealants, adhesives, and primers are to have low VOC content limits.

.2 Steel framing: ASTM C754; ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
.1 Bailey Metal Products Limited
.2 Corus Metal Profiles

.3 Steel studs and track runners: ASTM C645; Galvanized steel studs and runners, 32 mm wide x depth as indicated on Contract Drawings. Formed from galvanized steel sheet, thicknesses as follows:
.1 Studs less than 3000 mm: Minimum 0.53 mm (25 ga.).
.2 Studs greater than 3000 mm and non-standard assemblies: Minimum 0.91 mm (20 ga.), unless stud thickness of greater thickness is required to accommodate intended loading, spans, or conditions.
.3 Track runners and ancillary components to match stud thickness.

.4 Main carrying channels: ASTM C645; Formed from galvanized steel sheet, 38 x 19 mm cold rolled, channels.

.5 Resilient channel: ASTM C645; 0.5 mm thick galvanized metal, 57 mm wide x 12 mm deep for walls and ceiling to reduce sound transmission.

.6 Furring channels: ASTM C645; Formed from galvanized steel sheet, 22 mm winged flange type, cold rolled.

.7 Furring channels (hat type): ASTM C645; 0.5 mm base steel thickness, galvanized. 70 mm wide x 22 mm deep hat shaped channel.

.8 Heavy duty furring channels: ASTM C645; 0.9 mm steel thickness, galvanized hat shaped channel with a wider and deeper size as required by manufacturers.

.9 Hanger wires: 4.1 mm minimum diameter galvanized pencil rod.

.10 Tie wire: 1.6 mm thick minimum diameter, soft annealed, galvanized steel wire.

.11 Corner bead, casing bead, and special shapes: Formed from 0.6 mm thick minimum, galvanized steel sheet, designed to be concealed by joint compound.

.12 Deflection track: ASTM C 645 top runner with 50.8-mm- deep flanges, in thickness indicated for studs and in width to accommodate depth of studs.

.13 Deflection track (fire rated): Provide 25 mm deep leg deflection track where indicated on rated walls. 'Fire Trak Shadowline' by Fire Trak Corporation or approved alternative.

.14 Ceiling clips: Hot dip galvanized partition attachment clips, in square and reveal edge; 'PAC 15 Series' to match grid system by CGC Inc. or approved alternative.

.15 Gaskets (acoustic partitions): Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 3.2 mm thick, in width to suit steel stud size.

.16 Control joint strip: Roll formed from galvanized steel sheet, with a tape protected recess, 6 mm wide x 11 mm deep.

.17 Screw fasteners: ASTM C1002 Type S; Corrosion resistant.

.18 Concrete anchors: tie wire sleeve anchors, 'Redi-Drive Anchors' by ITW Red Head or approved alternative.

.19 Insulation: In accordance with Section 07 21 00.

.20 Standard sealants:

- .1 Acoustic sealant (non-rated): Non-hardening acoustic sealant for use at non-rated assemblies, ASTM C834; Acrylic, mould resistant sealant, paintable. 'Smoke and Acoustic Sealant CP506' by Hilti or approved alternative.
- .2 Standard sealants: In accordance with Section 07 92 00.

.21 Fire rated seal: Provide one of the following for use at fire rated assemblies:
- .1 Fire-rated sealant: Non-hardening sealant for use at fire-rated assemblies: ASTM E84; Acrylic based firestop sealant, colour: red or white as selected by Consultant. 'Flexible Firestop Sealant CP606' by Hilti or approved alternative.
- .2 Fire-rated seal: Non-hardening seal for use at fire-rated assemblies: ASTM E84; Flexible seal for installation between top track and substrate. 'Firestop Top Track Seal CFS-TTS' by Hilti or approved alternative.

.22 Polyethylene vapour retarder: In accordance with Section 07 26 00.

.23 Vibration isolation ceiling hangers: unit shall consist of a steel spring in series with a neoprene isolating element. Model W30N manufactured by Mason Industries Inc., or approved alternative by PAC International. Provide hangers to ensure that working load does not exceed 2/3 of solid load. Design hangers to tolerate 30 deg. misalignment.

.24 Fire rated gypsum board: ASTM C1396; gypsum board 15.9 mm thick of maximum practical lengths to minimize end joints, unless indicated otherwise. Furnish Type X Board by Certainteed Gypsum Canada, CGC Inc., or Georgia-Pacific Canada LP.

.25 Abuse Resistant Panels: ASTM C1396; 15.9 mm thick unless indicated otherwise on drawings; 'Abuse Resistant' by Certainteed Gypsum Canada, 'Sheetrock AR' by CGC Inc. or 'ToughRock' by Georgia-Pacific Canada LP.

.26 Moisture, mould, and abuse resistant panels: 15.9 mm thick unless indicated otherwise on drawings; 'AirRenew Extreme Impact Resistant with M2Tech' by Certainteed Gypsum Canada, 'Sheetrock Mold Tough AR' by CGC Inc. or 'DensArmor Plus Abuse-Resistant Interior Panel' by Georgia-Pacific Canada LP.

.27 Tile Backer: Water resistant tile backer board meeting ASTM C1178 or ASTM C1278, thickness as indicated. 'Diamondback Tile Backer' by Certainteed Gypsum Canada, 'Fiberock Aqua-Tough Underlayment' by CGC Inc. or 'Dens Shield' by Georgia-Pacific Canada LP.

.28 Primer: Where indicated by board manufacturer, provide primer as required to achieve finishes as defined in ASTM C840.

.29 Joint reinforcing tape:
- .1 Standard gypsum board: ASTM C475; 50 mm wide x 0.25 mm thick, perforated paper, with chamfered edges.
- .2 Moisture resistant and tile backer boards: ASTM C475; fibreglass mat joint tape as recommended by board manufacturer to suit location.

.30 Bonding adhesive: Type for purpose intended and as recommended and approved by manufacturer.

.31 Joint and patching compound: ASTM C475; Asbestos-free, supplied by manufacturer of gypsum board used.

.32 Fast setting patching compound: ASTM C475; Asbestos-free, Sheetrock or Durabond by CGC Inc., 'Moisture and Mold Resistant Setting Compound with M2Tech' by Certainteed Gypsum Canada or approved alternative.

.33 Access doors: Supplied by other Sections for installation as part of the work of this Section.

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 of this Section means acceptance of existing conditions.

3.2 **SUSPENSION FRAMING**

.1 Install ceiling systems in accordance with reviewed Shop Drawings and manufacturer's written instructions.

.2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.

.3 Install vibration isolation hangers at all locations where indicated in strict accordance with manufacturer's printed instructions.

.4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.

.5 Install additional hangers at lighting fixture and ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.

.6 Install main carrying channels transverse to structural framing members. Lap main carrying channels 200 mm minimum at splices and wire each end with two loops and prevent clustering or lining-up of splices.

.7 Install furring channels at 400 mm o.c., not less than 25 mm, and not more than 150 mm from perimeter walls, at openings, at interruptions in ceiling continuity, and at change in plane. Install furring channels to a tolerance of 3 mm maximum in 3600 mm.

.8 Install additional main carrying and furring channels to frame and to reinforce openings such as recessed lighting fixtures, access hatches, ceiling grilles, outlet boxes, ventilating outlets and similar items.

3.3 STEEL STUDS AND FURRING

.1 Install steel studs and furring in accordance with reviewed Shop Drawings and manufacturer's written instructions.

.2 Install steel stud partitions to underside of structure unless indicated otherwise.

.3 Install track runners at floors, ceilings, and underside of structure; align track runners accurately and secure to structure at 600 mm centres maximum.

.4 Install double top track runner assembly to prevent the transmission of structural loads to steel studs.

.5 Install steel studs vertically at 400 mm o.c., unless otherwise indicated, and not more than 50 mm from abutting walls, at openings, and at each side of corners. Install studs securely to track runners.

.6 Schedule and coordinate steel framing installation with mechanical and electrical services installation.

.7 Install full height, double studs at door and service openings, fastened together and stiffened back to the structure to prevent vibration when doors close.

.8 Provide double studs boxed together at all openings, sill, head and jambs and at door jambs, fastened together and stiffened back to the structure to prevent vibration. At each opening exceeding 900 mm in width double studs shall be 20 ga. extending to structure above, and adequately anchored at each end. Provide steel studs above and below openings spaced at 400 mm oc maximum. All metal stud partitions above doors and screens over 1220 mm wide shall be secured to structure over and reinforced with sway bracing to stabilize walls to prevent lateral movement.

.9 Erect three studs at corner and intermediate intersections of partitions. Space 50 mm apart and brace together with wired 19 mm channels.

.10 Stiffen partitions over 2440 mm high or 3000 mm long, or both, with horizontal bracing extended for full length of partitions. Provide one line of bracing in partitions. Space lines to provide equal unbraced panels. Provide bracing for portions of partitions over door openings in partitions over 3000 mm high, and bracing both above and below openings in partitions located no greater than 150 mm from top and bottom of opening, and extending two stud spaces beyond each edge of opening for both doors and windows. Wire tie or weld bracing to studs.

.11 Frame control joints using back to back double studs at abutting structural elements, at dissimilar backup interface, at dissimilar walls and ceilings, at structural expansion and control joints, at door and other openings, and at 9000 mm maximum spacing in continuous runs. Install control joint strips and secure in place.

.12 Install additional support framing at openings and cutouts for built-in equipment, upper cabinet support, access panels and similar items.

.13 Attach to framing adequate steel reinforcing members or an 18 ga. steel stud mounted horizontally and notched around furring members to support the load of, and to withstand the withdrawal and shear forces imposed by, items installed upon the work of this Section. Such items include, but are not restricted to, coat hooks, washroom accessories, handrail anchors, rub rails, grab bars, guards, wall-hung cabinets and fitments, shelving, curtain and drape tracks; Owner supplied equipment; and minor mechanical and electrical work. Heavy mechanical and electrical equipment shall be self-supporting in Divisions 21, 22, 23 and 26.

.14 Provide for support and incorporation of flush-mounted and recessed mechanical and electrical equipment and fixtures only after consultation and verification of methods with those performing the work of Divisions 21, 22, 23 and 26.

.15 Install cross bracing in accordance with the steel stud manufacturer's recommendations.

3.4 FIRE RATED ASSEMBLIES

.1 Install Products in fire rated assemblies in strict accordance with reviewed Shop Drawings and applicable tested and approved designs required by Authorities Having Jurisdiction.

.2 Install firestop fill material behind fire rated acoustical sealant and provide firestop identification tag.

.3 Stiffen fire rated walls over 3.66 m high, where linear length of wall is greater than 2.44 m between perpendicular wall supports, with diagonal bracing above the ceiling extending perpendicular to wall at a 45° angle to structure above. Locate diagonal bracing at maximum 2.44 m o.c.

.4 Where double layers of gypsum board are shown, and required for fire rating, screw first layer to studs and furring and laminate the second layer to the first using joint filler as an adhesive. Stagger joints between first and second layers.

3.5 INSULATION

.1 Install non-rated and fire-rated/acoustic insulation as required for Work of this Project in accordance with Section 07 21 00.

3.6 ACOUSTICAL SEALANT

.1 Install acoustical sealant to acoustically insulated partitions in accordance with the manufacturer's instructions and Contract Drawings.

.2 Install acoustical sealant under floor runner track, at partition perimeter both sides and at openings, cut-outs, and penetrations, concealed from view in the final installation.

.3 Smooth acoustical sealant with trowel prior to skin forming.

3.7 GYPSUM BOARD

.1 Comply with ASTM C840. Install gypsum board in accordance with reviewed Shop Drawings and manufacturer's written instructions.

.2 Install gypsum board vertically or horizontally, whichever results in fewer end joints. Locate end joints over supporting members.

.3 Install gypsum board in lightly butted contact at edges and ends and with 1.6 mm maximum open space between boards; do not force gypsum board into place. Do not install imperfect, damaged or damp boards.

.4 Install gypsum board butting paired tapered edge joints, and mill-cut or field-cut end joints; do not place tapered edges against cut edges or ends.

.5 Install vertical joints minimum 300 mm from the jamb lines of openings and stagger vertical joints over different studs on opposite sides of partitions.

.6 Do not locate joints within 200 mm of corners or openings, except where control joints occur at jamb lines or where openings occur adjacent to corners. Where necessary, place a single vertical joint over the centre of wide openings.

.7 Install gypsum board over concrete and concrete masonry units with adhesive as recommended by gypsum board manufacturer where indicated on Drawings.

.8 Cut, drill and patch gypsum board as may be necessary to accommodate the work of other trades.

9. Fire Separations:
   .1 Construct gypsum board assemblies, where located, in accordance with tested assemblies to obtain required or indicated fire rated assemblies. As a minimum fire separations shall consist of metal framing covered on both sides by fire-rated gypsum board.
   .2 Install assemblies tightly to enclosing constructions to maintain integrity of the separations. Install casing beads at all perimeter edges.

3.8 CORNER, CASING BEADS AND TRIM

.1 Corner reinforcing bead: Install along all external angles, erect plumb, level and with a minimum of joints. Secure with screws at 225 mm o.c. apply filler over flanges flush with nose of the bead and extending at least 75 mm onto surface of board each side of corner. When filler dries, apply a thin coat of topping cement and blend onto adjoining surfaces.

.2 Casing bead: Install where wallboard butts against a surface having no trim concealing the juncture and where shown on drawings. Erect casing beads plumb or level, with minimum joints, and secure with screws at 300 mm o.c. apply filler over flange flush with bead and extending at least 75 mm onto surface of board. When dry, apply a thin coat of topping cement and blend onto adjoining surfaces.

.3 Recess channels and trim: Install recess channels and special metal trim where shown. Secure to substrate. Provide casing beads full height on wallboard edges at recess channels and metal trim.

3.9 JOINT TAPING AND FINISHING

.1 Install reinforcing tape and a minimum of 3 coats of joint compound over gypsum board joints, metal trim and accessories, and screw fasteners in accordance with the gypsum board manufacturer's instructions.

.2 Fill gaps between ,and any imperfections in, gypsum boards with joint compound, allow to dry, and sand smooth ready for painting.

.3 Install finished gypsum board work smooth, seamless, plumb, true, flush, and with square, plumb, and neat corners.

.4 Finish gypsum board in accordance with ASTM C840 to the following grades:

- .1 Level 0: No taping, finishing, or accessories required. Use above suspended ceilings and within other concealed spaces, unless the assembly is fire rated, sound rated, sound or smoke controlled, or unless the space serves as an air plenum.
- .2 Level 1: At joints and interior angles embed tape in joint compound. Leave surface free of excess joint compound. Tool marks and ridges are acceptable. Use above suspended ceilings and within other concealed spaces if the gypsum board assembly is fire rated, sound rated, sound or smoke controlled, or the space serves as an air plenum.
- .3 Level 2: At joints and interior angles embed tape in joint compound with one separate coat of joint compound applied over joints, angles, fastener heads, and accessories. Use for water resistant gypsum board indicated for use as a substrate for ceramic tile.
- .4 Level 3: At joints and interior angles embed tape in joint compound with two separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use where heavy grade wall coverings are the final decoration.
- .5 Level 4: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use for all locations except those indicated for other finish levels.
- .6 Level 5: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply a thin skim coat of joint compound, or a material manufactured especially for this purpose, to the entire surface. Leave surface smooth and free of tool marks and ridges. Use where semi-gloss or gloss finish coatings are the final decoration.

3.10 ACCESS DOORS

.1 Install access doors, supplied as part of other parts of the work, in accordance with manufacturer’s written instructions.

3.11 **SITE TOLERANCES**

.1 Install metal support systems to ensure that, within a tolerance of +3 mm and -1.5 mm for plaster thickness, finish surfaces will be flat within 3 mm under a 3 m straightedge, and with no variation greater than 1.5 mm in any running 300 mm, and that surface planes shall be within 3 mm of dimensioned location.

3.12 **REPAIR**

.1 Make good cut-outs for services and other work, fill in defective joints, holes and other depressions with joint compound.

.2 Make good defective work, and ensure that surfaces are smooth, evenly textured and within specified tolerances to receive finish treatments.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for tile work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ANSI A108/A118/A136.1, Installation of Ceramic Tile.

.2 ANSI A137.1, Specifications for Ceramic Tile.

.3 ASTM C144, Specification for Aggregate for Masonry Mortar.

.4 ASTM C920, Specification for Elastomeric Joint Sealants.

.5 CAN/CSA A3000, Cementitious Materials Compendium.

.6 TTMAC Specification Guide 09 30 00 Tile Installation Manual.

.7 TTMAC, Maintenance Guide.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations and warranties.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Tile layout, patterns, and colour arrangement.
  - .2 Perimeter conditions, junctions with dissimilar materials.
  - .3 Setting details.

.3 Samples:
- .1 Submit following sample panels in accordance with Section 01 30 00.
  - .1 Each colour, texture, size, and pattern of tile.
  - .2 Adhere tile samples to 400 x 400 x 12.5 mm thick cement board complete with selected grout colour in joints.

.4 Certificates: Submit manufacturer's certificates stating that materials supplied are in accordance with this specification.

.5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

.6 Closeout submittals: Submit recommended maintenance instructions and listing of recommended maintenance Products for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 QUALITY ASSURANCE

.1 Perform work of this Section by a company that is a member in good standing of the Terrazzo Tile and Marble Association of Canada with proven, acceptable experience on installations of similar complexity and scope.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials in adequate crates or containers with manufacturer’s name and product description clearly marked.

.2 Handle and store tiles in a manner to avoid chipping, breakage or the instruction of foreign matter. Take precautions to protect the mortar and grout admixtures from freezing or from excessive heat.

1.6 SITE CONDITIONS

.1 Do not install work of this Section outside of the following environmental ranges without the Consultant's and Product manufacturer's written acceptance:
.1 Ambient air and surface temperature: 15^0C to 45^0C.
.2 Precipitation: None.

.2 Install temporary protection and facilities to maintain the Product manufacturer's, and specified, environmental requirements for 7 Days before, during, and 7 Days after installation.

1.7 MAINTENANCE

.1 Submit extra tile amounting to 3% of gross area covered, allowing proportionately for each pattern and type specified and which are part of the same Production run as installed Products. Store maintenance Products as directed by the Consultant.

2 Products

2.1 **MATERIALS**

.1 General: All materials under work of this Section, including but not limited to, sealants, adhesives, and sealers are to have low VOC content limits.

.2 Tile (PT-#):
- .1 To CAN/CGSB-75.1-M.
- .2 Supply coves, caps, inside and outside corners and bullnose tile as required.
- .3 Where unfinished tile edge is exposed, supply cap to Consultant's selection.
- .4 Colours and styles as indicated on Colour and Material Schedule.

.3 Tile Base: Cove base tile to match floor tile.

2.2 **ACCESSORIES**

.1 Metal trims and caps (TT-#): Metal trims with trapezoid anchoring leg by Schluter or approved alternative. Profiles, materials and finish as indicated on Colour and Material Schedule.

.2 Cement: CAN/CSA A3000, Type GU.

.3 Sand: ASTM C144.

.4 Water: Potable and free of minerals and other contaminants which are detrimental to mortar and grout mixes.

.5 Flexible thin-set mortar: ANSI A108/A118/A136.1; ServoStar 3000 Flex White by Kiesel.

.6 Medium bed mortar: to ANSI A118.4; Servoflex-Trio-schnell SuperTec by Kiesel.

.7 Thick bed sloped topping: Factory mixed blend of portland cement and aggregates with latex admix. as manufactured by Kiesel.

.8 Primer: To meet specified requirements of adhesive manufacturer.

.9 Cleaner: In accordance with TTMAC's requirements and as recommended by tile manufacturer.

.10 Grout:
- .1 Joint widths 1 mm - 10 mm for walls and floors: Fast-setting, flexible, water and dirt repellant grout; Servoperl Royal Schnell by Kiesel.
- .2 Joint widths 3 mm - 25 mm for walls and floors: Universal flexible sanded grout; Servoflex F by Kiesel.
- .3 Grout colour: To be selected by the Consultant from the manufacturer's full colour range.

.11 Joint backing: Round, closed cell, foam rod, oversized by 30% to 50%, Shore A hardness of 20, tensile strength 140 to 200 kPa.

.12 Sealer: CAN/CGSB-25.20, penetrating, type as recommended by tile manufacturer.

.13 Tile sealant: In accordance with Section 07 92 00.

2.3 **MIXES**

.1 Levelling bed mix:
- .1 1 part Portland cement.
- .2 4 parts sand.
- .3 1 part water (including polymer additive), adjusted for water content of sand.
- .4 1/10 part polymer additive.

3 Execution

3.1 **SURFACE PREPARATION**

.1 Clean and dry surfaces thoroughly. Remove oil, wax, grease, dust, dirt, paint, tar, primers, form release agents, curing compound, and other foreign material from substrate surfaces which may prevent or reduce adhesion.

.2 Neutralize any trace of strong acids or alkali from the substrate.

3.2 **CONTROL JOINTS**

.1 Provide control, expansion and isolation joints in accordance with TTMAC specification 301MJ and as indicated on drawings. Install in locations indicated on drawings and specified herein.

.2 Continue control, construction, and cold joints in the structural substrate up through the tile finish, and align with mortar joints where possible. Review joint locations on Site with the Consultant.

.3 Install joint widths to match grout joint widths, except where a minimum width is indicated.

.4 Install control joints in the following typical locations:
- .1 Aligned over changes in type of substrate.
- .2 At the restraining perimeters such as walls and columns.
- .3 Interior areas (not subject to sunlight): 6 mm minimum width, at 7320 mm o.c. maximum.
- .4 Interior areas (subject to sunlight): 6 mm minimum width, at 3660 mm o.c maximum.
- .5 As indicated on the Contract Drawings.

.5 Seal control joints in accordance with Section 07 92 00.

3.3 LEVELLING BED

.1 Install a levelling bed on uneven substrate surfaces, level and plumb substrates in accordance with the following tolerances:
- .1 Vertical surfaces: 3 mm in 2.4 m maximum .
- .2 Horizontal surfaces: 6 mm in 3 m from finished levels of the surface, or better.

.2 Clean structural substrate control joints and blow-clean with compressed air. Grout fill control joints flush to slab with levelling bed.

.3 Provide slopes to drains in washrooms and as indicated on drawings.

3.4 GENERAL INSTALLATION REQUIREMENTS

.1 Install tiles in accordance with manufacturer's instructions and TTMAC Specification Guide 09300 Tile Installation Manual. Manufacturer's installation instructions govern over TTMAC Installation Manual.

.2 Lay out Work to produce a symmetrical pattern with minimum amount of cutting. Ensure cut tile at room perimeter and at joints is not less than ½ full size.

.3 Install trim to be placed under tile in locations indicated on Drawings.

.4 Set tiles in place and rap or beat with a beating block as necessary to ensure a proper bond and to level surface. Align tile for uniform joints and allow to set until firm. Clean excess mortar from surface of tile with a wet cloth or sponge while mortar is fresh.

.5 Ensure following minimum mortar contact coverage to back of tiles. Contact must be evenly distributed to give full support of the tile.
- .1 90% for interior applications.

.6 Adjust joints between units uniform, plumb, straight, even, and true, with adjacent tile flush. Align grout joints in both directions unless indicated otherwise.

.7 Align floor and base grout joints.

.8 Install tile accessory fittings for a complete and fully coordinated tile assembly.

.9 Do not place tile, trim, and accessories over control, expansion, or isolation joints. Stop materials in either side on joints and provide control, expansion and isolation joints as specified.

.10 Cut and fit tile neatly around piping, fittings, joints, projections and around recesses items e.g. washroom accessories. Where surface mounted equipment and accessories are installed on tile surfaces, extend tile over surfaces. Cut edges smooth, even, and free from chipping; chipped and broken edges are not acceptable.

.11 Do not proceed with grouting until minimum 48 hours after tile has set, to prevent displacement of tiles.

.12 Apply grout in accordance with grout manufacturer's directions to produce watertight, filled joints without voids, cracks and excess grout. Thoroughly compact and tool floor grout. Finish grout flush to edge thickness of tile and remove excess grout with soft burlap or sponge moistened with clean water.

3.5 CLEANING

.1 Clean off excess grout with soft burlap or sponge moistened with clean water.

.2 Polish tile after grout has cured in accordance with TTMAC recommendations in the Maintenance Guide; do not use acid for cleaning.

.3 Apply 2 coats of sealer to unglazed floor tile in accordance with sealer manufacturer’s printed directions.

.4 Re-point joints after cleaning as required to eliminate imperfections, then re-clean as necessary. Avoid scratching tile surfaces.

3.6 JOINT BACKING AND TILE SEALANT

.1 Install joint backing under sealant as necessary.

.2 Install tile sealant around piping and fittings extending through tiled surfaces.

.3 Seal tile control joints.

.4 Seal internal tile to tile junctions. Tool to a smooth, flush surface, free from air bubbles and contamination.

3.7 PROTECTION

.1 Prevent traffic over tiled areas, and protect tiled assemblies from weather, freezing, and water immersion, for 72 hours minimum, after final installation.

.2 Prevent direct impact, vibration and heavy hammering on adjacent and opposite walls for 24 hours minimum, after final installation.

.3 Cover work temporarily with building paper properly lapped and taped at joints until work has been approved by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for acoustical ceilings work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 ASTM C635, Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

.3 ASTM C636, Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.

.4 ASTM C645, Specification for Non-Load Bearing (Axial) Steel Studs, Runners (Tracks), and Rigid Furring Channels for Screw Application of Gypsum Board.

.5 ASTM E1264, Classification for Acoustical Ceiling Products.

1.3 **DESIGN REQUIREMENTS**

.1 Design acoustical ceiling system in accordance with following Climatic Design Data for Brampton contained in the Ontario Building Code:
  .1 Design temperature: January 1%, July 2 1/2%.
  .2 Hourly wind pressures: 1 in 50 year occurrence.
  .3 Seismic design: Class “C”.

.2 Design acoustical ceiling suspension system and anchors in accordance with specified Seismic Design requirements.

.3 Design ceiling suspension systems in accordance with ASTM C636 and manufacturer's printed directions.

.4 Design tile ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority. Acoustic panel system is not designed to carry the weight of electrical equipment.

.5 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.

.6 Design tile suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures. Acoustic panel system is not designed to carry the weight of mechanical and electrical equipment.

.7 Design subframing as necessary to accommodate, to avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.

1.4 SUBMITTALS

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Suspension system layout including hangers and supports for acoustic tile system.
  - .2 Acoustic panel system including suspension system, hangers, supports and panel sizes and locations.
  - .3 Conditions at abutting, intersecting, and penetrating construction.
  - .4 Dimensioned locations of lighting fixtures, diffusers, sprinkler heads and other items that pierce the ceiling plane.
  - .5 Seismic anchors, supports and accessories for complete installation.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 30 00:
  - .1 One full-size sample of each type of tile panels to be used.
  - .2 One of each type of suspension system members.

.3 Certificates: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

1.5 QUALITY ASSURANCE

.1 Mock-up:
- .1 Construct one 3 m^2 mock-up for each type of ceiling system incorporating typical light fixture and other typical mechanical and electrical fixtures.
- .2 Test the adequacy of the suspension system to support the fixtures without deflection of ceiling or failure of hanging wire anchorage. Supply copy of Test Results to Consultant.
- .3 Change materials and installation methods if tests indicate proposed system is inadequate and re-test as necessary until system approved.
- .4 Give early notice to Consultant and Mechanical and Electrical Trades and co-operate with them in selecting suitable location for sample ceiling and timing of installation and test.
- .5 Do not commence general installation work until sample ceiling approved, then install ceiling to conform with approved samples.
- .6 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.6 SITE CONDITIONS

.1 Do not install the work of this Section until:
- .1 Mechanical and electrical work above the ceiling is complete.
- .2 Relative humidity is below 80 %.
- .3 Ventilation is adequate to remove excess moisture.

.4 Areas are closed and protected against weather, and maintained at no less than 10°C.

.2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and after installation.

1.7 **MAINTENANCE**

.1 Submit extra acoustic ceilings amounting to 2% of gross ceiling area, allowing proportionately for each pattern and type specified to nearest full carton. Submit Products which are part of same production run as installed Products. Store maintenance Products as directed by Consultant.

1.8 **DELIVERY, STORAGE AND HANDLING**

.1 Transport, handle and store material in manner to prevent warp, twist, damage to panel edges and surfaces in accordance with Manufacturer's recommendations.

.2 Any warped and/or damaged panels and trim shall be rejected and be replaced by new, straight, undamaged and acceptable material at no cost to Owner.

.3 Bent, twisted or otherwise damaged Tee grid suspension components shall not be used under any circumstances. Replace such damaged items with new undamaged material at no additional cost to Owner.

.4 Store material in warm, dry place away from water and the elements. Protect against undue loading stresses and shock.

.5 All packaged material shall be delivered in original manufacturers wrappers and containers with labels and seals intact. All cartons shall bear U.L. label.

2 Products

2.1 **MATERIALS**

.1 Galvanized steel sheet: ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.

.2 Main carrying channels: ASTM C645; Channels formed from galvanized steel sheet, 38 x 19 mm cold rolled.

.3 Subframing: ASTM C645; Channels formed from galvanized steel sheet, dimensions and spans as required.

.4 Hangers: 2.6 mm minimum diameter, galvanized steel wire.

.5 Tie wire: 1.6 mm minimum diameter, soft annealed galvanized steel wire.

.6 Concrete anchors: tie wire sleeve anchors, ‘Redi-Drive Anchors' by ITW Red Head or approved alternative.

.7 Seismic anchors and supports: Provide wall moulding, seismic clips and perimeter hanger wires as required and in accordance with reviewed shop drawings.

.8 Wall mouldings and accessories, including but not limited to, corner caps, edge mouldings, panel hold over clip, metal closures, and trim. Finish and colour: same as main tees.

.9 Exposed main, cross tees, and relocatable cross tees: ASTM C635, 38 mm high steel, bulb tee design double steel web, rectangular single spans without exceeding a deflection of 1/360 of the span. Splices to be integral and reversible; cross tee interlocking into main tee. Colour and finish: Manufacturer's standard white.

.1 Suspension system:

.1 Armstrong World Industries Inc.
.2 CGC Inc.
.3 Certainteed Ceilings Canada.
.4 Rockfon/Chicago Metallic.

.10 Acoustic tiles for suspended ceiling system (ACT-1): Refer to Colour and Material Schedule for acoustical tile types.

.11 Wall mouldings: To match acoustical ceiling suspension system.

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 of this Section means acceptance of existing conditions.

3.2 SUSPENSION SYSTEM

.1 Coordinate locations and openings of mechanical and electrical services support, and penetration through the acoustical ceilings. Coordinate field conditions, clearances, measurements, and mechanical and electrical services testing and commissioning, above the acoustical ceilings.

.2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.

.3 Install acoustical ceiling systems in accordance with manufacturer's written instructions, reviewed shop drawings, and ASTM C636, listed in order of precedence.

.4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.

.5 Install additional hangers at lighting fixture and air distribution ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.

.6 Install acoustical ceiling suspension system to a tolerance of 1:1200 of span and 0.4 mm maximum between adjacent metal members. Tolerances are not cumulative. Refer to Electrical Contract Drawings for fixture layout.

.7 Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.

.8 Install edge moulding at intersection of ceiling and vertical surfaces.

.9 Centre acoustical ceiling suspension systems on room axis; install equal border pieces. Install hangers onto the ends of main tee runners at not more than 150 mm from ends of runners, adjacent and perpendicular to walls.

.10 Support the suspension system independently of walls, columns, ducts, pipes and conduits.

.11 Install main runners in maximum available lengths. Layout joints in suspension members to avoid the perimeters of recessed fixtures. Lock grid members to form a rigid assembly. Install additional tee, suspension system framing around recessed fixtures, diffusers, grilles and other items for a complete assembly.

.12 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.

3.3 ACOUSTIC LAY-IN TILES

.1 Install acoustic tile in grid system openings supported by bottom flanges of members. Provide special shapes and sizes to provide a complete installation by cutting tile to fit into openings. Fit tile moderately tight between upright legs of members.

.2 Carefully cut and trim acoustic tiles to accommodate items piercing the finished ceiling plane.

.3 Remove and replace acoustic tiles with broken edges, or damaged, marked, discoloured, soiled, or stained faces.

3.4 ADJUSTMENTS AND CLEANING

.1 Clean soiled or discoloured surfaces of exposed work on completion of work.

.2 Replace components which are visibly damaged, marred or uncleanable.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for resilient base work and accessories in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM F1861, Specification for Resilient Wall Base.

1.3 **SUBMITTALS**

.1 Product data:
  .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    .2 Product transportation, storage, handling and installation requirements.

.2 Samples: Submit two 250 mm long samples of resilient base in accordance with Section 01 30 00.

.3 Closeout submittals: Submit maintenance and cleaning data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 **SITE CONDITIONS**

.1 Maintain air temperature and structural base temperature at installation area above 20°C for 48 hr before, during and 48 hr after installation.

.2 Store materials for 2 days prior to installation in area of work to achieve temperature stability.

.3 Do not install base in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.

.4 Provide adequate ventilation during installation.

1.5 **MAINTENANCE**

.1 Submit extra 5% or to nearest full roll of each colour, pattern and type of base required for maintenance use. Identify each carton. Store where directed.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, primers, and adhesives are to have low VOC content limits.

.2 Rubber base (RB-#): ASTM F1861, Refer to Colour and Material Schedule for rubber base colours and types.

.3 Reducing edge strips, transition strips, thresholds and accessories: Refer to Colour and Material Schedule.

.4 Primers and adhesives: Low VOC, waterproof, recommended by base manufacturer for specific material on applicable substrate, above, at or below grade.

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 of this Section means acceptance of existing conditions.

.2 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this Section.

3.2 **RESILIENT BASE APPLICATION**

.1 Install resilient base in accordance with manufacturer’s written instructions.

.2 Lay out base to keep number of joints at minimum.

.3 Prior to installing base, fill cracks and irregularities with a filler recommended by base manufacturer.

.4 Set base in adhesive using a 3 kg hand roller, against wall and floor surfaces.

.5 Install straight and level to variation of 1:1000.

.6 Scribe and fit to door frames and other obstructions.

.7 Cope internal corners.

3.3 **CLEANING**

.1 Forty-eight hours after installation, clean resilient base surfaces with a mild soap solution approved by finish manufacturer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for resilient sheet flooring work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine.

.2 ASTM F710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

.3 ASTM F970, Standard Test Method for Static Load Limit.

.4 ASTM F1516, Standard Practice for Sealing Seams of Resilient Floor Products by the Heat Weld Method.

.5 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Cloride.

.6 ASTM F2170, Standard Test Method for Determining Relative Humidity in Concrete Slabs Using in-situ Probes.

.7 ASTM F2034, Standard Specification for Sheet Linoleum Floor Covering.

.8 CAN/ULC-S102.2-M, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

.9 ISO 717-2, Acoustics - Rating of Sound Insulation in Buildings and of Building Elements - Part 2: Impact Sound Insulation.

1.3 **SUBMITTALS**

.1 Product data:
  .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
    .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings: Submit shop drawings indicating seam layout and welding procedures in accordance with Section 01 30 00.

.3 Samples:
.1 Submit samples in accordance with Section 01 30 00:
.1 Two 250 x 200 mm samples of each type of sheet material and colour.
.2 Two 250 mm long samples of each accessory and colour.

.4 Extended warranties: Submit extended warranties signed and registered by the manufacturer providing the warranties in the name of the Owner for the timeframe and coverage specified in this Section.

.5 Closeout submittals: Submit maintenance and cleaning data for incorporating into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 SITE CONDITIONS

.1 Maintain air temperature and structural base temperature at flooring installation area above 20°C for 48 hr before, during and 48 hr after installation.

.2 Store materials for 2 days prior to installation in area of Work to achieve temperature stability.

.3 Do not lay flooring in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.

.4 Provide adequate ventilation during installation.

1.5 EXTENDED WARRANTY

.1 Manufacturer's warranty:
.1 Resilient flooring: Provide flooring manufacturer's warranty naming Owner as beneficiary, covering excessive wear for a period of 5 years from the date Work is certified as Substantially Performed.

1.6 MAINTENANCE

.1 Submit extra 5% or to nearest full roll of each colour, pattern and type of flooring material required for maintenance use. Identify each roll. Store where directed. Submit maintenance material in one piece and of same production run as installed materials.

2 Products

2.1 MATERIALS

.1 All materials under work of this Section, including but not limited to, primers and adhesives are to have low VOC content limits.

.2 Linoleum sheet flooring (LINO-1):
- .1 Conforming to ASTM F2034, Type 1, 2.5 mm thick, homogeneous resilient flooring, made from natural ingredients, mixed and calendared onto a natural jute backing.
- .2 Flame spread: 150 to CAN/ULC-S102.2-M.
- .3 Smoke developed: 160 to CAN/ULC-S102.2-M.
- .4 Impact sound reduction: when tested to ISO 717/2, 6 dB.
- .5 Slip resistance: Static coefficient of slip resistance meets or exceeds 0.6 when tested in accordance with ASTM D2047.
- .6 Static load limit: 450 pounds per square inch when tested in accordance with ASTM F970.
- .7 Colour: Refer to Colour and Material Schedule.
- .8 Acceptable products and manufacturers: 'Marmoleum' by Forbo Flooring or approved alternative.

.3 Base and accessories: In accordance with Section 09 65 00.

.4 Welding rod: type recommended by flooring manufacturer to complement flooring.

.5 Primers and adhesives: Low VOC, waterproof, of types recommended by flooring manufacturer for specific material on applicable substrate, above, on or below grade.

.6 Reducing edge strips, thresholds: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive as recommended by manufacturer.

.7 Concrete skim coat compound: High-performance, rapid-setting cement based skim coating compound. 'Ultra SkimCoat' by Mapei or approved alternative for filling minor voids and leveling existing substrate.

.8 Stain sealer and polish: Type recommended by flooring manufacturer.

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 of this Section means acceptance of existing conditions.

.2 Ensure concrete floors meet the following minimum requirements and requirements of the flooring manufacturer. If there is a conflict between these requirements and those of the flooring manufacturer, the more stringent shall apply.
- .1 Internal Relative Humidity Test: Perform internal relative humidity testing in accordance with ASTM F2170. Results shall not exceed 80% RH.
- .2 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) must not exceed 3 lbs per 1000sf per 24 hours (1.4 kg H2O/24 hr/93 m2) for acrylic adhesive and 5lbs for polyurethane adhesive via the Calcium Chloride Test Method (ASTM F1869).
- .3 The pH level of the subfloor surface shall not be higher than 9.9. If higher, subfloor must be neutralized.

.3 Ensure that sub-floors have been provided as specified without holes, protrusions, cracks, depressions or other major defects.

.4 Ensure that control joints have been filled and levelled.

.5 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this Section.

3.2 SUBFLOOR TREATMENT

.1 Flooring shall be installed over subfloors conforming to ASTM F710 for concrete.

.2 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.

.3 Apply sub-floor filler to low spots and cracks to achieve floor level to a tolerance of 1:1000, allow to cure.

.4 Meet ASTM F710 Standard for Concrete or other monolithic floors.

.5 Clean and remove all deleterious materials from surfaces to receive this work in accordance with the adhesive manufacturer's recommendations.

.6 Prime concrete to flooring manufacturer's printed instructions.

3.3 RESILIENT SHEET FLOORING APPLICATION

.1 Install resilient sheet flooring in accordance with manufacturer’s written instructions.

.2 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturers instructions. Do not spread more adhesive that can be covered by flooring before initial set takes place.

.3 Run sheets in direction of traffic. Double cut sheet joints and continuously seal according to manufacturer's printed instructions. Remove adhesive seepage of seams or surface while adhesive is still wet.

.4 Heat weld seams in accordance with ASTM F1516 and manufacturer's printed instructions.

.5 As installation progresses and after installation, roll flooring with minimum 45 kg roller to ensure full adhesion.

.6 Cut flooring neatly around fixed objects.

.7 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.

.8 Install reducing edge strips at unprotected or exposed edges where flooring terminates or where there are two finishes of different thicknesses.

3.4 RESILIENT BASE APPLICATION

.1 Resilient base: In accordance with Section 09 65 00. Coordinate with noted Section as required for installation of resilient base with resilient sheet flooring.

3.5 CLEANING AND SEALING

.1 Forty-eight hours after installation, clean sheet flooring surfaces with a mild soap solution approved by finish manufacturer. Rinse clean and allow to dry.

3.6 PROTECTION OF FINISHED WORK

.1 Protect floors and bases from time of final set of adhesive until accepted by Consultant.

.2 Prohibit traffic on floor for 48 hours after installation.

.3 Cover cleaned surfaces with fibre reinforced, clean, non-staining clean, kraft paper. Secure in position with gummed tape to prevent drifting. Remove covering when directed by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for resilient tile flooring Work and accessories in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM F710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

.2 ASTM F1066, Specification for Vinyl Composition Floor Tile.

.3 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Cloride.

.4 ASTM F 2170, Standard Test Method for Determining Relative Humidity in Concrete Slabs Using in-situ Probes.

1.3 **SUBMITTALS**

.1 Product data:
  .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    .2 Product transportation, storage, handling and installation requirements.

.2 Samples:
  .1 Submit following samples in accordance with Section 01 30 00:
    .1 Two 250 x 200 mm samples of each type of tile material and colour.
    .2 Two 250 mm long samples of each accessory and colour.

.3 Closeout submittals: Submit maintenance and cleaning data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 **SITE CONDITIONS**

.1 Maintain air temperature and structural base temperature at flooring installation area above 20°C for 48 hr before, during and 48 hr after installation.

.2 Store materials for 2 days prior to installation in area of Work to achieve temperature stability.

.3 Do not lay flooring in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.

.4 Provide adequate ventilation during installation.

1.5 **MAINTENANCE**

.1 Submit extra 5% or to nearest full carton of each colour, pattern and type of flooring material required for maintenance use. Identify each carton. Store where directed.

2 Products

2.1 **MATERIALS**

.1 All materials under Work of this Section, including but not limited to, primers, adhesives, sealers, and waxes are to have low VOC content limits.

.2 Static dissipative vinyl tile (SDT-1): CSA A126.2-M, Type A, mottled, asbestos free, 305 x 305 x 3.178 mm, meeting the following requirements:
- .1 Static Propensity: less than 2 kV with conductive footwear per AATCC-134 at 20% relative humidity.
- .2 Static Decay: 5,000 volts to zero in less than 0.01 seconds per US Federal Test Method 101B, Method 4048 at 15% relative humidity.
- .3 Flame Spread: 25 to CAN/ULC S102.2-M.
- .4 Smoke Developed: 50 to CAN/ULC S102.2-M.
- .5 Colour: Refer to Colour and Material Schedule.
- .6 Acceptable products and manufacturers:
  - .1 ‘Excelon SDT’ by Armstrong.
  - .2 Or approved alternative.

.3 Reducing edge strips, transition strips, thresholds, etc.: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive recommended by flooring manufacturer.
- .1 ‘Finishing Accessories’ Johnsonite or approved alternative.

.4 Primers and adhesives: Low VOC, waterproof, recommended by flooring manufacturer for specific material on applicable substrate, above, at or below grade.

.5 Concrete skim coat compound: High-performance, rapid-setting cement based skim coating compound. 'Ultra SkimCoat' by Mapei or approved alternative for filling minor voids and leveling existing substrate.

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.

.2 Ensure concrete floors meet the following minimum requirements and requirements of the flooring manufacturer. If there is a conflict between these requirements and those of the flooring manufacturer, the more stringent shall apply.

.1 Internal Relative Humidity Test: Perform internal relative humidity testing in accordance with ASTM F2170. Results shall not exceed 80% RH.

.2 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) must not exceed 3 lbs per 1000sf per 24 hours (1.4 kg H2O/24 hr/93 m2) for acrylic adhesive and 5lbs for polyurethane adhesive via the Calcium Chloride Test Method (ASTM F1869).

.3 The pH level of the subfloor surface shall not be higher than 9.9. If higher, subfloor must be neutralized.

.3 Ensure that sub-floors have been provided as specified without holes, protrusions, cracks, depressions or other major defects.

.4 Ensure that control joints have been filled and levelled.

.5 Defective Work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the Work of this Section.

3.2 SUBFLOOR TREATMENT

.1 Flooring shall be installed over subfloors conforming to ASTM F710 for concrete.

.2 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.

.3 Apply sub-floor filler to low spots and cracks to achieve floor level to a tolerance of 1:1000, allow to cure.

.4 Sub-floor shall be feathered up to meet adjacent floor finishes to ensure a smooth, flush transition.

.5 Meet ASTM F710 Standard for Concrete or other monolithic floors.

.6 Clean and remove all deleterious materials from surfaces to receive this Work in accordance with the adhesive manufacturer's recommendations.

.7 Prime concrete to flooring manufacturer's printed instructions.

3.3 TILE APPLICATION

.1 Install resilient tile flooring in accordance with manufacturer’s written instructions.

.2 Install flooring wall to wall before installation of floor-set cabinets, casework, furniture, equipment, etc. Extend flooring into toe spaces, door recesses, closets and similar openings.

.3 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturer's instructions. Do not spread more adhesive that can be covered by flooring before initial set takes place.

.4 Make tile joints flush, uniform, in moderate contact, in straight lines and as inconspicuous as possible. Lay tile patterns of adjacent tiles parallel to each other. In general, grain pattern and continuous joints will run in one direction of room, staggered joints will run in opposite direction. Verify with Consultant on site which way grain pattern and joints will run in each room.

.5 As installation progresses, and after installation, roll flooring in 2 directions with minimum 45 kg minimum roller to ensure full adhesion.

.6 Remove adhesive seepage at seams or surface while adhesive is still wet, in accordance with manufacturer's recommendation.

.7 Cut tile and fit neatly around fixed objects.

.8 Install feature strips and floor markings where indicated. Fit joints tightly.

.9 Terminate flooring at centerline of door in openings where adjacent floor finish or colour is dissimilar.

.10 Install resilient tactile warning edge in accordance with manufacturer’s written instructions.

.11 Install reducing edge strips at unprotected or exposed edges where flooring terminates and at edges where there are two finishes of different thicknesses.

3.4 ACCESSORIES AND WHEELED TRANSITION APPLICATION

.1 Install accepted adaptors between different flooring materials in accordance with manufacturer’s instructions.

.2 Ensure that adaptors have been clipped into place properly to provide a smooth, gradual transition between floors of different height.

.3 Install accessories in accordance with manufacturer’s written instructions.

3.5 PROTECTION OF FINISHED WORK

.1 Protect floors from time of final set of adhesive until final waxing.

.2 Prohibit traffic on floor for 48 hours after installation.

.3 Cover polished surfaces with fibre reinforced, clean, non-staining kraft paper. Secure in position with gummed tape to prevent drifting. Remove covering when directed by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for athletic flooring work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM F1861, Standard Specification for Resilient Wall Base.

.2 CPSC FF 1-70, Flammability of finished textile floor covering material.

1.3 **SUBMITTALS**

.1 Shop drawings: Submit shop drawings indicating seam layout and welding procedures in accordance with Section 01 30 00.

.2 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

.3 Closeout submittals: Submit maintenance and cleaning data for incorporating into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 **SITE CONDITIONS**

.1 Maintain air temperature and structural base temperature at flooring installation area above 20°C for 48 hr before, during and 48 hr after installation.

.2 Store materials for 2 days prior to installation in area of Work to achieve temperature stability.

.3 Do not lay flooring in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.

.4 Do not install floor system until concrete has been cured sixty (60) days.

1.5 **MAINTENANCE**

.1 Submit extra 5% or to nearest full roll of each colour, pattern and type of flooring material required for maintenance use. Identify each roll. Store where directed. Submit maintenance material in one piece and of same production run as installed materials.

1.6 **EXTENDED WARRANTY**

.1 Submit manufacturer's extended warranty for flooring extended to 3 years covering the full replacement of system due to defects in materials.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, coatings and adhesives are to have low VOC content limits.

.2 Rubber athletic flooring (RSF-1): 610 mm x 610 mm x 25 mm thick rubber floor tile, high-density wear layer with shock absorption. 'Everlast UltraTile' as manufactured by Ecore Athletic or approved alternative. Colour: Refer to Colour and Material Schedule.

.3 Adhesive: Polyurethane or epoxy adhesive as recommended by flooring manufacturer.

.4 Wall base: 100 mm high, 3 mm thick, conforming to ASTM 1861, Type TV, Group 1; 'Duracove Rubber Wall Base' by Johnsonite or approved alternative.

.5 Sub-floor filler and leveller: White premix latex requiring water only to produce cementitious paste as recommended by flooring manufacturer

.6 Reducing edge strips, thresholds: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive as recommended by manufacturer.

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 of this Section means acceptance of existing conditions.

3.2 **SUBFLOOR TREATMENT**

.1 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.

.2 Trowel and float sub-floor filler to leave smooth, flat hard surface. Prohibit traffic until filler is cured and dry.

.3 Clean and remove all deleterious materials from surfaces to receive this work in accordance with the adhesive manufacturer's recommendations.

.4 Prime concrete to flooring manufacturer's printed instructions.

3.3 **FLOORING APPLICATION**

.1 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturers instructions. Do not spread more adhesive that can be covered by flooring before initial set takes place.

.2 Unroll flooring into freshly applied adhesive ensuring that all seams are in contact without compression.

.3 Cut flooring neatly around fixed objects.

.4 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.

.5 Roll flooring in both directions when complete.

.6 Install reducing edge strips at unprotected or exposed edges where flooring terminates or where there are two finishes of different thicknesses.

3.4 **BASE APPLICATION**

.1 Lay out base to keep number of joints at minimum.

.2 Prior to installing base, fill cracks and irregularities with a filler recommended by base manufacturer.

.3 Set base in adhesive using a 3 kg hand roller, against wall and floor surfaces.

.4 Install straight and level to variation of 1:1000.

.5 Scribe and fit to door frames and other obstructions.

.6 Cope internal corners.

3.5 **CLEANING**

.1 Clean up all unused materials and debris and remove from the premises. Dispose of empty containers in accordance with federal and local statutes.

.2 72 hours after installation, clean rubber mat by vacuuming then damp mopping. Rinse clean and let dry.

3.6 **PROTECTION OF FINISHED WORK**.

.1 Protect floors from time of final set of adhesive until accepted by Consultant.

.2 Prohibit traffic on floor for 72 hours after installation.

.3 Cover cleaned surfaces with fibre reinforced, clean, non-staining clean, kraft paper. Secure in position with gummed tape to prevent drifting. Remove covering when directed by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for epoxy flooring work in accordance with the Contract Drawings.

1.2 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating:
- .1 Two copies of manufacturer's Product data on characteristics, performance criteria, and limitations.
- .2 Preparation, installation requirements and techniques, Product storage, and handling criteria.

.2 Samples: Submit duplicate samples of each type and colour of epoxy flooring mounted on 250 x 200 mm hardboard in accordance with Section 01 30 00.

.3 Reports: Submit manufacturer's acceptance of substrate prior to installation in writing. Submit verification of moisture content of floor prior to installation.

.4 Close-out submittals: Submit maintenance data for incorporation into Operations and Maintenance manuals in accordance with Section 01 78 00.

1.3 **QUALITY ASSURANCE**

.1 Perform work of this Section by a company that has a minimum of five years proven experience in installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator’s current certificate of approval by the material manufacturer as proof of compliance.

.2 Mock-up:
- .1 Construct one 3 m^2 mock-up of each type and colour of epoxy flooring in location acceptable to Consultant.
- .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
- .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

.3 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.4 **SITE CONDITIONS**

.1 Do not install the work of this Section outside of the following environmental ranges without Product manufacturer's written acceptance:
- .1 Ambient air and surface temperature: 15^0C to 30^0C.
- .2 Relative Humidity: In accordance with manufacturers' requirements.
- .3 When no dust is being raised.
- .4 In well-ventilated and broom clean areas.

.2 Do not apply epoxy flooring over materials that contain over 4% moisture.

.3 Install temporary protection and facilities to maintain the Product manufacturer's, and the above specification, environmental requirements for 24 hours before, during, and 24 h after installation.

.4 Post do not enter and appropriate warning signs at conspicuous locations.

1.5 **DELIVERY, STORAGE, AND HANDLING**

.1 Package, seal and label each epoxy flooring material to show manufacturer's and product name, and colour.

.2 Store materials at site in an area specifically set aside for purpose that is locked, ventilated, and maintained at a minimum temperature of 16°C.

.3 Ensure that health and fire regulations are complied with in storage area, and during handling and application.

2 Products

2.1 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers and epoxy flooring are to have low VOC content limits.
- .2 Each material used in the application of each flooring system shall be as recommended or manufactured by the supplier of the flooring system.

.2 Epoxy flooring and base (EXP-1): Nominal 2 to 3 mm thick, two component, 100% solids, decorative, quartz aggregate broadcast flooring system. ‘Stonshield SLT’ by Stonhard or approved alternative. Refer to Colour and Material Schedule for colour and texture types.

.3 Primer: As recommended by manufacturer.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that concrete floor has cured 28 days minimum and that substrate is acceptable to epoxy manufacturer.

.3 Test surfaces for moisture content to ensure that they are suitable for application.

3.2 **PREPARATION**

.1 Prepare substrate using steel aggregate blast method and vacuum substrate free of debris and dust.

.2 Fill minor cracks and voids and prime surfaces in accordance with manufacturer's recommendations.

.3 Project adjacent surfaces from damage resulting from this work. Mask and/or cover adjacent surfaces, fixtures, and equipment as necessary.

.4 Fill open control joints, and other cracks and voids with material compatible with epoxy materials.

.5 Clean prime and seal surfaces as recommended by epoxy manufacturer.

3.3 **APPLICATION**

.1 Apply epoxy flooring in accordance with manufacturer’s printed instructions. Epoxy manufacturer shall supervise application.

.2 General: Apply each component of resinous flooring system in compliance with manufacturer's directions to produce a uniform monolithic surface of thickness indicated, uninterrupted except at expansion joints or other types of joints (if any), indicated or required.

.1 Mix and apply primer over properly prepared substrate with strict adherence to manufacturer's installation procedures and coverage rates. Coloured, quartz aggregate shall be broadcast into the wet primer until refusal. Excess aggregate shall be removed following appropriate cure time. Coordinate timing of primer application with application of flooring system to ensure optimum inter-coat adhesion.

.2 Apply cove base material immediately after mixing using preformed cove trowels to a height of 100 mm where indicated on the room finish schedule in accordance with manufacturer's recommended procedures. Cove base shall be finished smooth and free of all possible waves, undulations, and other surface defects. Minor imperfections shall be mechanically removed prior to application of topcoat.

.3 Apply undercoat material immediately after mixing using squeegees or premium nap rollers in accordance with manufacturer's recommended procedures. Coloured, quartz aggregate shall be broadcast into the wet undercoat until refusal. Excess aggregate shall be removed following appropriate cure time. Strict adherence to manufacturer's coverage rates shall be maintained.

.4 Topcoat material shall be applied in one coat at 6-8 mils per coat immediately after mixing using high quality medium nap rollers in accordance with manufacturer's recommended procedures. Strict adherence to manufacturer's coverage rates shall be maintained.

.5 Chase edges to "lock" the flooring system into the concrete substrate along lines of termination.

.3 Stop epoxy in a straight line on each side of control joints; fill space over expansion joint with a self-levelling, non-sag polyurethane sealant.

.4 Apply epoxy with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform colour, sheen and texture, all within limitations of materials and areas concerned.

.5 Match colours and textures of approved samples.

.6 Make clean true junctions with no visible overlap between adjoining applications of epoxy.

.7 Chase edge of adjacent floor systems so that epoxy finishes flush with adjacent floor systems.

3.4 SITE TOLERANCES

.1 Finish surfaces shall be level, or straight where sloped to drains, within a tolerance of 1.5 mm in 3 m, and shall not vary more than 0.8 mm in any running 300 mm.

3.5 REPAIR

.1 Touch-up and refinish minor defective work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.

3.6 CLEANING

.1 Remove promptly as work progresses spilled or spattered materials from surfaces of work performed under other Sections. Clean floors on completion of work. Do not mar surfaces while removing.

.2 Leave storage and mixing areas in same condition as equivalent spaces in project.

3.7 PROTECTION

.1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of epoxy flooring, and for 48 hours following completion of application.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for waterproof flooring Work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

.1 Product data:
- .1 Submit manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, characteristics, limitations, preparation, and installation requirements and techniques.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Sections, details, materials, thicknesses, finishes, joint layout and locations, and coating terminations.

.3 Samples: Submit two 300 x 300 mm samples, on cement board, of waterproof flooring in accordance with Section 01 30 00.

.4 Reports/Certificates:
- .1 Submit manufacturer's written acceptance of substrate prior to installation. Submit verification of moisture content of floor prior to installation.
- .2 Submit applicator’s current certificate of approval, for installation of waterproof flooring, by the material manufacturer as proof of compliance.
- .3 Submit letter certifying that materials proposed for use on this project meet criteria specified, are compatible with each other, and that the manufacturer recommended the product for it’s intended end use.
- .4 Submit certification from waterproofing flooring manufacturer that installation meets specified and manufacturer’s requirements.

.5 Closeout submittals: Submit maintenance data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 30 00.

1.3 **QUALITY ASSURANCE**

.1 Installers qualifications: Perform Work of this Section by a company that has a minimum of five years proven experience in waterproof flooring installations of a similar size and nature and that is approved by manufacturer.

.2 Mock-up:
- .1 Construct 10 m^2 mock-up of waterproof flooring in location acceptable to Consultant.

.2 Mock-up shall demonstrate the minimum standard for workmanship, material thicknesses, surface profile, flashing, and juncture details, slip resistance, and finished appearance.

.3 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with Work.

.4 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

.5 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

.3 Pre-installation meetings: Arrange with Consultant, manufacturer's representative, and waterproof flooring applicator to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver products in original factory packaging bearing identification of product, manufacturer, and batch number. Provide Material Safety Data Sheets for each product.

.2 Store product in location protected from freezing, damage, construction activity, precipitation, and direct sunlight, in strict accordance with manufacturer's recommendations.

.3 Prior to application, condition products in accordance with manufacturer's recommendations.

.4 Handle all products with appropriate precautions and care as stated on Material Safety Data Sheet.

1.5 SITE CONDITIONS

.1 Do not install Work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:

.1 Ambient air and surface temperature: 10^0C to 32^0C.

.2 Relative Humidity: 80%.

.3 Moisture content of concrete is above 4% by weight of concrete.

.2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 48 hours before, during, and 72 hours after installation.

1.6 EXTENDED WARRANTY

.1 Submit a extended warranty for Work of this Section in accordance with General Conditions, except that warranty period is extended to 2 years for the following:

.1 Warrant against leaking, failure to stay in place, deformation, and breaking of watertight seals.

.2 Coverage: Complete replacement including affected adjacent Work at no cost to Owner.

2 Products

2.1 **MATERIALS**

.1 Waterproof Flooring: Combining primer, membrane and slip resistant wearing surface with non-slip surface texture. Minimum 0.762 mm (30 mils) thick, Class A fire resistance or better; 'Sikafloor Resoclad MRW Type III' by Sika Canada Inc.or approved alternative. Colour: Refer to Room Finish and Colour Schedule for colour type.

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.

.2 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance.

.3 Verify that specified environmental conditions are ensured before commencing work.

.4 Test substrate surfaces to ensure that moisture level and acid-alkali balance does not exceed limits recommended manufacturer. Provide one copy of tests results to Consultant prior to installation.

3.2 **PREPARATION**

.1 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from Work of this Section.

.2 Thoroughly clean all surfaces to receive coating by steel shotblasting or other method in accordance with manufacturer's written instructions.

.3 Remove projections and other conditions that may affect the installation of the coating.

.4 Fill open control joints, and other cracks and voids with material compatible with waterproof floor treatment materials.

.5 Clean prime and seal surfaces as recommended by waterproof flooring manufacturer.

3.3 **INSTALLATION**

.1 Install waterproof flooring in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Stop waterproofing flooring in a straight line on each side of control/expansion joints.

.3 Apply waterproof flooring with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform colour, sheen and texture, all within limitations of materials and areas concerned.

.4 Make clean true junctions with no visible overlap between adjoining applications of waterproof flooring.

.5 Chase edge of adjacent floor systems so that waterproof flooring finishes flush with adjacent floor systems.

.6 At projections through floor post, pipes, vents and similar locations of potential movement, install a sealant bead and tool to form a cove and allow to cure prior to application of waterproof flooring.

.7 Apply waterproof flooring over entire floor areas and extend up vertical surfaces such as walls, columns and curbs to a height of 100 mm.

3.4 **REPAIR**

.1 Touch-up and refinish minor defective work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.

3.5 **PROTECTION**

.1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of waterproof flooring, and for 48 hours following completion of application.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for concrete floor sealer work in accordance with the Contract Drawings.

1.2 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating:
- .1 Two copies of manufacturer's Product data on characteristics, performance criteria, and limitations.
- .2 Preparation, installation requirements and techniques, Product storage, and handling criteria.

.2 Samples: Submit samples in accordance with Section 01 30 00 indicating coating and final concrete finish.

.3 Reports: Submit manufacturer's acceptance of substrate prior to installation in writing. Submit verification of moisture content of floor prior to installation.

.4 Close-out submittals: Submit maintenance data for incorporation into Operations and Maintenance manuals in accordance with Section 01 78 00.

1.3 **QUALITY ASSURANCE**

.1 Perform work of this Section by a company that has a minimum of five years proven experience in installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator’s current certificate of approval by the material manufacturer as proof of compliance.

.2 Mock-up:
- .1 Construct one 2 m^2 mock-up of floor sealer in location acceptable to Consultant.
- .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with Work.
- .3 Mock-up may remain as part of Work if accepted by Consultant. If sealer application is unacceptable to Consultant, rework sealer in accordance with manufacturer’s recommendations to provide a sealed concrete surface acceptable to Consultant.
- .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

.3 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review mock-up and installation procedures 48 hours in advance of installation.

1.4 **SITE CONDITIONS**

.1 Do not install the work of this Section outside of environmental ranges as recommended by the manufacturer without Product manufacturer's written acceptance and as follows:
- .1 Relative Humidity: In accordance with manufacturers' requirements.
- .2 When no dust is being raised.
- .3 In well-ventilated and broom clean areas.

.2 Install temporary protection and facilities to maintain the Product manufacturer's, and the above specification, environmental requirements for 24 hours before, during, and 24 h after installation.

.3 Post do not enter and appropriate warning signs at conspicuous locations.

1.5 **DELIVERY, STORAGE, AND HANDLING**

.1 Store materials at site in an area specifically set aside for purpose that is locked, ventilated, and maintained at a minimum temperature of 16°C.

.2 Ensure that health and fire regulations are complied with in storage area, and during handling and application.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealers and coatings are to have low VOC content limits.

2. Each material used in the application of each flooring system shall be as recommended or manufactured by the supplier of the flooring system.

.3 Concrete floor sealer: Alkali-silicate, water-soluble, inorganic concrete hardener and dustproofer; ‘MasterKure HD 200WB’ by Master Builders Solutions or ‘Sikafloor 3S’ by Sika Canada Inc.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that concrete floor has cured 28 days minimum and that substrate is acceptable to sealer manufacturer.

.3 Test surfaces for moisture content to ensure that they are suitable for application.

3.2 **PREPARATION**

.1 Prepare substrate in accordance with manufacturer's written instructions. [Diamond grind and vacuum substrate free of debris and dust.

.2 Project adjacent surfaces from damage resulting from work of this Section. Mask and/or cover adjacent surfaces, fixtures, and equipment as necessary.

.3 Clean surfaces to be sealed as recommended by sealer manufacturer.

3.3 **APPLICATION**

.1 Apply concrete floor sealer in accordance with manufacturer's written instructions. Sealer manufacturer shall supervise application.

.2 Spray apply concrete sealer to entire surface and keep from drying for 30 minutes as recommended by manufacturer.

.3 Sprinkle surface with water as sealer begins to penetrate (after 30 minutes).

.4 Flush surface with water and drying begins to remove excess material. Allow to harden for 24 hours.

.5 Lightly buff floor with a commercial floor buffer and non-aggressive pad to bring up required sheen.

3.4 **CLEANING**

.1 Remove promptly as work progresses spilled or spattered materials from surfaces of work performed under other Sections. Clean floors on completion of work. Do not mar surfaces while removing.

3.5 **PROTECTION**

.1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of floor sealer, and for 48 hours following completion of application.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for fibreglass reinforced plastic cladding work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Elevations, sections, details, materials, dimensions, thicknesses, trim and accessory pieces, and interfacing with adjacent construction.

.3 Samples:
- .1 Submit following samples in accordance with Section 01 30 00.
  - .1 Two 300 x 300 mm samples of wall cladding.
  - .2 Two 300 mm samples of each trim and accessory proposed for use.

.4 Certificates: Submit certification from material manufacturer that installation is in accordance with manufacturer’s instructions.

.5 Closeout submittals: Submit maintenance and cleaning instructions for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.3 **QUALITY ASSURANCE**

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of three years proven experience in the installation of wall cladding on projects of a similar size and nature and that is approved by manufacturer. Submit to Consultant, installer’s current certificate of approval by the cladding manufacturer as proof of compliance.

.2 Mock-up:
- .1 Construct one 2 m^2 mock-up of wall cladding system in location acceptable to Consultant.
- .2 Arrange for Consultant's and manufacturer’s review and acceptance prior to start of installation.
- .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

1.4 **SITE CONDITIONS**

.1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
- .1 Ambient air and surface temperature: 15^0C to 30^0C.
- .2 Relative Humidity: 45%.

.2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealants and adhesives are to have low VOC content limits.

.2 Fibreglass reinforced plastic cladding:
- .1 Extruded rigid FRP sheets, coloured throughout, smooth finish backside with smooth front texture, Agriculture and Agri-Food Canada Approved, 2440 mm x 1220 mm x 1.9 mm thick. ‘Glasbord FRP’ by Crane Composites, ‘Panolam FRP’ by Panolam Industries, or ‘Glasliner FRP Panels’ by Stabilit.
- .2 Wall cladding to come complete with thermoformed corners and all accessories required to provide a complete system.

.3 Adhesive and sealant: Types as recommended by cladding manufacturer to suit intended application.

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 of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Verify substrate surfaces are solid, free of moisture, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.

3.3 **INSTALLATION**

.1 Install wall cladding in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Dry-fit sheet prior to fixing.

.3 Bevel leading edges of sheet prior to fitting joint and cap strips.

.4 Apply adhesive to back of sheet uniformly using a 4.5 mm ‘V’ notched trowel. Allow adhesive to dry tacky to the touch.

.5 Offer sheet to wall substrate. Roll sheet thoroughly with a wall roller to ensure full adhesion.

.6 Cut sheet neatly to accommodate pipes, electrical boxes, etc., providing a 3 mm gap for expansion.

.7 Fit sheets neatly at door and window trim providing a 3 mm gap for expansion.

.8 Thermoform all inside and outside corners and specific shapes to fit building contours.

.9 Install joint strips to each sheet as installation progresses.

.10 Provide water tight seal to all pipes, projections, door and window trims with sealant.

3.4 CLEANING

.1 Upon completion of installation, remove the protective film and wash with a dilute soap/detergent solution and rinse with clean water.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for painting work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 Master Painters Institute (MPI), Painting Specification Manual.

.2 SSPC Steel Structures Painting Council, Standards.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.
- .2 Submit listing of manufacturer's Product types, Product codes, and Product names, number of coats, and dry film thicknesses, corresponding to each Painting Schedule code; submit listing minimum of 8 weeks before materials are required.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 30 00.
  - .1 Three 300 x 150 mm draw downs of each colour minimum 4 weeks before paints are required.
  - .2 Identify each sample with Contract number and title, colour reference, sheen, date, and name of applicator.

.3 Certificates:
- .1 Submit certification from paint manufacturer, on company letterhead, indicating each product proposed for use is Manufacture's premium grade, first line Product.
- .2 Submit certified documentation to confirm each airless spray painter has minimum of 5 years experience on applications of similar complexity and scope.
- .3 Submit certified documentation to confirm each worker has Provincial Tradesman Qualification certificate of proficiency.

.4 Reports:
- .1 Submit written field inspection and test report results after each inspection.
- .2 Submit Field Quality Control test result reports for alkali content, substrate moisture, and dry film thickness.
- .3 Submit electronic moisture meter manufacturer's specifications including tolerances. Submit record of latest meter calibration to meet manufacturer's recommendations.

1.4 QUALITY ASSURANCE

.1 Finishing work: Perform work to MPI requirements for premium grade.

.2 Supervision: Have work supervised by a full-time qualified foreperson who has 10 years minimum experience on Contracts of similar complexity and scope.

.3 Mock-up:
- .1 Construct three 3 m^2 mock-ups of different Paint Schedule code systems, selected by Consultant, in locations acceptable to Consultant to demonstrate installation workmanship, colour, and hiding power of Products.
- .2 Obtain Consultant's acceptance in writing before proceeding with the work of this Section.
- .3 Mock-ups may remain as part of the Work if acceptable to Consultant and will serve as a standard for similar code systems.
- .4 Repaint over mock-ups which do not form part of the Work.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Install correct, safe temporary storage for paint, thinner, solvents, and other volatile, corrosive, hazardous, and explosive materials in accordance with requirements of authorities having jurisdiction.

.2 Post hazard warning signage in areas of storage and mixing. Install and maintain sufficient CO_2 fire extinguishers of minimum 9 kg capacity, accessible in each storage mixing and storage areas.

.3 Maintain storage enclosures at minimum 10°C ambient temperature and to manufacturer's instructions.

1.6 SITE CONDITIONS

.1 Apply coatings under the following conditions:
- .1 Exterior coatings (except Latex): 5° C minimum.
- .2 Exterior latex coatings: 10°C minimum.
- .3 24 hours minimum after rain, frost, condensation, or dew.
- .4 When no condensation is possible (unless specifically formulated against condensation).
- .5 Interior coatings: 7°C minimum.
- .6 Relative humidity: 85% maximum.
- .7 Not in direct exposure to sun light.

.2 Maintain temperature conditions indicated above for 24 hours before, during and 24 hours after painting.

.3 Install clean plywood sheets to protect floors and walls in storage and mixing areas, from paint drips, spatters, and spills.

.4 Apply sufficient masking, clean drop cloths, and protective coverings for full protection of work not being painted including, but not limited to, the following:
- .1 Light fixtures, fire and smoke detectors.
- .2 Data cabling and data infrastructure.
- .3 Sprinkler heads.
- .4 Prepainted diffusers and registers.
- .5 Prepainted equipment.
- .6 Fire rating labels and equipment specification plates.
- .7 Finished surfaces.

1.7 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

1. Provide paint products meeting MPI "Green Performance Standard GPS-1-12.

1.8 MAINTENANCE

1. Deliver to Owner's place of storage on completion of work, sealed containers of each finish painting material applied, and in each colour. Label each container as for original, including mixing formula. Provide the following:
   - .1 1 L of extra materials when less than 50 L are used for Project;
   - .2 3.78 L of extra stock when 50 to 200 L are used;
   - .3 7.57 L of extra stock when over 200 L are used.

2 Products

2.1 MATERIALS

.1 Paint:
- .1 All materials under work of this Section, including but not limited to, primers, stains, and paints are to have low VOC content limits.
- .2 Products in accordance with the MPI Painting Specification Manual, Exterior and Interior Systems;
  - .1 For each MPI paint code, manufacture's premium grade, first line Products is to be use.
  - .2 Uniform dispersion of pigment in a homogeneous mixture.
  - .3 Ready-mixed and tinted whenever possible.
- .3 Products within each MPI paint system code: From single manufacturer.
- .4 Acceptable manufacturers:
  - .1 AkzoNobel.
  - .2 Benjamin Moore.
  - .3 PPG Industries Inc.
  - .4 Sherwin Williams.

.2 Wood sealer: Three coat wood sealer system as manufactured by Sikkens or approved alternative.
- .1 Wood basecoat: One coat of translucent oil alkyd basecoat ‘Cetol 1RE’ by Sikkens.

.2 Wood topcoat: Two coats of 'Cetol 23RE' by Sikkens topcoat consisting of translucent alkyd resin and UV absorbers, in colour as selected by the Consultant.

2.2 COLOUR SCHEDULE

.1 Refer to Colour and Material Schedule for selected colour references.

.2 Conform to gloss reflectance definitions listed in MPI Specification Manual.

2.3 PAINTING AND FINISHING SCHEDULE

.1 Refer to Table 1, MPI Painting and Finishing Schedule coded systems, comply with MPI Painting Specification Manual.

Table 1: Painting and Finishing Schedule

EXTERIOR SUBSTRATES	Typical substrates (Including but not limited to)	MPI Manual Ref.	MPI Finish System Code	Sheen	Topcoat
Galvanized steel	HM doors & frames, handrails	EXT 5.3	EXT 5.3L		Pigmented polyurethane
Galvanized steel (structural steel)	Structural steel components with galvanized finish	EXT 5.3	EXT 5.3L		Pigmented polyurethane
Wood	Wood screen	N/A	N/A		See Note 6
INTERIOR SUBSTRATES	Typical substrates (Including but not limited to)	MPI Manual Ref.	MPI Finish System		Topcoat
Concrete walls and ceilings		INT 3.1	INT 3.1A		Latex
Concrete floors		INT 3.2	INT 3.2C		Epoxy
Concrete block masonry		INT 4.2	INT 4.2A		Latex

Table 1: Painting and Finishing Schedule					
Metal Fabrications (Factory primed)	Steel stairs, ladders	INT 5.1	INT 5.1R		High performance latex
Galvanized metal	HM doors & door frames, handrails	INT 5.3	INT 5.3B	Semi-Gloss	WB light industrial coating
Wood Millwork	Benches	INT 6.4	INT 6.4C	Satin	Semi-transparent stain
Wood paneling & casework	Millwork, partitions	INT 6.4	INT 6.4E	Satin	Poly-urethane
Gypsum board	Drywall, walls, ceilings	INT 9.2	INT 9.2A	Eggshell	Latex
Gypsum board	Wet areas	INT 9.2 .	INT 9.2F	Semi-Gloss	Epoxy-modified latex
Gypsum Board	Ceilings	INT 9.2	INT 9.2A	Flat	Latex

.2 Notes:

.1 Provide three coat wood sealer system consisting of one coat of the basecoat and two coats of topcoat specified herein in accordance with this specification and the manufacturers directions.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 General:

.1 Clean substrate surfaces free from, dust, grease, soiling, or extraneous matter, which are detrimental to finish.

.2 Patch, repair, and smoothen minor substrate defects and deficiencies e.g. machine, tool and sand paper marks, shallow gouges, marks, and nibs.
.3 Clean, sweep, and vacuum floors and surfaces to be painted, debris and dust-free prior to painting.
.4 Refer to MPI Painting Specification Manual for surface preparation requirements of substrates not listed here.

.2 Where finish hardware has been installed remove, store, re-install finish hardware, to accommodate painting. Do not clean hardware with solvent that will remove permanent lacquer finishes.

.3 Alkali Content tests and neutralization:
.1 Test for ph level using litmus paper on dampened substrate.
.2 Neutralize surfaces over 8.5 ph with 4% solution of Zinc Sulphate for solvent based systems and tetrapotassium pyrophosphate for latex based systems, to below 8.0 ph, and allow to dry.
.3 Brush-off any residual Zinc Sulphate crystals.
.4 Coordinate paint system primer / sealer to be alkali-resistant.

.4 Substrate moisture tests:
.1 Test for moisture content over entire surface to be painted, minimum one test/ 2 m^2 in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.
.2 If any test registers above 10% allow entire substrate surfaces, within the plane, to dry further before paint system application. Install temporary drying fans if necessary.
.3 Re-test employing same criteria.

.5 Mildew removal: Scrub with solution of trisodium phosphate and sodium hypochlorite (Javex) bleach, rinse with water, and allow to dry completely.

.6 Cementitious and masonry (Concrete, block, brick, stucco, cement rendering):
.1 Allow 28 days cure before painting.
.2 Coordinate repair of protrusion-chipping and grinding, and honeycomb filling with responsible trades.
.3 Remove dirt, loose mortar, scale, powder, efflorescence, and other foreign matter.
.4 Remove form oil and grease with trisodium phosphate, rinse, and allow to dry thoroughly.
.5 Remove rust stains with solution of sodium metasilicate after thorough wetting; allow to dry thoroughly.

.7 Concrete floors (new):
.1 Allow 28 days cure before painting.
.2 Remove contamination, acid etch, rinse with water, and allow to dry completely. Test and adjust for neutral ph.

.8 Galvanized steel sheet:
.1 Z275 (Satin & Spangled Sheet): SSPC SP7 brush blast.
.2 ZF075 (Wiped Coat): Remove contamination, wash with Xylene solvent.

.3 Touch-up damaged galvanized areas with organic zinc rich primer.

.9 Galvanized iron and steel: Prepare galvanized and ungalvanized metal surfaces as follows:
- .1 Unpassivated, unweathered and weathered: Remove contamination, wash with Xylene or Toluol solvent, allow to dry thoroughly. Make paint system primer/sealer an etching type primer.
- .2 Manufacturer pre-treated (including passivated): SSPC SP7.
- .3 Touch-up damaged galvanized areas with organic zinc rich primer.

.10 Structural steel and miscellaneous metal fabrications:
- .1 Coordinate the following with the responsible trades:
  - .1 Rust, mars, mill scale, and weld-burn touch-ups.
  - .2 Oil, grease, weld flux and other residue removal.
- .2 Prime paint items, not otherwise indicated to be primed as part of another Section.
- .3 Touch-up damaged galvanized areas with organic zinc rich primer.

.11 Wood and Millwork:
- .1 Wood surfaces to be clean and dry with a moisture content of less than 15%.
- .2 Remove foreign matter prior to prime coat; spot coat knots, pitch streaks and sappy sections with sealer.
- .3 Fill nail holes and fine cracks after primer has dried.
- .4 Backprime interior and exterior woodwork.

.12 Factory primed surfaces:
- .1 Touch up damaged areas.
- .2 Clean as required for top coat.

.13 Gypsum board:
- .1 Apply primer/sealer paint to reveal defects and deficiencies and to equalize absorption areas.
- .2 Coordinate repairs and touch-ups with the responsible trade.
- .3 Re-prime repairs.

.14 Coordinate with other trades to prevent:
- .1 Damage, and inadvertent activation of fire and smoke detectors.
- .2 Odour and dust distribution by permanent HVAC systems including fouling of ducts and filters.

.15 Field-mix Products in accordance with manufacturer's written instructions.

3.3 APPLICATION

.1 Apply painting systems in accordance with the MPI Painting Specification Manual. Apply each Product to manufacturer's recommended dry film thickness.

.2 Painting systems listed are required minima, apply additional coats if necessary to obtain substrate hiding acceptable to the Consultant.

.3 Tint intermediate coats lighter than final top coats for identification of each succeeding coat and to facilitate inspections. Include only manufacturer's recommended reducing and tinting accessories. Do not add adulterants.

.4 Primer to be specialized primer coating system as required by manufacturer for selected colour. Standard primer being tinted shall be tinted to a maximum of 1.5% by volume.

.5 Sand lightly between coats to achieve a tooth or anchor for subsequent coats.

.6 Apply paint uniformly in thickness, colour, texture, and gloss, as determined by the Consultant under adequate illumination and viewed at a distance of 1500 mm. Apply finishes free of defects in materials and application which, in the opinion of the Consultant, affect appearance and performance. Defects include, but are not limited to:
- .1 Improper cleaning and preparation of surfaces.
- .2 Entrapped dust, dirt, rust.
- .3 Alligatoring, blisters, peeling.
- .4 Scratches, blemishes.
- .5 Uneven coverage, misses, drips, runs, and poor cutting in.

.7 Do not apply coatings on substrates which are not sufficiently dry. Unless indicated otherwise, allow each painting system coat to cure dry and hard before following coats are applied.

.8 Repaint entire areas of damaged or incompletely covered surfaces, to the nearest inside or outside corner; patching will not be permitted.

.9 Miscellaneous painting requirements:
- .1 Paint projecting ledges, and tops, bottoms and sides of doors both above and below sight lines to match adjacent surfaces.
- .2 Paint door frames, access doors and frames, door grilles, prime coated butts, and prime coated door closers to match surface in which they occur.
- .3 Finish closets and alcoves as specified for adjoining rooms.
- .4 Paint light coves white whether a light lense is installed or not, unless otherwise indicated.
- .5 Paint interior columns to match walls of room.
- .6 Allow for:
  - .1 2 wall colours per room, one ceiling colour per room.
  - .2 Different door colours in each functionally different area.
  - .3 Different colours on both sides of same door.

.10 Mechanical, electrical and other painting coordination:
- .1 Paint following items unless specified or indicated on drawings not to be painted.
- .2 Paint mechanical services in accordance with Mechanical Identification Division 21, 22 and 23.
- .3 Coordinate painting of pipes, ducts, and coverings with the work of Division 21, 22 and 23 to precede pipe colour banding, flow arrows, and other pipe identification labeling installation.

.4 Paint exposed conduit, pipes, hangers, ductwork, grilles, gratings, louvres, access panels, fire hose cabinets, registers, convector and radiator covers, enclosures, and other mechanical and electrical equipment including services concealed inside cupboard and cabinet work; apply colour and sheen to match adjacent surfaces, except as noted otherwise.

.5 Paint portions of surfaces such as duct interiors, piping, ductwork, hangers, insulation, walls, and similar items, visible through grilles, louvres, convector covers etc., matte black in colour.

.6 Remove the following to accommodate painting, carefully store, clean, then re-install on completion of each area and when dry:

.1 Switch and receptacle plates, fittings and fastenings, grilles, gratings, louvres, access panels, convector covers, and enclosures .

3.4 FIELD QUALITY CONTROL

.1 Dry film thickness tests:

.1 Test for film thickness over entire surface to be painted, minimum one test/2 m^2 in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.

.2 If any test registers below specified thickness, re-apply paint to entire surface to nearest inside and outside corners.

.3 If test registers more than 50% above specified thickness, consult with paint manufacturer, determine if problem exists, offer solutions to Consultant, and repair as directed.

.4 Re-test employing same criteria after repair.

3.5 CLEANING

.1 Remove spilled, splashed, and spattered paint promptly as work proceeds and on completion of work. Clean surfaces soiled by paint spillage and paint spatters. Repair or replace damaged work, as directed by Consultant.

3.6 PROTECTION

.1 Post Wet Paint signs during drying and restrict or prevent traffic where necessary.

.2 Post sign, after Consultant's inspection and acceptance of each room, reading: PAINTING COMPLETE - NO ADMITTANCE WITHOUT CONTRACTOR'S PERMISSION.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for signage Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 CSA-A23.1; Concrete Materials and Methods of Concrete Construction.

.2 CAN/CSA-G40.20/G40.21; General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steels.

.3 CAN/CSA-G164; Hot Dip Galvanizing of Irregular Shaped Articles.

1.3 **SUBMITTALS**

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Provide full scale sign layouts for all signs specified, for review by the Consultant. Layouts shall include correct symbols, lettering, lettering styles, and shall indicate colours.
  - .2 All signs shall be bilingual (English/French).

2 Products

2.1 **MATERIALS**

.1 Sign Posts:
- .1 One piece, cold-rolled channel sign posts, 64 mm wide x 32 mm deep, hot-dip galvanized steel, 4.2 mm base metal thickness, minimum 340 MPa yield, perforated for sign attachment, as manufactured by Armtec Limited, or an approved alternative. Provide mounting hardware.
- .2 Post Lengths: As per drawings.

.2 Signs: 1.63 aluminum with MTO standard traffic colours and graphics.

.3 Concrete:
- .1 Proportion normal density concrete in accordance with CSA-A23.1, and as follows:
- .2 Cement: Type 10 Portland Cement.
- .3 Minimum compressive strength at 28 days: 25Mpa.
- .4 Exposure Classification: C-2.
- .5 Coarse Aggregate Size: 16mm, crushed (smooth aggregate not acceptable).
- .6 Slump at time and point of discharge: 80mm ± 20mm.

3 Execution

3.1 **INSTALLATION**

.1 Place concrete in post holes then embed posts into concrete to minimum 914mm depth. Extend concrete 25mm above ground level and slope to drain away from posts.

.2 Brace posts in plumb position and true to alignment and elevation until concrete has set.

.3 Bolt signs to top of posts with tamper-proof galvanized steel bolts and nuts.

3.2 **SCHEDULE**

.1 Refer to Drawings for sign types and locations.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services for washroom accessories work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A167, Specification for Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.2 ASTM A312, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.

.3 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.4 ASTM F2285, Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use.

.5 CAN/CSA B651-M, Accessible Design for the Built Environment.

1.3 **SUBMITTALS**

.1 Product data: Submit Product data to requirements of Section 01 30 00 indicating each washroom accessory describing size, finish, details of function, attachment methods, hardware and locks, description of rough-in frame, and building-in details of anchors for grab bars.

.2 Closeout submittals:

.1 Submit for each Product operation and maintenance instructions for incorporating into the Operations and Maintenance Manuals in accordance with Section 01 78 00.

.1 Supply 2 keys for each lockable washroom accessory to Consultant.

.2 Master key washroom accessories which are keyed..

.3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **DELIVERY, STORAGE AND HANDLING**

.1 Deliver materials in sealed cartons and containers with manufacturer’s name and product description clearly marked.

1.5 **EXTENDED WARRANTY**

.1 Submit an extended warranty for washroom accessories work in accordance with the General Conditions, except that the warranty period is extended to 10 years.
- .1 Against cracked or scratched mirrors, spoiling or deterioration of silvering or backing, loosening of fastenings or adhesive
- .2 Coverage: complete replacement including effected adjacent work.

1.6 **MAINTENANCE**

1. Maintenance Tools: Provide special tools necessary for accessing, assembly/disassembly or removal of toilet, bath and cleaning accessories in accordance with Section 01 78 00.

2 Products

2.1 **MATERIALS**

.1 Stainless steel:
- .1 Sheet metal: ASTM A167, Type 304.
- .2 Tubing: ASTM A312, Type 304.

.2 Sheet steel: ASTM A653M, Z275; Cold rolled, commercial quality, surface preparation and pretreatment as required for applied finish.

.3 Fasteners, screws and bolts: ASTM A167, Type 304 stainless steel, tamper-proof.

2.2 **ACCESSORIES**

.1 The following Products are by Bobrick Washroom Equipment of Canada Ltd. except where noted. Quantity and location of accessories as shown on Contract Drawings. Equivalent Products from ASI/Watrous and Bradley are acceptable.

.2 All washroom accessories shall be mounted in strict conformance to meet all requirements of the Ontario Building Code 2012 and all amendments. Confirm mounting configurations and heights with Consultant prior to installing at all washroom accessories.

.3 Toilet tissue dispenser: Owner supplied, Contractor installed.

.4 Soap dispenser: Owner supplied, Contractor installed.

.5 Paper towel dispenser/disposal: Owner supplied, Contractor installed.

.6 Soap dish:
- .1 #B4380; Recessed mounted 185 mm W x 125 mm H x 90 mm deep, drawn and beveled, one piece seamless with countersunk mounting holes.
- .2 Finish: Type 304 stainless steel with matte polish.

.7 Mirror: 6 mm thick, mirror quality tempered glass with type 304 stainless steel frame in satin finish. Corners to be heliarc welded, ground and polished smooth.
- .1 Standard frame (M): #B-290 Series; 610 mm x 914 mm.

.8 Grab Bars: 38mm diameter, 1.2mm thick, concealed mounting with snap flange, complete with escutcheons, type 304 stainless steel with a satin finish and peened grip in the following configurations:
- .1 GB1: 762 mm long horizontal and vertical legged "L" shaped grab bar beside watercloset: Series 6806.99-L30x30 by Bobrick Washroom Equipment of Canada or approved alternative.
- .2 GB2: 610 mm long straight grab bar to be located behind watercloset table of : Series B-6806.99 by Bobrick Washroom Equipment of Canada or approved alternative.
- .3 GB3: 305 mm long straight grab bar for use at urinals: Series B-6806.99 by Bobrick Washroom Equipment of Canada or approved alternative.
- .4 GB4: 1000 mm long straight grab bar beside showerseat: Series B-6806.99 by Bobrick Washroom Equipment of Canada or approved alternative.

.9 Coat hook:
- .1 Model 1150-SS by Frost Product Inc. or approved alternative; collapsible single spring loaded coat hook, maximum weight capacity 11 kg.
- .2 Finish: Type 304 stainless steel, #4 Finish.

.10 Stainless steel shelf:
- .1 #0692 Series by ASI Group Canada or approved alternative; shelf fabricated from 1.2 mm thick stainless steel with 13 mm return edge and front edge hemmed for safety.
- .2 Shelf complete with brackets fabricated from 1.2 mm thick stainless steel.
- .3 Size: 100 mm wide x 450 mm length.
- .4 Finish: Type 304 stainless steel, satin finish.

.11 Folding Shower seat:
- .1 #B-5191; surface wall mounted seat with 8 mm thick water-resistant, ivory coloured solid phenolic.
- .2 Dimensions: 405 mm deep x 460 mm wide.
- .3 Finish: Type 304 stainless steel frame.

.12 Hand Dryer:
- .1 Surface mounted on pressed anti-rust steel back plate, polycarbonate ABS casing with anti-microbial scuff resistant coating on exterior surfaces in colour to be selected by Consultant with touch-free infra-red activation, 10-15 second drying time and HEPA filter.
- .2 Electrical supply: 120V, 1HP, 350-700 W, 50/60 Hz.
- .3 Canadian model ‘Ultra Series - iStorm 2 Electric Hand Dryer' by Palmer Fixture or approved alternative.

13. Shower curtain rod:
    .1 #B6047; 32 mm diameter, 1.0 mm thick tube, complete with 81 mm diameter flanges, #B204-1 by Bobrick or #1200-SHU by ASI Group Canada stainless steel curtain hooks. Length as indicated on drawings.
    .2 Finish: Type 304 stainless steel satin finish.

14. Shower curtain:
    .1 #B204-2; 0.2 mm thick matte white vinyl, anti-bacterial treated, bottom and sides hemmed, complete with nickel plated brass grommets at 150 mm o.c.
    .2 Size: 1065 mm wide x 1830 mm high.

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 of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Verify and coordinate templates, inserts, and rough-in frames and verify exact location of washroom accessories for installation.

.2 Verify there is adequate supports and/or blocking in gypsum wall assemblies prior to installation of washroom accessories.

.3 Provide fastening and mounting kits for washroom accessories.

.4 Locate washroom accessories where indicated on Drawings and where directed by Consultant.

.5 Install washroom accessory fixtures, accessories, and items in accordance with manufacturer's instructions and CAN/CSA B651-M. Provide exposed tamper-proof screws of stainless steel to match units.

.6 Install washroom accessories plumb, level, and securely and rigidly anchored to substrate surfaces and framing. Adjust accessories for proper operation and verify mechanisms function smoothly.

.7 Install grab bars to withstand minimum load of 1.3 kN applied vertically or horizontally. Provide necessary reinforcements as required.

.8 Clean and polish exposed surfaces and fill accessories with necessary supplies prior to acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for lockers Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 CAN/CGSB-44.40, Steel Clothing Locker.

1.3 **SUBMITTALS**

.1 Product data:
  .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
    .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating type and class of lockers, elevations, sections, dimensions, gauges, tops, bases, hooks, shelves, trim, numbering, doors, handles, anchorage and hardware, and finishes.

.3 Samples:
  .1 Submit following samples in accordance with Section 01 30 00.
    .1 Two 50 mm x 50 mm samples of colour and finish on actual base metal.

.4 Closeout submittals: Submit maintenance and cleaning instruction for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

2 Products

2.1 **MANUFACTURED UNITS**

.1 Tactical Gear Locker (Type 1): Welded steel lockers in colour shown on Colour and Material Schedule, 533 mm x 533 mm x 1981 mm; Model TA-1-212178 by Lincora or approved alternative complete with the following options:
  .1 Hat Shelf;
  .2 Bottom Drawer;
  .3 Boot Tray;
  .4 Coat Bar.

.2 Lockers (Bunker Gear Locker Room): Custom sized as indicated on drawings, open style locker; Freestanding Racks and Wall Mounted Racks by Ready Rack Lockers or approved alternative. Locker Construction:
  .1 Frames: Tubular steel frames.
  .2 Walls and backs: Large open steel mesh.
  .3 Equipment: Manufacturer's standard hooks and shelves.

.4 Numbering: Each locker to have number plate with non-removable numerals, one number designation for each locker space.

.5 Finish: High performance baked on epoxy powder coating. Colours: Refer to Colour and Material Schedule.

3 Execution

3.1 **INSTALLATION**

.1 Assemble and Install lockers in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Securely fasten lockers to bases and grounds and nailing strips and to each other when in locker banks.

.3 Install trim and closures where indicated and where obstructions occur.

.4 Install locker numbers.

.5 Upon completion, test doors and adjust for ease of operation.

3.2 **CLEANING**

.1 Touch up scratches and abrasions to match original finish. Clean and polish lockers prior to final acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for miscellaneous specialties Work as listed below in accordance with the Contract Documents.

.1 Foot grilles.
.2 Janitor shelf.
.3 Corner guard.
.4 Tackboard.
.5 Whiteboard.
.6 Flag pole.
.7 Work Stations

1.2 **SUBMITTALS**

.1 Product data:
.1 Submit duplicate copies of manufacturer's Product data for each Product specified in accordance with Section 01 30 00 indicating:
.1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
.2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating elevations, sections, details, dimensions, materials, gauges, and finishes.

.3 Closeout submittals: Submit cleaning and maintenance instructions for miscellaneous specialties for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.3 **DELIVERY, STORAGE, AND HANDLING**

.1 Package or crate, and brace products to prevent distortion in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings.

2 Products

2.1 **MANUFACTURED UNITS**

.1 Foot Grilles (with drain pan):
.1 Frame and Grid: Level base frame with drain pan, minimum 46 mm deep by area shown on drawings, Recessed type, extruded 6105-T5 aluminum alloy tread rails joined mechanically by extruded 6061-T6 aluminum alloy key lock bars. Tread rails to incorporate vinyl cushion unless indicated other wise. Furnish anchors for attachment to, or for casting in, concrete.
.2 Evaporator Pan: 1.5 mm aluminum waterproof pan.
.3 Finish: Clear anodized.
.4 Tread insert: Serrated aluminum.

.5 Floor grilles size: As indicated on Drawings.
.6 Acceptable Manufacturer: To be selected by Consultant.

.2 Janitor's shelf with mop and broom holders and hooks:
.1 #B-239 x 34 by Bobrick Washroom Equipment of Canada or approved alternative.
.2 330 mm H by 205 mm deep. Shelf constructed of minimum 1.2 mm stainless steel, mop and broom holders to have spring loaded rubber cam to grip handles up to 30 mm in diameter, and stainless steel hooks positioned below shelf.
.3 Finish: Type 304 stainless steel with satin finish.

.3 Stainless steel corner guard (CG-1): 89 mm x 89 mm x 90°, stainless steel corner guard. Surface mounted 'CO-0' by C/S Group or approved alternative by McGill Architectural Products. Finish: #4 Satin Finish

.4 Tackboard: "Tackboards" by ASI Visual Display Products or approved alternative consisting of 6 mm natural cork laminated under heat and pressure to 6 mm hardboard, clear aluminum frame; wall mounted with concealed wall hanger.

.5 Whiteboard:
.1 Porcelain on steel laminated to 8 mm impregnated core with zinc coated backing sheet, with recessed tray and clear anodized aluminum perimeter trim with squared corners.
.2 Colour and finish: High gloss finish in white, 'Porcelain Surface' by ASI Visual Display Products or approved alternative.
.3 Sizes and layout: As shown on Contract Drawings.

.6 Flagpole: Tapered aluminum 6063 T-6 flag pole 30 ft exposed height of wall thickness between minimum 4.0 mm, designed to withstand 93 Mph winds. 14 gauge clear anodized aluminum ball with flush seams. Supply all trucks, halyards, cleats, collar, anchor base and accessories. 'Ground set architectural cone tapered aluminum' as manufactured by Ewing or approved alternative by Holards International.

.7 Work Stations: Adjustable height and flip-down work surface. 710 mm H x 1030 mm D x 550 mm with surface raised work station; Colour to be Selected by Consultant from manufacturer standard colour finish. Capacity: maximum 18.2 kg. Manufactured to be 'WorkFit Elevate' by Ergotron or approved alternative.

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 of this Section means acceptance of existing conditions.

3.2 PREPARATION

.1 Verify substrate surfaces are solid, free from surface water, dust, oil, grease, projections and other foreign matter detrimental to performance.

.2 Items to be built-in: Provide information and templates required for installation of work of this Section, and assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with products specified in this Section in order that they function as intended.

.3 Verify there is adequate supports and/or blocking in gypsum wall assemblies prior to installation of miscellaneous specialty items as required and janitors shelf.

3.3 INSTALLATION

.1 Install miscellaneous specialties level and securely and rigidly anchored to substrate in accordance with authorities having jurisdiction, reviewed shop drawings, and manufacturer's written instructions.

.2 After installation, adjust miscellaneous specialties in accordance with manufacturer’s written instructions.

3.4 CLEANING

.1 Clean and polish exposed surfaces prior to acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for manually operated window coverings Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 611, Voluntary Standards for Anodized Architectural Aluminum.

.2 ANSI, H35.1M, Alloy and Temper Designation Systems for Aluminum (Metric).

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, and finishes.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Elevations, sections and details of opening size, clearances, handling of operating components, anchorage, dimensions, gauges, materials, and finishes.

.3 Samples:
- .1 Submit following samples in accordance with Section 01 30 00.
  - .1 Two 300 x 300 mm samples of fabric type.

.4 Closeout submittals:
- .1 Submit following for each Product for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00:
  - .1 Functional description detailing operation and control of components.
  - .2 Performance criteria and maintenance data.
  - .3 Operating instructions and precautions.
  - .4 Safety precautions.

1.4 **EXTENDED WARRANTY**

.1 Manufacturer shall provide warranty that all components are free of manufacturing defects for two years from date of installation. This warranty is void if the product has been improperly installed or subjected to improper care.

2 Products

2.1 **ACCEPTABLE PRODUCTS AND MANUFACTURERS**

.1 Manual Roller Shade: Factory assembled, manual chain operated, roller type fabric shades with “snap-in” mounting, end brackets, shade tube, aluminum fascia, hembar and fabric as indicated on drawings and as specified herein. ‘Teleshade’ by Solarfective or approved alternative by Sun Glow, Sun Project or Urban Edge Shading.

2.2 **SHADING FABRIC (3% OPENNESS)**

.1 Yarn: Vinyl coated polyester, 0.46 mm thick, basket weave design.

Openness factor	3 %
Weight (g/sq.m)	21(oz./sq.yd.)
Warp ends per 25.4 mm (1") approx.	42
Fill ends per 25.4 mm (1") approx.	31
Grab tensile strength	Warp - 1180 N Fill - 667 N
Stretch (% at 12.2 kg.wt.)	Warp - 2% Fill - 3%
Set %	Warp - 1.5% Fill - 1.5%
Abrasion resistance (500 Taber cycles)	- Yarn rupture none
Wear	- trace
U.V. Deterioration(200 Sun Fade hours)	- Fade none
Tensile retention	- 96%

.2 Flame Retardance: Fabric shall be certified by an independent laboratory to pass CAN/ULC-S109.

.3 Fabric colour: Selected by Consultant from full colour range of any of the specified manufacturers. Shade fabric on any one floor shall be from the same dye lot.

.4 Fabric shall be sealed under heat and pressure to retain weave pattern, with additional heat seal at sides, to prevent fraying and to eliminate rough edges.

2.3 **FABRICATION**

.1 Extruded Aluminum Shade Tube: 1.52 mm thick, 38 mm diameter with three internal, continuous fins 4.82 mm high for strength and drive capabilities when attached to the nylon sprocket. The fins shall be spaced 120 degrees apart.

.2 Fascia: 1.7 mm thick, extruded aluminum cover, complete with three continuous screw flutes which accept end brackets to form unitized unit (totally assembled). To cover front of shade and return at underside to conceal roller and hardware, notched for chain clearance.

.3 Drive Assemblies:
- .1 Factory set, spring clutch type drive assembly to suit size and travel of fabric shades, complete with built-in shock absorber system to prevent chain breakage under normal conditions, and balancing spring or lift assist mechanism.
- .2 Capable of being field adjusted from exterior of shade without having to disassemble shades.

.4 Exterior Hembar: Extruded aluminum in clear anodized finish with plastic end finials.

.5 Drive Chain:
- .1 No. 10 “bright” finished series 300 stainless steel bead type chain forming continuous loops and capable of withstanding 400 N pull test.
- .2 Provide drive chains with upper and lower stops to prevent overwinding or underwinding.

.6 Dynamic Hembar: At sill locations, in lieu of bottom channel, provide aluminum Dynamic Hembar with same finish as side channels. Upon contact with sill, it shall provide a light seal even if the sill is slightly out of level.

.7 End Bracket: Two piece moulded ABS construction with a nylon drive sprocket. Incorporate snap-in clip on each end bracket to engage snap-in mounting hardware. Bracket colour shall coordinate with the fascia colour.

.8 Colour: Exposed surfaces (excluding fabric) shall be colour selected by Consultant, and not necessarily from manufacturer's full colour range. Metal components shall be pretreated and finished with an acceptable baked enamel finish.

.9 Fasteners: Non-corrosive metal screws for attachment to windows or curtain wall framing, concealed in completed installation.

.10 Mounting System: Snap-in brackets which allow the shade to be removed without disassembling the shade unit.

.11 Shade and mounting system to be designed to allow air between shade and glass.

.12 Fabric shall hang flat, without buckling or distortion. Trimmed edges shall hang straight without curling or raveling.

.13 Unguided vertical shades shall not drift sideways more than 3 mm in total run.

.14 Provide stops at highest and lowest shade positions to prevent over winding and unrolling.

.15 Design and fabricate shades so that there is a maximum 12 mm gap both sides of fabric.

.16 Shades shall be Fully Factory Assembled Units of unitized construction consisting of end brackets, shade tube, extruded aluminum fascia, Hembar and specified fabric.

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**

.1 Install shade in accordance with accepted shop drawings and manufacturer's written instructions.

.2 Install shades in locations shown using specified fasteners, plumb, true, square, straight, and level in proper planes, complete with all fascias/soffits, trims and accessories.

3.3 **ADJUSTMENT AND CLEANING**

.1 The shade cloth fabric shall hang flat, without buckling or distortion. The edge, when trimmed, shall hang straight without ravelling. An unguided roller shade cloth shall roll true and straight, without shifting sideways more than 3 mm in either direction due to warp distortion, or weave design.

.2 Adjust, correct and lubricate fabric shade as required, to provide smooth and efficient operation without binding.

.3 Clean shade surfaces and remove all finger marks and smudges from fascia, soffits, and trim surfaces. Remove all protective films.

.4 Leave fabric shade in raised position and in first-class condition upon completion of the Work of this Section.

END OF SECTION

1 General

1.1 REFERENCES

.1 Division 00 and Division 01 apply to and are a part of each Mechanical Division:

.1 Division 21 – Fire Suppression;

.2 Division 22 – Plumbing;

.3 Division 23 – Heating, Ventilating, and Air Conditioning;

.4 Division 25 - Integrated Automation.

1.2 APPLICATION

.1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions. It is intended as a supplement to each Section and is to be read accordingly.

1.3 SUBMITTALS

.1 Submit shop drawings/product data sheets for:

.1 pressure gauges and thermometers;

.2 electric motors (submit with equipment they are associated with).

.2 Submit weight loads for selected equipment (upon request).

.3 Submit copy of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.

.4 Submit a list of equipment identification nameplates indicating proposed wording and sizes.

.5 Submit a list of pipe and duct identification colour coding and wording.

.6 Submit a proposed valve tag chart and a list of proposed valve tag numbering and identification wording.

.7 Submit drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

.8 Submit any other submittals specified in this Section or other Sections of Mechanical Divisions.

2 Products

2.1 PIPE SLEEVES

.1 Galvanized Sheet Steel – Minimum #16 gauge galvanized steel with an integral flange at one end to secure sleeve to formwork construction.

.2 Polyethylene – Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.

.3 Waterproof Galvanized Steel Pipe – Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at sleeve midpoint.

.4 Galvanized Steel or Cast Iron Pipe – Schedule 40 mild galvanized steel, or Class 4000 cast iron.

2.2 FIRESTOPPING AND SMOKE SEAL MATERIALS

.1 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in Section 20 05 17 - Sleeves and Sleeve Seals for Mechanical Piping and work is to be done as part of mechanical work unless otherwise specified in Division 07.

2.3 WATERPROOFING SEAL MATERIALS

.1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.

.2 Acceptable products are:

.1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;

.2 The Metraflex Co. "MetraSeal" type ES.

2.4 PIPE ESCUTCHEON PLATES

.1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to building surface, each plate sized to completely cover pipe sleeve or building surface opening, and to fit tightly around pipe or pipe insulation.

2.5 PIPING HANGERS AND 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 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 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.

.4 Floor supports for vertical risers as follows:

.1 copper tubing riser clamp – MSS Type 8;

.2 heavy-duty steel riser clamp – MSS Type 8.

.5 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.

.6 For horizontal pipe on racks, Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:

.1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;

.7 Special hangers and supports for various applications as follows:

.1 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;

.2 for sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS Type 48 spring cushions;

.3 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 all required accessories;

.4 for plastic piping – generally as specified above but in accordance with pipe manufacturer's recommendations;

.5 for fire protection piping – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard applicable to piping system;

.6 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;

.7 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;

.8 insulation protection shields to and including 40 mm (1-½") dia. – MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger.

.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 in any case 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.

2.6 ACCESS DOORS

.1 Provide all access doors required for Mechanical work unless otherwise specified in Division 08. Coordinate consistency of look and finish of access doors on project with each Division of Work. Coordinate exact requirements with General Trades Contractor.

.2 Access doors to be rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frame to be suitable for wall installation and have integral keys for plaster walls. Doors in tile wall to be stainless steel and in ceilings to be suitable for plaster covering with only frame joint showing. Other doors to be prime painted steel.

.3 Size access doors to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.

.4 Lay-in type tiles, properly marked, may serve as access panels. Coordinate marking of ceiling tiles with Consultant. Panels in glazed tile walls to be 12 gauge, 304 alloy stainless steel, No. 4 finish, with recessed frame secured with stainless steel counter-sunk flush head screws.

.5 Panels in plaster surfaces to have dish-shaped door and welded metal lath, ready to take plaster. Provide a plastic grommet for door key access.

.6 Other access doors to be welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant for review, details of non-standard door construction details.

.7 Access doors in fire rated ceilings, walls, partitions, structures, etc., to be ULC listed and labelled and of a rating to maintain fire separation integrity.

.8 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting finish in which they are to be installed so as to maintain final building surface appearance throughout.

.9 Acceptable manufacturers include Le Hage, SMS, Pedlar and Acudor.

2.7 PRESSURE GAUGES AND THERMOMETERS

.1 Pressure gauges as follows:

.1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-½") diameter and each accurate to within 1% of scale range;

.2 type 304 stainless steel case with relief valve and polished stainless steel bayonet;

.3 stainless steel rotary movement with stainless steel bushings and socket;

.4 clear acrylic window;

.5 dual scale white dial with a scale range such that working pressure of system is at approximate mid-point of scale;

.6 black pointer.

.2 Pressure gauge accessories and additional requirements as follows:

.1 a bronze ball type shut-off valve is to be provided in the piping to each pressure gauge;

.2 each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber;

.3 each pressure gauge for steam piping or steam equipment is to be equipped with a steel coil syphon;

.4 pressure gauges in fire protection piping must be ULC listed and labelled;

.3 Thermometers as follows:

.1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;

.2 hermetically sealed stainless steel case with stainless steel ring;

.3 dampened bimetal coil;

.4 calibration adjustment screw;

.5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;

.6 black aluminum pointer;

.7 double strength glass window;

.8 12 mm (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem;

.9 suitable thermowell.

.4 Acceptable manufacturers are:

.1 H.O. Trerice Co.;

.2 Weiss Instruments;

.3 Ashcroft.

2.8 EQUIPMENT BELT DRIVES

.1 ANSI/RMA Standard V-belt type rated at minimum 1.5 times motor nameplate rating, and in accordance with following requirements:

.1 belts are to be reinforced cord and rubber, and multiple belts are to be matched sets;

.2 sheaves are to be cast iron or steel, secured to shafts with removable keys unless otherwise specified, standard adjustable pitch (± 10% range) for motors under 10 HP, fixed pitch type with split tapered bushing and keyway for motors 10 HP and larger, and, if required, replaced as part of mechanical work to suit system air/water quantity testing and balancing work;

.3 motor slide rail adjustment plates are to allow for centre line adjustment.

.2 Supply a spare belt set (tagged and identified) for each belt drive and hand to Owner upon Substantial Performance of the Work.

2.9 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

.1 For V-belt drives – removable, 4-sided, fully enclosed, galvanized sheet steel guards to OHSA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-½") diameter tachometer openings at each shaft location.

.2 For flexible couplings – removable "U" shaped galvanized steel guards to OHSA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.

.3 For unprotected fan inlets and outlets – unless otherwise specified, removable 20 mm (¾") galvanized steel wire mesh with galvanized steel frames, all to OHSA Standards.

2.10 ELECTRIC MOTORS

.1 Unless otherwise specified, motors are to conform to NEMA Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.

.2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.

.3 Efficiency of 1-phase motors to 1 HP is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 HP and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.

.4 Unless otherwise specified, 1-phase motors smaller than ½ HP are to be 115 volt, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.

.5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 volt continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.

.6 Unless otherwise specified, motors ½ HP and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.

.7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.

.8 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG-1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.

.9 Acceptable manufacturers are:

.1 TECO-Westinghouse Motors (Canada) Inc.;

.2 Canadian General Electric;

.3 Baldor Electric Co.;

.4 U.S. Electrical Motors;

.5 Weg Electric Corp.;

.6 Marathon Electric;

.7 Toshiba Corp.;

.8 Leeson Canada.

2.11 SPRINKLER PROOFING

.1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:

.1 factory constructed by respective equipment manufacturers;

.2 constructed from non-combustible materials (sheet steel);

.3 enamel painted to match equipment;

.4 surfaces and edges filled/sanded smooth prior to painting;

.5 supported from equipment with structural steel rods/metal framing or other method approved by Consultant;

.6 structural support finish painted to match shield.

.2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.

.3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.

.4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.

.5 Above requirements are additional minimum "sprinkler proof" standards for equipment specified as NEMA 1, 2 or 12.

.6 Obtain CSA approval where required by local governing authorities.

2.12 MECHANICAL WORK IDENTIFICATION MATERIALS

.1 Confirm with the Owner if an existing mechanical work identification system is in place and, if so, match accordingly.

.2 If an existing mechanical work identification system is not in place, the following is to be used:

.1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:

.1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;

.2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;

.3 supply stainless steel screws for securing nameplates in place;

.4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.

.2 Valve tags are to be coloured, 40 mm (1-½") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:

VALVE V12
200 mm (8")
CHILL. WATER
NORMALLY OPEN

.3 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:

.1 for pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;

.2 for pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.

.4 Identification wording and colours for pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
domestic cold water	green	DOM. COLD WATER
domestic hot water supply	green	DOM. HW SUPPLY
domestic hot water recirculation	green	DOM. HW RECIRC.
tempered domestic water	green	TEMP. DOM. WATER
storm drainage	green	STORM
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
fire protection sprinklers	red	F.P. SPRINKLER

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
natural gas	to Code	to Code, c/w pressure
natural gas vent	to Code	to Code
low pressure steam	yellow	….kPa STEAM
low pressure condensate	yellow	L.P. CONDENSATE
pumped condensate	yellow	PUMPED CONDENSATE
refrigerant suction	yellow	REFRIG. SUCTION
refrigerant liquid	yellow	REFRIG. LIQUID
refrigerant hot gas	yellow	REFRIG. HOT GAS

.5 Colours for pipe identification legends and directional arrows are to be as follows:

IDENTIFICATION COLOUR	LEGEND & ARROW COLOUR
yellow	black
green	white
red	white

.6 Duct identification is to be custom made Mylar stencils with 50 mm (2") high lettering to accurately describe duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with lettering background.

2.13 FLEXIBLE CONNECTORS

.1 Double wall stainless steel flexible connectors for piping connections to vibration isolated equipment, each selected by manufacturer to suit the application. Shop drawings or product data sheets must indicate construction and performance requirements that suit the application. Acceptable manufacturers are:

.1 Hyspan Precision Products Inc.;

.2 Senior Flexonics Ltd.;

.3 The Metraflex Co.

3 Execution

3.1 GENERAL PIPING AND DUCTWORK INSTALLATION REQUIREMENTS

.1 Unless otherwise specified, locate and arrange horizontal pipes and ducts above or at ceiling on floors, arranged so that under consideration of all other work in area, maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant’s approval.

.2 Unless otherwise specified, install work concealed in finished spaces, and concealed to degree possible in partially finished and unfinished spaces. Refer to and examine Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Walls which are painted are considered finished.

.3 Install pipes and ducts parallel to building lines and to each other.

.4 Neatly group and arrange exposed work.

.5 Locate work to permit easy access for service or maintenance as required and/or applicable. Locate valves, dampers and any other equipment which will or may need maintenance or repairs and which are to be installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping

or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate accessories at floor level.

.6 Make connections between pipes of different materials using adapters suitable for application. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.

.7 Comply with equipment and material manufacturer's installation instructions unless otherwise specified herein or on drawings, and unless such instructions contradict governing codes and regulations.

.8 Carefully clean ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.

.9 Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around pipe or duct, except for ductwork at fire barriers, in which case insulation will be terminated at each side of the duct fire damper.

.10 Inspect surfaces and structure prepared by other trades before performing work. Verify surfaces or structure to receive work has no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of work will constitute acceptance of such surfaces as being satisfactory.

.11 Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both, is to be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean piping prior to being concealed.

.12 Provide continuous galvanized sheet metal drip pan under drain, water and water solution piping extending through rooms with electrical equipment such as electrical, elevator equipment and transformer rooms, and other spaces provided primarily for the installation of electrical equipment. Drip pans are to be complete with a drain pipe connection and drain piping is to be extended to closest drain.

.13 For factory applied finishes, repaint or refinish surfaces damaged during shipment and installation. Quality of repair work is to match original finish. This requirement also applies to galvanized finishes.

.14 Where mechanical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on products to protect against corrosion or provide products which will not corrode in the environment, i.e. aluminium ductwork, copper or stainless steel pipe, etc.

.15 Provide screwed unions or flanges in piping connections to equipment and in regular intervals in long (in excess of 12 m [40']) piping runs to permit removal of sections of piping.

.16 Unless otherwise specified and except where space limitations do not permit, piping elbows are to be long radius. Eccentric reducers are to be installed with straight side at top of piping.

3.2 PIPE JOINT REQUIREMENTS

.1 Do not make pipe joints in walls or slabs.

.2 Ream piping ends prior to making joints.

.3 Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After pipe has been screwed into fitting, valve, union, or piping accessory, not more than 2 pipe threads are to remain exposed.

.4 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove scale and oxide from bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.

.5 Welded joints are to be made by CWB certified licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification

for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.

.6 Unless otherwise specified, make flanged joints with Garlock 5500 or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than length necessary to screw nut up flush to the end of bolt. Bolts used for flanged connections in piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A-193 Grade B-7, with heavy hexagon nuts to ASTM A-194 CL-2H. Provide suitable washers between each bolt head and flange and between each nut and flange.

.7 A random check of bolted flanged connections will be made to verify flanged connections are properly mated with no shear force acting on bolts. Supply labour to disconnect and reconnect selected flanged joints. If improperly mated joints are found, remove and reinstall affected piping so flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.

.8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean the outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.

.9 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.

.10 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.

.11 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.

.12 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.

.13 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

3.3 INSTALLATION OF PIPE SLEEVES

.1 Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:

.1 in poured concrete slabs – unless otherwise specified, minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves;

.2 in concrete or masonry walls – Schedule 40 galvanized steel pipe or Class 4000 cast iron pipe.

.2 Sleeves in waterproofed slabs or walls are to be lengths of Schedule 40 mild galvanized steel pipe with a waterstop plate in accordance with drawing detail. Provide waterproof sleeves in following locations:

.1 in mechanical room floor slabs, except where on grade;

.2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets;

.3 in floors equipped with waterproof membranes;

.4 in roof slab;

.5 in waterproof walls.

.3 Size sleeves, unless otherwise specified, to leave 12 mm (½") clearance around pipes, or where pipe is insulated, a 12 mm (½") clearance around pipe insulation.

.4 Pack and seal void between pipe sleeves and pipe or pipe insulation in non-fire rated construction for the length of sleeves as follows:

.1 pack sleeves in interior construction with mineral wool and seal both ends of sleeves with non-hardening silicone base caulking compound;

.2 pack sleeves in exterior walls above grade with mineral wool and seal both ends of sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified;

.3 seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified.

.5 Where sleeves are required in masonry work, accurately locate and mark sleeve location, and hand sleeves to mason for installation.

.6 Terminate piping for sleeves that will be exposed so sleeve is flush at both ends with building surface so sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above finished floor.

.7 "Gang" type sleeving will not be permitted.

.8 Where sleeves are provided in non-fire rated construction for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of sleeved opening.

3.4 INSTALLATION OF WATERPROOF MECHANICAL SEALS

.1 Provide watertight link type mechanical seals in exterior wall openings.

.2 Assemble and install each mechanical seal in accordance with manufacturer's instructions.

.3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until seal is completely watertight.

3.5 DUCT OPENINGS

.1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by trade responsible for particular construction in which opening is required.

.2 Size openings for fire dampers to 600 mm (24") high to suit damper arrangement with folding blade out of air stream.

.3 For duct openings except where fire dampers are required, pack and seal space between duct or duct insulation and duct opening as specified above for pipe openings in non-fire rated construction.

3.6 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

.1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

.2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.

.3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.7 INSTALLATION OF PIPE ESCUTCHEON PLATES

.1 Provide escutcheon plates suitably secured over exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.

.2 Install plates so they are tight against building surface concerned, completely covering pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case fit plate tightly around sleeve.

3.8 INSTALLATION OF FASTENING AND SECURING HARDWARE

.1 Provide fastening and securing hardware required for mechanical work to maintain installations attached to structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding dead loads, live loads, superimposed dead loads, and any vibration of installed products.

.2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.

.3 Where floor, wall or ceiling construction is not suitable to support loads, provide additional framing or special fasteners to ensure proper securement to structure that is to support the products. Provide reinforcing or connecting supports where required to distribute loading to structural components.

.4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CAN/CSA Z166.1 and CAN/CSA Z166.2.

.5 Do not attach fasteners to steel deck without written consent from Consultant.

3.9 INSTALLATION OF PIPE HANGERS AND SUPPORTS

.1 Provide 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 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.

.4 Support requirements for underground piping are as follows:

.1 support underground pipe, unless otherwise specified, on a well compacted bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted material as specified;

.2 support underground service piping penetrating building exterior walls or foundations to prevent pipe damage if minor building settlement occurs;

.3 ensure bedding and supports for underground pipes are flat and true and allowances are made for pipe hubs, couplings, or other protrusions so no voids are left between pipe and bedding.

.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 (1-½") 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 glass pipe – conform to pipe manufacturer's recommended support spacing and support requirements;

.4 copper and steel pipe – hang or support at spacing in accordance with following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
65 mm (2-½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12’)	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')

.5 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints;

.7 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") 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 150 mm (6") diameter and conveying a material 75°C (170°F) 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 3 m (10') intervals or at every floor, whichever is lesser;

.2 for sections of vertical piping with a length less than 3 m (10'), 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 3 m (10'), 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 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 less than or equal to 40 mm (1-½") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.

.14 Do not support piping from steel deck without written consent from Consultant.

3.10 SUPPLY OF ACCESS DOORS

.1 Supply access doors to give access to mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on drawings.

.2 Before commencing installation of mechanical work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange mechanical work to suit.

.3 Access doors will be installed by trade responsible for particular type of construction in which doors are required. Supply access doors to trade installing same at proper time.

.4 Wherever possible, access doors to be of a standard size for each application. Confirm exact dimensions and minimum size restrictions with Consultant prior to ordering.

.5 Group piping and ductwork to ensure minimum number of access doors is required.

.6 Coordinate with Electrical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services should, where possible, be accessible from common access door. Coordinate work to ensure common location access doors are not supplied by both Mechanical Divisions and Electrical Divisions.

3.11 INSTALLATION OF VALVES

.1 Generally, valve locations are indicated or specified on drawings or specified in Sections of the Specification where valves are specified, however, regardless of locations shown or specified, following requirements apply:

.1 provide shut-off valves to isolate systems, at base of vertical risers, in branch take-offs at mains and risers on floors, to isolate equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;

.2 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;

.3 unless otherwise specified, provide a check valve in discharge piping of each pump;

.4 valve sizes are to be same as connecting pipe size;

.5 valves are to be permanently identified with size, manufacturer's name, valve model or figure number and pressure rating, and wherever possible, valves are to be product of same manufacturer;

.6 for valves in insulated piping, design of valve stem, handle and operating mechanism is to be such that insulation does not have to be cut or altered in any manner to permit valve operation.

3.12 INSTALLATION OF PRESSURE GAUGES AND THERMOMETERS

.1 Provide pressure gauges in following locations where applicable:

.1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;

.2 in expansion tank(s);

.3 in separate domestic hot water storage tank(s);

.4 at top most outlet in each standpipe fire protection system riser;

.5 in potable water service piping downstream of meter;

.6 wherever else shown and/or specified.

.2 Provide thermometers in following locations where applicable:

.1 in supply and return piping connections to main mechanical plant equipment such as domestic water heaters, boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;

.2 wherever else shown and/or specified.

.3 Conform to following installation requirements where applicable:

.1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;

.2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;

.3 locate, mount and adjust instruments so they are easily readable;

.4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.

3.13 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES

.1 Provide OHSA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.

.2 Install belt guards to allow movement of motors for adjusting belt tension.

.3 Provide a means to permit lubrication and use of test instruments with guards in place.

.4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.

.5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

3.14 MECHANICAL WORK IDENTIFICATION

.1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:

.1 at every end of every piping or duct run;

.2 adjacent to each valve, strainer, damper and similar accessory;

.3 at each piece of connecting equipment;

.4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;

.5 at 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;

.6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.

.2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:

.1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;

.2 at maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;

.3 at each access door location;

.4 at each piece of connected equipment, automatic valve, etc.

.3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.

.4 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with Code requirements. Identify piping at intervals as specified above.

.5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on

each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.

.6 For electrically traced mechanical work, identification wording is to include "ELECTRICALLY TRACED".

.7 Tag valves and prepare a valve tag chart in accordance with following requirements:

.1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;

.2 prepare a digital valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);

.3 if an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;

.4 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals.

.8 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:

.1 HVAC piping valves and equipment: yellow

.2 fire protection valves and equipment: red

.3 plumbing valves and equipment: green

.4 HVAC ductwork dampers and equipment: blue

.5 control system hardware and equipment: orange

3.15 FINISH PAINTING OF MECHANICAL WORK

.1 Finish paint exposed mechanical work as specified and/or scheduled in accordance with requirements of Division 09.

.2 Touch-up paint damaged factory applied finishes on mechanical work products.

3.16 PIPE LEAKAGE TESTING

.1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.

.2 Tests are to be witnessed by Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.

.3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.

.4 Gravity Drainage and Vent Piping

.1 Test piping in accordance with local governing building code.

.2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform a smoke test if required by local governing authorities.

.5 Domestic Water Piping

.1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.

.6 Sprinkler System Piping

.1 Test system piping in accordance with requirements of NFPA No. 13, "Installation of Sprinkler Systems", and in accordance with any additional requirements of governing authorities.

.7 Steam and Condensate Piping

.1 Test piping with cold water for a minimum of 2 hours at following pressures:

.1 0 kPa to 105 kPa (0 psi to 15 psi) low pressure piping – 690 kPa (100 psi);

.8 Natural Gas Piping

.1 Test piping in accordance with requirements of CAN/CSA B149.1 and any additional requirements of local governing authorities.

.2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.

.3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.

.9 Refrigerant Piping

.1 Test refrigerant piping for leakage and dehydrate in accordance with requirements of Chapter 18 of ASHRAE Handbook - Fundamentals.

.10 Following requirements apply to all testing:

.1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;

.2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;

.3 when testing is carried out below highest level of the particular system, increase test pressure by the hygrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point;

.4 include for temporary piping connections required to properly complete tests;

.5 piping under test pressure is to have zero pressure drop for length of test period;

.6 make tight leaks found during tests while piping is under pressure, and if this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;

.7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;

.8 tests are be done in reasonably sized sections so as to minimize number of tests required;

.9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

3.17 ELECTRICAL WIRING WORK FOR MECHANICAL WORK

.1 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of the electrical work:

.1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment;

.2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment;

.3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment;

.4 provision of receptacles for plug-in equipment;

.5 provision of disconnect switches for motors in excess of 10 m (30') from starter location, or cannot be seen from starter location, and associated power wiring;

.6 motor starter interlocking in excess of 24 volts;

.7 wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts;

.8 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;

.9 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units;

.10 120 volt wiring connections to duplex receptacles integral with air handling unit control panels;

.11 120 volt wiring connections to BAS system controllers/panels and other control system or component requiring 120 volt power including, but not limited to, VAV boxes, dampers, low voltage transformers, etc.

.2 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

3.18 EQUIPMENT BASES AND SUPPORTS

.1 Unless otherwise specified or required, set floor mounted equipment on minimum 100 mm (4") high reinforced concrete housekeeping pads 200 mm (8") clear of equipment on each side and end, or a minimum of 200 mm (8") from centreline of equipment anchor bolts to edge of the base, whichever is larger. Conform to 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 concrete pour and be responsible for required levelling, alignment, and grouting of 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 following requirements:

.1 provide stands and supports, except those for small equipment, designed by a structural engineer registered in jurisdiction of the work, and submit stamped and signed design drawings with calculations as shop drawings for review;

.2 flange bolt steel stands to concrete housekeeping pads;

.3 seismically restrained stands and supports in accordance with applicable requirements.

3.19 CONCRETE WORK FOR MECHANICAL EQUIPMENT BASES/PADS

.1 Unless otherwise specified in Division 03, provide poured concrete work, including reinforcing and formwork, required for mechanical equipment bases/pads. Perform concrete work in accordance with requirements specified in Division 03.

.2 Unless otherwise specified in Division 03, concrete is to be minimum 20,700 kPa ready-mix concrete in accordance with CAN/CSA-A23.1 and the Building Code.

.3 Ensure that bases and pads are keyed into the structure to meet seismic restraint requirements where applicable.

3.20 EXCAVATION AND BACKFILL WORK

.1 Unless otherwise specified in Division 31, provide all excavation and backfill associated with the mechanical scope of work.

.2 Before commencement of excavation for work, determine in consultation with Consultant, Owner, Municipality and utilities, presence, if any, of existing underground services at site. Engage local utilities to locate and mark out such services. Ensure trades concerned are aware of their presence.

.3 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.

.4 Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.

.5 Unless otherwise specified in Division 31, provide excavation, backfill and related work required for mechanical work. Obtain a copy of soil test report if available from Consultant. Depth of excavations must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of the Work.

.6 Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Confirm inverts and locations are correct, prior to commencing excavation and contact Utilities to accurately locate their services. Where discrepancies are found, immediately inform Consultant, and await a direction. Grade bottom of trench excavations as required.

.7 In firm, undisturbed soil, lay pipes directly on soil, unless otherwise directed.

.8 Before backfilling, arrange for inspection of work by Consultant. Do not backfill work unless reviewed with Consultant. Failure to do so prior to backfilling will require re-excavating work and re-backfill at no additional cost to Owner.

.9 Unless otherwise specified, backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm (6”) thickness compacted to a density of 100% Standard Proctor. Hand compact first layers up to a compacted level of minimum 300 mm (12") above top of pipe. Hand or machine compact the balance up to grade.

.10 Unless otherwise specified, backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") thick above the pipe, hand compacted to a density of 95% Standard Proctor, using granular "A" gravel. Backfill the balance in 150 mm (6") layers with approved excavated material, compacted to 95% Standard Proctor density.

.11 Unless otherwise specified, backfill trenches outside building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level.

.12 Provide minimum 1.37 m (4.5') of cover for underground piping subject to freezing and located outside building.

.13 Provide minimum 450 mm (18") of cover for underground piping subject to freezing and located inside building.

.14 After first lift of backfill has been compacted, mark entire path of pipe using continuous 75 mm (3") wide detectable identified marking tape equal to SMS Ltd. D-UGMT.

.15 Unless otherwise directed in Division 02 and/or Division 31, store and dispose of excavated materials as follows:

.1 during progress of contract, place material as directed in such a manner to minimize damage or disfigurement of ground and which in no way impedes progress of work;

.2 separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.

.16 Perform pumping as required to keep excavations free of water.

.17 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit a copy of testing agency's report to Consultant for review.

.18 Fill depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement.

.19 Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, etc.) with General Contractor.

3.21 CUTTING, PATCHING AND CORE DRILLING

.1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of mechanical work. Perform cutting in a neat and true fashion, with proper tools and equipment to Consultant's approval. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by Consultant.

.2 Criteria for cutting holes for additional services:

.1 cut holes through slabs only; no holes to be cut through beams;

.2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;

.3 keep at least 100 mm (4") clear from beam faces;

.4 space at least 3 hole diameters on centre;

.5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;

.6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;

.7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.

.3 Do not cut or drill any existing work without approval from Owner and Consultant. Be responsible for damage done to building and services caused by cutting or drilling.

.4 Where pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around pipes or pipe insulation.

.5 Prior to drilling or cutting an opening, determine, in consultation with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Coring is not permitted through concrete beams or girders.

.6 Where drilling is required in waterproof slabs, size opening to permit snug and tight installation of a pipe sleeve sized to leave 12 mm (½") clearance around pipe or pipe insulation. Provide a pipe sleeve, constructed of Schedule 40 galvanized steel pipe with a flange at one end and of a length to extend 100 mm (4") above slab, in opening. Secure flange to the underside of slab and caulk void between sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.

.7 Firestop and seal openings in fire rated construction. Do not leave openings open overnight unless approved by Owner and Consultant.

3.22 FLASHING FOR MECHANICAL WORK PENETRATING ROOF

.1 Unless otherwise specified in Division 07, perform required flashing work, including counter-flashing, for mechanical work penetrating and/or set in roof.

.2 Perform flashing work in accordance with requirements of drawing details and/or requirements specified in Division 07.

3.23 CLEANING MECHANICAL WORK

.1 Refer to cleaning requirements specified in Division 01.

.2 Clean mechanical work prior to application for Substantial Performance of the Work.

.3 Include for vacuum cleaning interior of air handling units and ductwork systems.

3.24 CONNECTIONS TO OTHER EQUIPMENT

.1 Carefully examine Contract Documents during bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

3.25 SEISMIC RESTRAINT ANCHOR POINTS FOR EQUIPMENT

.1 Where mechanical equipment requires seismic restraint, it is to be complete with manufacturer designed and rated seismic restraint anchor points and attachments, certified by equipment manufacturers, so equipment may be bolted down or restrained in the field.

.2 Equipment to be restrained must be designed such that the strength and anchorage of the internal components of equipment exceeds force level used to restrain and anchor equipment itself to the supporting structure.

3.26 INSTALLATION OF FLEXIBLE CONNECTORS

.1 Provide flexible connectors in piping connections to seismically restrained equipment, where applicable, and wherever else shown.

.2 Provide flexible connectors in piping connections to vibration isolated equipment.

3.27 FAN NOISE LEVELS

.1 Submit sound power levels with fan shop drawings/product data, with levels measured to AMCA 300 and calculated to AMCA 301.

3.28 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

.1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to Consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

3.29 EQUIPMENT AND SYSTEM START-UP

.1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with following requirements:

.1 submit a copy of each equipment/system manufacturer's start-up report sheet to Consultant for review, and incorporate any comments made by Consultant;

.2 under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit to Consultant complete set of start-up documentation sheets signed by manufacturer/supplier and Contractor.

End of Section

1 General

1.1 REFERENCES

.1 Division 00 and Division 01 apply to and are a part of this Section.

1.2 APPLICATION

.1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or Division 01 to take precedence.

.2 Be responsible for advising product vendors of requirements of this Section.

1.3 DEFINITIONS

.1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.

.2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.

.3 "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.

.4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.

.5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.

.6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.

.7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; 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 Owner and reviewed with Consultant.

.8 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.

.9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.

.10 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, 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.

.11 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.

.12 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.

.13 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.

.14 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.

.15 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.4 DOCUMENTS

.1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.

.2 Specification is arranged in accordance with CSI/CSC 49 Divisions of MasterFormat.

.3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.

.4 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.

.5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.

.6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.

.7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.

.8 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.

.9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.

.10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.

.11 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.

.12 When scale and date of Drawings are the same, or when discrepancy exists within Specification, include most costly arrangement to take precedence.

.13 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in "General Conditions", however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence. In not specified in "General Conditions", documents will govern in the following order:

.1 Specification;

.2 Drawings of larger scale;

.3 Drawings of smaller scale;

.4 Drawings of later date when scale of Drawings is same.

1.5 METRIC AND IMPERIAL MEASUREMENTS

.1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.6 EXAMINATION OF DOCUMENTS AND SITE

.1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.

.2 Report to Purchasing Representative, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.

.3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Purchasing Representative, in writing.

1.7 WORK STANDARDS

.1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.

.2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with Consultant.

.3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:

.1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);

.2 Air Movement and Control Association (AMCA);

.3 American Iron and Steel Institute (AISI);

.4 American National Standards Institute (ANSI);

.5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);

.6 American Society of Mechanical Engineers (ASME);

.7 American Society of Testing and Materials (ASTM);

.8 American Water Works Association (AWWA);

.9 Associated Air Balance Council (AABC);

.10 Building Industry Consulting Services, International (BICSI);

.11 Canadian Gas Association (CGA);

.12 Canadian General Standards Board (CGSB);

.13 Canadian Standards Association (CSA);

.14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);

.15 Electrical Safety Authority (ESA);

.16 Electronic Industries Association (EIA);

.17 Factory Mutual Systems (FM);

.18 Illuminating Engineering Society (IES);

.19 Institute of Electrical and Electronic Engineers (IEEE);

.20 International Standards Organization (ISO);

.21 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);

.22 National Building Code of Canada (NBC);

.23 National Electrical Manufacturers Association (NEMA);

.24 National Environmental Balancing Bureau (NEBB);

.25 National Fire Protection Association (NFPA);

.26 National Standards of Canada;

.27 NSF International;

.28 Occupational Health and Safety Act (OHSA);

.29 Ontario Building Code (OBC);

.30 Ontario Electrical Safety Code (OESC);

.31 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);

.32 Technical Standards and Safety Authority (TSSA);

.33 Thermal Insulation Association of Canada (TIAC);

.34 Underwriters' Laboratories of Canada (ULC);

.35 Workplace Hazardous Materials Information System (WHMIS);

.36 Material Safety Data Sheets by product manufacturers;

.37 Local utility inspection permits;

.38 Codes, standards, and regulations of local governing authorities having jurisdiction;

.39 Additional codes and standards listed in Trade Sections;

.40 Owner's standards.

.4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.

.5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.

.6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.

.7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.

.8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review with Consultant at any time.

.9 Experienced and qualified superintendent is to be on-site at times when work is being performed.

.10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.

.11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of Owner and reviewed with Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.

.12 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products must bear a CRN number.

.13 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

1.8 PERMITS, CERTIFICATES, APPROVALS, AND FEES

.1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for all permits other than building permit, certificates, and approvals required to complete Work. Sprinkler permit to be applied for by GC.

.2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.

.3 Obtain and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.

.4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

1.9 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

.1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work. General contractor is responsible for ensuring all sub-contractors and sub-consultants maintain proper insurance.

.2 Retained engineer’s professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.

.3 Unless otherwise specified in Division 00 or 01, liability insurance requirements are as follows:

.1 coverage is to be a minimum of $1,000,000.00 CDN inclusive of any one occurrence;

.2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;

.3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;

.4 retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;

.5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

1.10 WORKPLACE SAFETY

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.

.2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.

1.11 PLANNING AND LAYOUT OF WORK

.1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.

.2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:

.1 piping requiring uniform pitch;

.2 piping 100 mm (4") dia. and larger;

.3 large ducts (main runs);

.4 cable tray and bus duct;

.5 conduit 100 mm (4") dia. and larger;

.6 piping less than 100 mm (4") dia.;

.7 smaller branch ductwork;

.8 conduit less than 100 mm (4") dia..

.3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.

.4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.

.5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or ¼"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.

.6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.

.7 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.

.8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.

1.12 COORDINATION OF WORK

.1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:

.1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;

.2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;

.3 depth and routing of excavation required for work, and requirements for bedding and backfill;

.4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.

.2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.

.3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.

.4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.

.5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.13 PRODUCTS

.1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.

.2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer’s authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.

.3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that

its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.

.4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where acceptable manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If acceptable manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.

.5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.

.6 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.

.7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.

.8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Do not order such products until they are accepted in writing by Consultant.

.9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.

.10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance

characteristics) are submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.

.11 Substitution of products supplied by a manufacturer not named as acceptable is not allowed during bid period.

.12 Any proposed changes initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if accepted by Owner and reviewed with Consultant, and costs for review, to be borne by Contractor.

.13 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.

1.14 SHOP DRAWINGS

.1 At start-up meeting, review with Consultant products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.

.2 Submit electronic copies of shop drawings unless otherwise directed by Consultant. Coordinate exact requirements with Consultant.

.3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:

.1 product literature cuts;

.2 equipment data sheets;

.3 equipment dimension drawings;

.4 system block diagrams;

.5 sequence of operation;

.6 connection wiring schematic diagrams;

.7 functionality with integrated systems.

.4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.

.5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.

.6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.

.7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:

.1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;

.2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.

.8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing or product data sheet submitted:

.1 "THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN

INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."

.9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system are to be submitted together.

.10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.

.11 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.

.12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.

.13 Applicable mechanical equipment has been selected to meet energy efficiency requirements of ANSI/ASHRAE/IES 90.1, Energy Standards for Buildings, and shop drawings/product data submittals for such equipment must indicate compliance with this Standard or they will be returned for correction and re-submittal.

1.15 EQUIPMENT LOADS

.1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Consultant, via shop drawing submissions, prior to construction.

.2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.

.3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Review locations of equipment with Consultant prior to construction.

1.16 OPENINGS

.1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.

.2 No openings are permitted through completed structure without written approval from Owner and reviewed with Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.

.3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless directed by Owner and reviewed with Consultant, do not leave any openings unprotected and unfinished overnight.

1.17 SCAFFOLDING, HOISTING AND RIGGING

.1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and reviewed with Consultant.

.2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.

.3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with Consultant.

1.18 CHANGES IN THE WORK

.1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation being proposed cost for executing change or revision.

.2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.

.3 Unless otherwise specified in Division 00 or 01, allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.

.4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to all quotations submitted:

.1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;

.2 material costs are not to exceed those published in local estimating price guides;

.3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;

.4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;

.5 costs for journeyperson and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;

.6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;

.7 costs for rental tools and/or equipment are not to exceed local rental costs;

.8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;

.9 quotations, including those for deleted work, to include a figure for any required change to Contract time.

.5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.

.6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.

.7 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.19 PROGRESS PAYMENT BREAKDOWN

.1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.

.2 Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.

.3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.20 NOTICE FOR REQUIRED FIELD REVIEWS

.1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.

.2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.

.3 Do not conceal work until Consultant advises that it may be concealed.

.4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.21 PRELIMINARY TESTING

.1 When directed by Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.

.2 When, in Consultant’s opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.

.3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.

.4 When, in Consultant’s opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.22 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

.1 Permanent building mechanical systems are not to be used for temporary heating or cooling purposes during construction.

1.23 TEMPORARY SERVICES

.1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary heating, cooling and water. Unless otherwise noted, provide required services in compliance with requirements of local governing building code and local governing inspection authorities.

.2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

1.24 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE

.1 Maintain 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 aluminium tubing.

.4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.

1.25 CLEANING

.1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.

.2 Clean equipment and devices installed as part of this project.

1.26 RECORD AS-BUILT DRAWINGS

.1 Drawings for this project have been prepared on a CAD system using Revit R20. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant.

.2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:

.1 dimensioned location of inaccessible concealed work;

.2 locations of control devices with identification for each;

.3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;

.4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;

.5 location of piping system air vents;

.6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.

.3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant’s comments, to satisfaction of Consultant.

.4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant.

.5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with AutoCAD software release version confirmed with Consultant.

.6 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with Consultant.

.7 For projects with phased turnover of project (refer to Division 01), review with Consultant completeness of as-built drawings prior to turn over of an area. Interim as-built drawings to be made available to Owner's maintenance personnel.

.8 Where part of the Mechanical Scope of Work, retain and pay for services of a land surveyor registered in Place of the Work to measure, verify, and record size, location, invert elevation and pitch of buried piping services, and, when complete, transfer survey work to as-built drawings.

1.27 OPERATING AND MAINTENANCE MANUALS

.1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Consolidate each copy of data as a PDF file on a USB drive. Consolidated O&M manual PDF to include:

.1 front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;

.2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;

.3 equipment manufacturer's authorized contact person name, telephone number and company website;

.4 Table of Contents sheet, and corresponding index tab sheets;

.5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;

.6 Operating data is to include:

.1 pressure test reports, and certificates issued by governing authorities;

.2 description of each system and its controls;

.3 control schematics for equipment/systems including building environmental controls;

.4 wiring and connection diagrams;

.5 if applicable, BAS architecture and all required operating data;

.6 description of operation of each system at various loads together with reset schedules and seasonal variances;

.7 operation instruction for each system and each component;

.8 description of actions to be taken in event of emergencies and/or equipment failure;

.9 valve tag schedule, and flow diagrams to indicate valve locations.

.7 Maintenance data is to include:

.1 operation and trouble-shooting instructions for each item of equipment and each system;

.2 schedules of tasks, frequency, tools required, and estimated task time;

.3 recommended maintenance practices and precautions;

.4 complete parts lists with numbers.

.8 Performance data is to include:

.1 equipment and system start-up data sheets;

.2 equipment performance verification test results, and final commissioning report;

.3 final testing, adjusting and balancing reports.

.9 copies of warranties;

.10 items requested specifically in Section Articles.

.2 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.

.3 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O & M Manual and submit to Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.

1.28 COMMISSIONING

.1 After successful start-up and prior to Substantial Performance of the Work, commission the mechanical work. Commissioning work is the process of Contractor demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or

subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.

.1 Retain services of a testing, adjusting, and balancing agency to perform testing and balancing of mechanical system air/fluid flows and capacities, prior to operational performance testing. Refer to Section 20 05 93 – Testing, Adjusting, and Balancing for Mechanical Systems.

.2 Test, adjust and operate equipment and systems after start-up but before functional performance testing, to confirm operations are in accordance with requirements of Contract Documents. Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.

.3 Repeat successful operational performance testing with completed commissioning data sheet documentation in the presence of Consultant and Owner to validate and verify equipment and systems are complete in all respects, function correctly, and are ready for acceptance.

.4 Submit final commissioning data sheets, TAB reports as specified in Section 20 05 93 – Testing, Adjusting, and Balancing for Mechanical Systems, project closeout documents, and other required submittals.

1.29 WARRANTY

.1 Unless otherwise specified in Divisions 00 and 01, warrant mechanical work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of a Certificate of Substantial Performance of the Work.

.2 Where equipment includes extended warranty period, e.g., 5 years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner. Submit signed and dated copies of extended warranties to Consultant.

.3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer’s authorized technician to provide factory authorized on-site service.

.4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner’s staff or agents is exempted.

.5 Do not include Owner deductible amounts in warranties.

.6 It is understood that warranties are to commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Be responsible for providing whatever "bridging" or additional extended warranty period is required from time that material is purchased until this time.

.7 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:

.1 once during 1st month of building operation;

.2 once during 3rd month of building operation;

.3 once between 4th and 10th month in a season opposite to 1st and 3rd month visits.

1.30 PROJECT CLOSEOUT SUBMITTALS

.1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following as applicable to the project:

.1 Operating and Maintenance Manuals;

.2 as-built record drawings and associated data;

.3 extended warranties for equipment as specified;

.4 operating test certificates, i.e. Sprinkler Test Certificate;

.5 final commissioning report and TAB report;

.6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;

.7 other data or products specified.

1.31 INSTRUCTIONS TO OWNER

.1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.

.2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.

.3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/ suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.

.4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:

.1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;

.2 Troubleshooting – diagnostic instructions, test and inspection procedures;

.3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;

.4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;

.5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.

.5 Before instructing Owner's designated personnel, submit to Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.

.6 Obtain in writing from Consultant list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:

.1 date instructions were given to Owner's staff;

.2 duration of instruction;

.3 names of persons instructed;

.4 other parties present (manufacturer's representative, consultants, etc.).

.7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.

.8 Submit to Consultant copy of electronic version of training materials and include in operating and maintenance manuals submission.

1.32 FINAL INSPECTION

.1 Submit to Consultant, written request for final inspection of systems. Include written certification that:

.1 deficiencies noted during job inspections have been completed;

.2 field quality control procedures have been completed;

.3 systems have been tested and verified, balanced and adjusted, and are ready for operation;

.4 maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted by Owner;

.5 tags and nameplates are in place and equipment identifications have been completed;

.6 clean-up is complete;

.7 spare parts and replacement parts specified have been provided and acknowledged by Consultant;

.8 as-built and record drawings have been completed and submitted to and reviewed with Consultant and accepted by Owner;

.9 Owner's staff has been instructed in operation and maintenance of systems;

.10 commissioning procedures have been completed.

2 Products – Not Used

3 Execution – Not Used

End of Section

1 General

1.1 SUBMITTALS

.1 Shop Drawings/Product Data: Submit shop drawings with product data sheets for variable frequency drives (VFDs). Include:

.1 construction and performance details;

.2 wiring and control schematics;

.3 dimensions of units;

.4 calculations specific to installation showing total harmonic voltage distortion is less than 5%;

.5 certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

.2 Certification Letter: Submit a start-up and installation certification letter from supplier of VFDs as specified in Part 3 of this Section;

.3 Parameters: Prepare list of parameters for uploading for Owner's future use as specified in Part 3 of this Section. Load on USB type flash drive and submit to Consultant.

.4 Extended Warranty: Where extended warranty is specified to be included, include a copy of VFD extended warranty in each Operating and Maintenance Manual. Prior to Substantial Performance of Work, submit a copy of warranty to Owner.

.5 Additionally, coordinate with Prime Contractor and Electrical Contractor to ensure that shop drawings clearly identify that proposed VFDs and connected motors are 100% compatible and Mechanical Contractor to sign off on selected VFDs.

1.2 COORDINATION WITH ELECTRICAL DIVISIONS

.1 This Section specifies VFD requirements for motors. Ensure that VFDs packaged with various system equipment, complies with specifications of this Section.

.2 VFDs are each to be approved by respective manufacturers of VFDs and connected motors, as suitable for installation on scheduled motors. VFD output current rating to match or exceed connected motor nameplate full load current rating.

.3 Coordinate and review with Electrical Divisions, responsibility requirements for supply of VFDs, harmonic filters and requirements for control and power conductors and connections.

.4 Check that motors are equipped with AEGIS or approved equal, shaft grounding ring system to protect bearings from damage in motors by diverting harmful shaft voltages and bearing currents to ground.

.5 Additionally, review and confirm responsibilities with Consultant and Prime Contractor.

2 Products

2.1 VFD BASIC REQUIREMENTS

.1 VFDs supplied on project to be products of same manufacturer and be CSA approved, ULC listed and labelled. Base specified product is ABB ACH series units that include compliance with following standards:

.1 CSA C22.2 No.14 Industrial Control Equipment;

.2 UL 508 - Industrial Control Equipment;

.3 UL 508C – Power Conversion Equipment;

.4 NEMA ICS 7 - Adjustable-Speed Drives.

.2 Basis for limiting harmonics is to be provided generally to IEEE Standard 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, except intended for user's electrical distribution system with point of common coupling (where harmonic limits are assessed) to be set at input terminals of harmonic mitigating equipment.

.3 VFDs to include following basic requirements:

.1 regardless of HP rating are to be of same VFD model; I/O and control circuit boards as well as keypads are to be identical and interchangeable regardless of HP rating;

.2 to be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without safety tripping or component damage (flying start);

.3 6-pulse width modulated (PWM) AC to AC converter utilizing latest isolated gate bipolar transistor (IGBT) technology; PWM switching pattern to include a motor flux optimization circuit that automatically reduces applied motor voltage to the motor to optimize energy consumption and audible motor noise;

.4 carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency without derating VFD or operating at high carrier frequency only at low speeds;

.5 provisions that determines motor torque and flux every 25 microseconds (40,000 times per second);

.6 completely assembled and tested by manufacturer in their facility;

.7 designed to provide at least 250,000 hours mean time before failure (MTBF) when specified preventative maintenance is performed.

.8 door interlocked padlockable disconnect switch that disconnects all input power from drive and all internally mounted options;

.9 control panel keyboard and display with password protection against parameter changes.

2.2 VFD RATINGS

.1 VFDs to be rated to operate from 3 phase input voltage of 208 or 600 volts ± 10%, as scheduled, 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 96% 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 with drip shield;

.2 in non-climate controlled areas – NEMA 3R.

2.3 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.

2.4 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 set point 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 set points, etc; independent, second PID loop that can utilize second analogue input and modulate analogue outputs to maintain set point of an independent process (ie. valves, dampers, etc.); set points, 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 fireman’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 fireman’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.

.2 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 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 l 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;

.5 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.

2.5 PROTECTIVE FUNCTIONS

.1 For each programmed warning and fault protection function, keypad displays a message in complete words or standard abbreviations.

.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 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 undervoltage 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 Overtemperature protection to provide a warning if power module temperature is less than 5C° (9F°) below overtemperature trip level.

.10 Input terminal to be provided for connecting a motor thermistor (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 dv/dt long lead filter (LRC) to protect power system network.

.14 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 Undervoltage;

.4 Analogue input signal reference loss;

.5 External fault.

.15 Additional built-in protection circuits include:

.1 Overcurrent trip limit;

.2 Undervoltage 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.

2.6 COMMUNICATIONS

.1 VFD to be complete with communications connections of integrated RS-485 port suitable to allow for VFD to be controlled, supervised, monitored and programmed from one remote control panel or PC with VFD system Windows based application software.

.2 Communications protocol to be industry standard compatible to BAS of building. Coordinate exact requirements with Mechanical Divisions controls contractor and BAS vendor to ensure that appropriate interface module is supplied for drive system to communicate with BAS being used in building with interface capability to include serial communication standard protocols as follows:

.1 BACnet.

.3 Serial communication to be used for drive setup, diagnostic analysis, monitoring and control with capabilities to include, but not be limited to:

.1 run-stop control;

.2 speed set adjustment;

.3 proportional/integral/derivative PID control adjustments;

.4 current limit;

.5 accel/decel time adjustments;

.6 ability to lock and unlock control panel keypad;

.7 capability of allowing BAS to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature;

.8 monitoring relays output status, and digital input status and analogue output values;

.9 transmitting diagnostic warning and fault information over communications bus to BAS or other monitoring system;

.10 remote fault reset.

2.7 WARRANTY

.1 VFDs to be warranted free from defective labour and materials for period of 36 months from date of Substantial Performance of the Work. Include for initial one year Contract warranty and an additional 2 year extended warranty direct to Owner. Extended warranty terms and conditions are to be identical to one year Contract warranty, and extended warranty period is to commence day Contract warranty expires.

2.8 SITE SERVICES, TRAINING, AND MAINTENANCE MANUALS

.1 Provide onsite inspection, testing, start up and verification work of VFDs and filters by manufacturer's authorized technician. Allow a minimum of 1/2 day per system. Also include for a second visit to site of one (1) day duration to train operating personnel in operation and maintenance of drives. Provide verification reports and supply soft copy of system programming parameters.

.2 Upon completion of installation, supplier of VFDs to supply minimum one hard copy of complete sets of service and maintenance manuals including wiring and connection diagrams. Include for digital copy loaded onto a USB type flash drive.

.3 Provide system training and instructions on operating and maintenance procedures. Refer to additional requirements in General Instructions section and Division 01.

2.9 ACCEPTABLE MANUFACTURERS

.1 Acceptable VFD manufacturers are:

.1 ABB;

.2 Schneider Electric (Square D);

.3 Rockwell Automation;

.4 Eaton Cutler Hammer;

.5 Siemens Electric;

.6 Control Techniques.

3 Execution

3.1 INSTALLATION OF VARIABLE FREQUENCY DRIVES

.1 Provide variable frequency drives for motorized equipment in accordance with drawing requirements. Coordinate requirements for conductors and connections with Electrical Divisions Contractor.

.2 Ensure that variable speed drives supplied are products of same manufacturer.

.3 Ensure wire length between VFD and motor is less than 15 m (50') with properly sized conductors.

.4 Install VFDs in accordance with manufacturer's instructions. Ensure that VFDs installation include upstream protection, either fuses or circuit breakers in accordance with VFD manufacturer's recommendations and local electrical code requirements. Advise Electrical Divisions Contractor of these requirements in addition to required conductors and connections. Provide required control wiring and connections.

.5 Review VFD and related connected motor installation. Provide local disconnect to VFD in accordance with local governing code requirements.

.6 Mount VFDs operating controls/display at approximately 1.5 m (5') above finished floor level, unless otherwise directed by Consultant. Provide dual back to back C-channel support system from floor to ceiling, complete with cross bracing to form a solid backing for VFD mounting at required locations.

.7 Properly support VFDs. Coordinate exact locations on site with Consultant.

.8 Where VFDs are required for commercial fans, mount each VFD generally where shown but with exact location to ensure that VFD is accessible in accordance with local governing electrical code requirements. "Line" and "load" side power wiring to these VFD's to be provided as part of Electrical Divisions work.

.9 Ground and bond equipment as per local governing electrical code requirements and manufacturer's instructions.

.10 Provide engraved lamacoid nameplate identifying each piece of equipment. Review exact nomenclature with Consultant.

.11 Be responsible for ensuring that VFDs and connected motors are properly installed, connected, tested in proper working order and operation verified.

3.2 TESTING, START-UP, AND VERIFICATION

.1 When installation of VFDs are complete, arrange for VFD manufacturer/supplier to:

.1 supply factory authorized technician at site for minimum of 4 hours per system to examine installation and connection of each VFD, and to perform start-up and set-up procedures in conjunction with equipment start-up and testing procedures;

.2 supply factory authorized technician at site for minimum of one 8 hour day to train Owner's personnel on VFD operating and maintenance procedures;

.3 prepare and submit letter to certify that VFDs have been properly installed, tested and adjusted, and are in proper operating condition;

.4 submit list of start-up and testing parameters for uploading for future use by Owner.

.2 Start-up data entries to include motor nameplate power, speed, voltage, frequency and current.

.3 Inspect VFDs and accessories for verification of proper operation and installation.

.4 Inspect interface wiring to BAS for verification of proper operation and installation.

.5 Verification of wire terminations to VFDs and bypass and to operational circuitry.

.6 Installation verification of VFD, bypass and motor being driven for proper operation and reliability.

.7 Verification that connections and communications to BAS or other monitoring/remote control system are of proper operation and installation and of full communications compatibility.

.8 Measurement for verification of proper operation on each of following items:

.1 Motor voltage and frequency;

.2 Verification of proper motor operation;

.3 Control input for proper building automation system interface and control calibration.

.9 Calibration check for following set points (and adjustment as necessary):

.1 minimum speed;

.2 maximum speed;

.3 acceleration and deceleration rates.

.10 Verify harmonic compliance with onsite field measurements of both voltage and current harmonic distortion at point of common coupling-input terminals of harmonic mitigating equipment with and without equipment operating. Utilize recording type Fluke 41 or equivalent harmonics analyser displaying individual and total harmonic currents and voltages.

.11 Document testing and results in a report signed by a Professional Engineer licensed in the Place of Work and authorized by system manufacturer. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review.

.12 Additionally, refer to applicable installation, testing, coordination and verification requirements in Electrical Divisions Sections.

End of Section

1 General

1.1 APPLICATION

.1 This Section specifies firestopping and smoke seal requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 SUBMITTALS

.1 Submit a product data sheet and a WHIMIS sheet for each firestopping and smoke seal product.

.2 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.

.3 Submit a letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

1.3 QUALITY ASSURANCE

.1 Applicator is to have a minimum of 3 years of successful experience on projects of similar size and complexity, and applicator's qualifications are to be reviewed by Consultant.

.2 Comply with firestopping and smoke seal product manufacturer’s recommendations regarding suitable environment conditions for product installation.

2 Products

2.1 FIRESTOPPING AND SMOKE SEAL SYSTEM MATERIALS

.1 Ensure all sealant and fire stopping is low VOC type in accordance with LEED.

.2 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with ULC S115 and ULC S101 for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than fire resistance rating of surrounding fire rated construction.

.3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer’s recommendations and ULC tested assembly.

.4 Pipe insulation forming part of a fire and smoke seal assembly is specified in Section entitled Mechanical Insulation.

.5 Acceptable manufacturers are:

.1 A/D Fire Protection Systems "FIREBARRIER";

.2 Tremco Inc. Fire Protection Systems Group "TREMSTOP";

.3 3M Canada;

.4 Hilti (Canada) Ltd. Firestop Systems;

.5 Specified Technologies Inc.

3 Execution

3.1 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

.1 Where mechanical work penetrates fire rated construction, provide ULC listed and labelled firestopping and smoke seal materials installed in accordance with requirements of ULC S115, ULC S101, and other governing authorities to seal penetrations.

.2 Abide by following requirements:

.1 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is to be installed. Confirm compatibility of surfaces.

.2 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.

.3 Report any unsuitable or unsatisfactory conditions to Contractor and Consultant in writing, prior to commencement of work. Commencement of work will mean acceptance of conditions and surfaces.

.4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces. Remove stains on adjacent surfaces.

.3 Conform to following application requirements:

.1 Prime substrates in accordance with product manufacturer's written instructions.

.2 Provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing.

.3 Tool or trowel exposed surfaces to a neat, smooth, and consistent finish.

.4 Remove excess compound promptly as work progresses and upon completion.

.5 At fusible link damper locations, seal perimeter of angle iron framing on both sides of wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal.

.4 Notify Consultant when work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of work by Municipal Building Inspector prior to concealing or enclosing work. Make any corrections required.

.5 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to mechanical service penetrations and that installation has been done in strict accordance with requirements of Provincial Building Code, any applicable local Municipal Codes, ULC requirements, and manufacturer's instructions.

End of Section

1 General

1.1 APPLICATION

.1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 SUBMITTALS

.1 Submit copies of manufacturer's product data sheets for products specified in this Section. Product data sheets are to include product characteristics, limitations, dimensions, finishes, and installation recommendations.

.2 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

1.3 SEISMIC RESTRAINT REQUIREMENTS

.1 Where applicable to the project, refer to Section 20 05 48.16 "Seismic Controls for Mechanical Systems" for requirements for the use of a Seismic Consultant and seismic restraint requirements required for vibration isolated materials and equipment.

2 Products

2.1 GENERAL

.1 Vibration isolation products are to be in accordance with the most recent edition of the ASHRAE Handbook and/or as indicated on drawings, schedules, details, and as specified below.

.2 Springs are to be stable, colour coded, selected to operate at no greater than ⅔ solid load, designed in accordance with Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with manufacturer's recommendations to suit static deflection and maximum equipment load.

.3 Steel components of isolation products not exposed to the weather or moisture are to be zinc plated. Steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and 2 coats of neoprene.

.4 Where weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.

.5 Seismic rated isolators and snubbers are to be listed, rated, and approved by State of California Office of Statewide Health and Planning Department (O.S.H.P.D.) and carry an O.S.H.P.D. pre-approved number. Seismic restraints supplied with vibration isolation are to meet requirements specified in Section entitled Seismic Control and Restraint.

.6 Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification.

2.2 ISOLATION PADS

.1 Sandwich type pads, 20 mm (¾") nominal thickness, selected for 3.2 mm (1/8") static deflection unless otherwise specified, consisting of 2 waffle type or ribbed 50 durometer neoprene pads permanently bonded to a minimum #10 gauge steel plate, and complete with rubber bushed bolt holes and equipment anchor bolts with neoprene isolation grommets.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type NSN;

.2 The VMC Group Vibration Mounting & Controls Inc. (Korfund-Dynamics) "SHEAR-FLEX PLATES";

.3 Kinetics Noise Control Vibron Products Group Type NGS/NGD;

.4 Mason Industries Inc. Type SW/S/SW with HG Bolt Insertion Washers;

.5 J. P. America Inc. Type JSJ.

2.3 RUBBER FLOOR ISOLATORS

.1 Captive, bridge bearing quality neoprene mount selected for a minimum 4 mm (0.15") static deflection unless otherwise specified, with an integral ductile iron housing and integral equipment anchor bolt.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type R;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type RSM;

.3 Kinetics Noise Control Vibron Products Group Type RQ;

.4 Mason Industries Inc. Type BR;

.5 J. P. America Inc. Type TRM.

2.4 SPRING FLOOR ISOLATORS

.1 Seismically rated captive spring mount isolator complete with levelling bolts, upper and lower neoprene spring cups, neoprene cushion, ductile iron housing, neoprene sound pads, and neoprene isolation grommets for securing bolts.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type SFS;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type AMSR;

.3 Kinetics Noise Control Vibron Products Group Type FLSS;

.4 Mason Industries Inc. Type SSLFH;

.5 J. P. America Inc. Type TSO-C-SC.

2.5 OPEN SPRING MOUNTS

.1 Base mount free-standing assemblies, each complete with a stable colour coded steel spring welded in place, drilled mild steel mounting plate bonded to a ribbed rubber or neoprene acoustical pad, and an external 16 mm (5/8") diameter level adjustment bolt.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type FS;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type A;

.3 Kinetics Noise Control Vibron Products Group Type FDS;

.4 Mason Industries Inc. Type SLFH;

.5 J. P. America Inc. Type TSO.

2.6 CLOSED SPRING MOUNTS

.1 Base mount free-standing enclosed assemblies, each complete with stable colour coded spring(s), 2 piece cast housing, non-binding rubber horizontal stabilizers, a ribbed rubber or neoprene acoustical pad bonded to base of the closed housing, and an external level adjustment bolt.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type CM;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Types B and C;

.3 Kinetics Noise Control Vibron Products Group Type FLS;

.4 Mason Industries Inc. Type C;

.5 J. P. America Inc. Type TSC.

2.7 TOTALLY RETAINED SPRING MOUNTS

.1 Base mount free-standing enclosed and retained assemblies to limit both vertical and lateral movement of mounted equipment, each complete with stable colour coded spring(s), drilled welded steel housing and top plate, ribbed rubber or neoprene acoustical pad bonded to bottom of housing, vertical limit adjusting hardware, and a level adjustment bolt.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type CSR;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type MS;

.3 Kinetics Noise Control Vibron Products Group Type SM;

.4 Mason Industries Inc. Type SLRSO;

.5 J. P. America Inc. Type TSR.

2.8 SPRING HANGERS

.1 Welded steel plate housing with top and bottom rod mounting holes and spring retainer, neoprene double deflection isolation element, stable colour coded spring, and heavy-duty rubber washers.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type SHR-SN;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Series HRSA;

.3 Kinetics Noise Control Vibron Products Group. Type SRH;

.4 Mason Industries Inc. Type 30N;

.5 J. P. America Inc. Type TSH.

2.9 NEOPRENE HANGER ISOLATORS

.1 Neoprene double deflection rod isolators with steel housing and hanger rod bushing, selected for a minimum 4 mm (0.15") static deflection unless otherwise specified.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type NH;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type HR;

.3 Kinetics Noise Control Vibron Products Group Type RH;

.4 Mason Industries Inc. Type HD or WHD;

.5 J. P. America Inc. Type TRH.

2.10 CONCRETE INERTIA TYPE EQUIPMENT BASE

.1 Welded steel bases, each complete with a structural black steel channel frame, concrete reinforcing rods, and brackets for spring mounts welded to frame.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type CIB;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type CPF;

.3 Kinetics Noise Control Vibron Products Group. Type CIB;

.4 Mason Industries Inc. Type KSL;

.5 J. P. America Inc. Type BCI.

2.11 STEEL EQUIPMENT BASE

.1 Fully welded structural steel equipment and motor support bases, each complete with a wide flange steel frame, full depth cross members, brackets for spring mounts, and adjustable motor slide rails.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type SB;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type WFB;

.3 Kinetics Noise Control Vibron Products Group Type SFB;

.4 Mason Industries Inc. Type WFSL;

.5 J. P. America Inc. Type BWS (with motor slide rail).

2.12 COMBINATION STEEL /CONCRETE INERTIA EQUIPMENT BASE

.1 Welded steel bases with a structural black steel channel frame, concrete reinforcing rods, bottom sheet steel pan, brackets for spring mounts welded to frame and adjustable motor slide rails.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type CIB (with motor slide rails);

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type WPF (with motor slide rails);

.3 Kinetics Noise Control Vibron Products Group Type CIB (with motor slide rails);

.4 Mason Industries Inc. Type BMK or K;

.5 J. P. America Inc. Type BSI (with motor slide rail).

2.13 SLUNG STEEL BASE

.1 Slung steel bases of structural members with gusset plates welded to ends and complete with adjustable motor slide rails and vertical section size to suit equipment’s motor power output.

.2 Acceptable products are:

.1 Vibro-Acoustics Ltd. Type SS;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type CPF;

.3 Kinetics Noise Control Vibron Products Group Type CIB-H;

.4 Mason Industries Inc. Type MSL.

3 Execution

3.1 INSTALLATION OF VIBRATION ISOLATION MATERIALS

.1 Unless otherwise stated in the drawings, schedules and/or typical details, vibration isolation is to be provided for all mechanical equipment as per the recommendations contained within in the most recent edition of the ASHRAE Handbook.

.2 Supply to vibration isolation product manufacturer or supplier a copy of a "reviewed" shop drawing or product data sheet for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated.

.3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.

.4 Ensure vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.

.5 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolated area of the isolated equipment. Additional requirements are as follows:

.1 block and shim bases level so ductwork and piping connections can be made to a rigid system at proper operating level, before isolated adjustment is made, and ensure there is no physical contact between isolated equipment and building structure;

.2 steel bases are to clear the sub-base by 25 mm (1");

.3 concrete bases are to clear the sub-base by 50 mm (2").

.6 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:

.1 for pipe less than or equal to 100 mm (4") dia. – first 3 points of support;

.2 for pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;

.3 for pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;

.7 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").

.8 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.

.9 Where it is impossible to use at least 2 spring hangers, provide Senior Flexonics Ltd. Style 102 (or 102-U as required) or equal, twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable in all respects for intended application, and complete with required nipples and connections to provide proper vibration isolation.

.10 For control wiring connections to vibration isolated equipment ensure flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to Consultant.

.11 Arrange and pay for vibration isolation product manufacturer to visit site to inspect installation of his equipment. Perform revision work required as a result of improper installation. When vibration isolation equipment manufacturer is satisfied with the installation, obtain and submit a letter stating manufacturer has inspected the installation and equipment is properly installed.

.12 Refer to Section entitled Seismic Control and Restraint for requirements pertaining to seismically restrained vibration isolation.

End of Section

1 General

1.1 APPLICATION

.1 This Section specifies seismic control and restraint requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 SEISMIC CONSULTANT

.1 Retain and pay for services of an experienced Seismic Consultant who is a registered professional engineer licensed in the jurisdiction of the work and a member in good standing of a Professional Engineers Association in the jurisdiction of the work.

.2 Seismic Consultant is to:

.1 determine proper seismic hazard level, design, recommend, and review proposed mechanical work seismic restraint shop, placement and securing drawings, and sign and stamp drawings prior to submittal for review as specified below;

.2 supervise installation of mechanical work seismic restraint and, when work is complete, certify in writing that seismic restraint work has been installed in accordance with signed, stamped and reviewed drawings;

.3 prepare and submit to Municipality and authorities having jurisdiction, on a form approved by Municipality and authorities having jurisdiction, at the beginning of seismic restraint work and when work is complete, original signed and sealed Letters of Assurance for design, installation and field review of seismic restraint work.

1.3 SUBMITTALS

.1 Obtain required equipment information and submit manufacturer's shop drawings/product data sheets for restraining devices and steel bases. Include placement data, and details of attachment to both equipment and structure meeting requirements of forces involved. Product data sheets and drawings are to be signed and stamped by Seismic Consultant referred to above.

.2 Submit copies of Seismic Consultant's Letters of Assurance as specified above.

.3 Submit copies of Seismic Consultant and seismic control manufacturer's certification letters as specified in Part 3 of this Section.

.4 If requested, submit samples of seismic restraint materials for review.

1.4 QUALITY ASSURANCE

.1 Seismic restraints are to be designed by a registered professional engineer as specified above, and are to be installed by qualified tradesmen under supervision of and to the approval of the design engineer.

.2 Unless otherwise specified, seismic control and restraints are to be designed in accordance with Code requirements, ANSI/SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, SMACNA/ASHRAE Service Restraint Applications CD-ROM, and the P.P.I.C. Manual Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems, all of which are to form a part of this Section.

.3 Seismic control and restraints for fire protection piping and equipment are to be in accordance with NFPA requirements. When specified and/or required, design is also to include Factory Mutual requirements.

.4 Restraint products must be tested in an independent testing laboratory, or certified by Seismic Consultant, to confirm restraint products meet requirements of this Section, i.e. dynamic ultimate limit load state as required by Code, "Fail Safe" design, etc. If particular tests are carried out to represent a restraint type, test is to be valid for the full load range of the restraint. Submit such tests or certification when requested.

.5 Seismic control and restraint product manufacturers are to provide required assistance during installation, and, when installation is complete, submit written reports listing any deficiencies to the installation.

2 Products

2.1 GENERAL

.1 Isolation, anchors, bolts, bases, restraints, etc., are to be designed to withstand without failure or yielding, the dynamic G load as specified in Code for the seismic zone in which building is located. Design loads are ultimate limit state loads (1.5 times working load) acting through the centre of gravity of the anchored or restrained equipment. "Fail Safe" designs are acceptable.

.2 For both isolated and non-isolated floor mounted equipment, i.e. tanks, heat exchangers, boilers, etc., design and provide anchors and bolts to withstand, without failure or yielding, a dynamic ultimate limit state load as defined in Code, of the greater of 0.3 g or as required by Code, applied horizontally through the centre of gravity.

.3 Where impact forces may be significant, use ductile materials.

.4 Seismic restraining devices factory supplied with equipment are to meet requirements of this Section.

.5 Acceptable manufacturers are:

.1 Mason Industries Inc.;

.2 Kinetics Noise Control;

.3 Vibro-Acoustics Ltd;

.4 Price Industries Inc.

2.2 SLACK CABLE RESTRAINTS

.1 Aircraft cable galvanized slack cable restraints meeting current requirements of Building Code, sized to suit the application and complete with required cable ties, anchor hardware (selected for a load equal to twice the weight of the equipment), and similar connection accessories.

2.3 ANCHOR BOLTS

.1 Equal to Mason Industries type SAB seismic anchor bolts.

2.4 FLEXIBLE PIPING CONNECTIONS

.1 Flexible piping connectors are to be supplied with seismic restraint materials. Where flexible connections are not specified with piping in other Sections they are to be equal to Mason Industries twin sphere, non-metallic connectors with hose lengths preset in strict accordance with manufacturer's instructions and to approval of Seismic Consultant, each rated for continuous operation at 1725 kPa at 87.7°C (250 psi at 190°F) or 1380 kPa at 121°C (200 psi at 250°F), and complete with:

.1 nylon tire cord reinforced EPDM body;

.2 ductile iron reinforcing ring and ductile iron screwed or flanged connections as required and to suit piping system operating pressure.

2.5 VIBRATION ISOLATION PRODUCTS

.1 Refer to Section “20 05 48.13 - Vibration Controls for Mechanical Systems”.

3 Execution

3.1 INSTALLATION OF SEISMIC RESTRAINT MATERIALS

.1 Provide seismic restraint for mechanical equipment, piping, and ductwork, including diffusers, grilles, etc., as per requirements of current edition of Building Code and this Section of the Specification.

.2 Following Mechanical Components Restraint Guide is to be used as a general guide only to establish appropriate restraint methods, hardware, and attachments, however, due to differences in construction, size, weight, and configuration of different manufacturer's equipment and variety of ways and means that equipment and

components can be installed, specific restraint methods are to be confirmed in the field. Seismic restraint materials and methods are to be reviewed and approved by Seismic Consultant.

MECHANICAL COMPONENT RESTRAINT GUIDE

ITEM	TYPE OF RESTRAINT	MINIMUM NO. OF RESTRAINTS	NOTES
In-line Pumps	SCR	2	Pipe mounted type pump
Pumps Non-Isolated	BTHP	4	Base mount type pump
Pumps Isolated	SNBR	4	Base mount type pump
Expansion Tanks	SCR	4	
D.H.W. Tanks	SCR	4	Attach to removable steel strap yoke
Unit Heaters	TSR-SCR	4	
Force Flow Heaters	TSR-SCR	4	
AHU's and A/C Units Free Standing			
- With Base	BTHP	4	
- Without base	CSSB	4	
AHU's and A/C Units Suspended			
- Isolated	SCR	4	
- Non-Isolated	SCR	4	
Packaged Rooftop Air Units (all types)			
On roof curb	BTRC	4	Roof curb bolted to roof.
Electronic Humidifiers		4	Bolt stand to housekeeping pad or structure.
Fans – Suspended			
- Isolated	SCR	4	
- Non-Isolated	SCR	4	
Fans – Freestanding			
- Isolated	SNBR	4	
- Non-Isolated	BTHP	4	
Grilles, Registers, Diffusers	SCR	4	Where not bolted to duct (i.e. in tee-bar ceilings)
Airflow Control Valves	SCR	4	Where suspended

ITEM	TYPE OF RESTRAINT	MINIMUM NO. OF RESTRAINTS	NOTES
Piping	SCR TSR	As required	As per Specification
Ductwork	SCR TSR	As required	As per Specification

LEGEND	
SCR	Slack cable restraint (bolted to structure)
SNBR	Seismic snubber (bolted to structure)
TSR	Threaded support rod (bolted or clamped to structure)
BTSLPR	Bolt to sleeper (sleeper bolted to structure)
BTHP	Bolt to concrete housekeeping pad (pad to be keyed to structure)
CSSB	Custom steel shoe base (bolted to structure)
BTRC	Bolt to roof curb (roof curb bolted to roof structure)

.3 Provide structural steel bases for equipment unless equipment manufacturer certifies direct attachment capabilities.

.4 Space restraints under equipment so minimum distance between adjacent corner restraints is at least equal to the height of the centre of gravity of the equipment. Include the height of the centre of gravity on shop drawings, otherwise, design for increased forces on supports and submit design calculations with shop drawings. In particular, chillers are to meet this requirement.

.5 Floor mounted isolated equipment is to be installed on 100 mm (4") high concrete housekeeping pads with at least 200 mm (8") clearance between drilled inserts and edges of pads. Ensure housekeeping pads are keyed to structure to resist seismic displacement.

.6 Requirements pertaining to seismic control work are as follows:

.1 execute seismic control and restraint work in accordance with drawing details, reviewed shop drawings, ANSI/SMACNA Seismic Restraint Manual, PIPC Manual: Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems, and National Uniform Seismic Installation Guidelines (NUSIG);

.2 seismic control systems are to work in all directions;

.3 fasteners and attachment points are to resist same maximum load as the seismic restraint;

.4 drilled or power driven anchors and fasteners are not permitted;

.5 no equipment, equipment supports or mounts are to fail before failure of structure;

.6 supports of cast iron or threaded pipe are not permitted;

.7 seismic control measures are not to interfere with integrity of firestopping;

.8 equipment is to be bolted to structure, and bolts are to be fitted with isolation washers;

.9 number, size, type, and installation of anchor bolts are to be as recommended by anchor bolt manufacturer and seismic design consultant;

.10 where more than a 3 mm (1/8") differential exists between an anchor or attachment bolt diameter, an anchor and attachment point hole, or an isolator gap attachment bolt and equipment anchor attachment hole, pack air gap with Mason type 0.5 FastSteel reinforced epoxy putty;

.11 hung equipment and pipe hangers are to be fitted with a means of preventing upward movement, and non-isolated equipment and pipe hanger rods are to be fitted with oversized steel washers and nuts above and below hanger or equipment attachment point, locked tight to prevent uplift of equipment or hanger;

.12 where suspended equipment hanger rod length exceeds 50 rod diameters between structure and equipment attachment point, reinforce rods with angle iron to prevent bending due to uplift forces;

.13 seismic control measures are not to jeopardize noise and vibration isolation systems, and 6 mm (¼") to 9 mm (3/8") clearance during normal operation of equipment and systems is to be provided between seismic restraint and equipment;

.14 where hold-down bolts for seismic restraint equipment penetrate roofing membranes coordinate with roofing trade for installation of pitch pockets/"gum cups" and sealing compound to maintain water-tight integrity of roof;

.15 where friction type clamps are used for support of equipment and connecting services, secure clamps to steel work by means of welding or other positive means to prevent slippage or loosening of clamps due to seismic forces.

.7 Provide slack cable restraint assemblies for:

.1 steam piping 32 mm (1-¼") dia. and larger;

.2 fuel gas, fuel oil, medical gas, compressed air and service piping 25 mm (1") dia. and larger;

.3 piping 32 mm (1-¼") dia. and larger located in boiler, fan, chiller, and similar equipment rooms;

.4 horizontal and vertical piping 65 mm (2-½") dia. and larger;

.5 ductwork and duct mounted equipment;

.6 isolated and non-isolated ceiling hung fans, tanks, equipment, etc.;

.7 generator exhaust system(s).

.8 Installation requirements for slack cable restraints include following:

.1 connect slack cable restraints to ceiling hung equipment in such a way that axial projection of wires passes through the centre of gravity of the equipment;

.2 orient restraint wires on ceiling hung equipment at approximately 90º to each other (in plan), and tie back to the ceiling slab at an angle not exceeding 45º to slab;

.3 install cables using appropriate grommets, shackles, and other hardware to ensure alignment of restraints and to avoid bending cables at connection points, and, where feasible, wrap cables directly around pipes as opposed to using collars;

.4 for piping systems, provide transverse slack cable restraints at a maximum spacing of 12.5 m (40'), and longitudinal restraints at 25 m (80') maximum spacing, or as limited by anchor/slack cable performance;

.5 for piping less than 250 mm (10") dia., reduce transverse restraint spacing to 6 m (20'), and note that smaller piping may be rigidly tied to larger piping for restraint, but not the reverse;

.6 vary adjacent spacing of restraints on a piping run by 10% to 30% to avoid coincident resonance;

.7 transverse bracing for one pipe section may also act as longitudinal bracing for piping connected perpendicular to it if bracing is installed within 600 mm (24") of elbow or tee, and if connected piping is same or smaller dia., and note that branch lines are not to be used to restrain main lines;

.8 provide flexibility in piping joints or sleeves where piping penetrates building seismic or expansion joints;

.9 wherever possible, support weight of vertical piping risers at a point or points above the centre of gravity of riser, and provide lateral guides at top and bottom of riser, and at intermediate points not to exceed the transverse spacing specified above for horizontal pipes, with guide clearance not exceeding 3 m (10');

.10 install restraints at least 50 mm (2") clear of other equipment and services;

.11 adjust restraint cables such that they are not visibly slack, or such that flexibility is approximately 40 mm (1-½") under thumb pressure for a 1.5 m (5') cable length, with an equivalent ratio for other cable lengths, and adjust clearance of cable strap/spacer piece restraints so as not to exceed 6 mm (0.23");

.12 provide transverse and axial restraints within 4 m (12') of a vertical bend;

.13 at steel trusses, connect to top chords at panel points and follow truss manufacturer's instructions;

.14 diffusers and grilles mounted in t-bar ceilings or which are not positively secured to ductwork or structure are to be fitted with slack cable restraints to prevent them from falling in the event the ceiling t-bar grid is displaced;

.15 do not bridge vibration isolators with slack cable restraints;

.16 other approved restraint systems are conventional pipe guides, rigid restraint where piping passes through a block or concrete wall, or a cable strap and spacer piece attached to structure and used where piping is adjacent to a wall and conventional slack cable restraints cannot be used.

3.2 INSTALLATION OF FLEXIBLE PIPING CONNECTORS

.1 Supply flexible piping connectors for connections (including plumbing) to seismically restrained equipment. Hand connectors to appropriate piping trade at site for installation.

3.3 SITE INSPECTION AND LETTERS OF CERTIFICATION

.1 When seismic control products have been installed, arrange for seismic control product manufacturer and Seismic Consultant to examine installation of seismic control products and to certify in writing (separate letters) that

products have been properly installed in accordance with governing Codes and Regulations, and recommendations and instructions. Seismic Consultant is to apply his professional stamp to the letter.

End of Section

1 General

1.1 SECTION INCLUDES

.1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 DEFINITIONS

.1 "Agency" – means agency to perform testing, adjusting and balancing work.

.2 "TAB" – means testing, adjusting and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.

.3 "air systems" – includes outside air, supply air, return air, exhaust air, and relief air systems.

.4 "flow rate tolerance" – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.

.5 "report forms" – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting and balancing.

.6 "terminal" – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

.7 "main" – means duct or pipe containing system's major or entire fluid flow.

.8 "submain" – means duct or pipe containing part of the systems' capacity and serving 2 or more branch mains.

.9 "branch main" – means duct or pipe servicing 2 or more terminals.

.10 "branch" – means duct or pipe serving a single terminal.

1.3 SUBMITTALS

.1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.

.2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.

.3 Submit a report by Agency to indicate Agency's evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.

.4 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.

.5 Submit a draft report, as specified in Part 3 of this Section.

.6 Submit a final report, as specified in Part 3 of this Section.

.7 Submit a testing and balancing warranty as specified in Part 3 of this Section.

.8 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

.1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:

.1 AABC - Associated Air Balance Council;

.2 NEBB - National Environmental Balancing Bureau.

.2 Testing, adjusting and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with 1 of following publications:

.1 National Standards for a Total System Balance published by Associated Air Balance Council;

.2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;

.3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

2 Products – Not Used

3 Execution

3.1 SCOPE OF WORK

.1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting results.

.2 Mechanical systems to be tested, adjusted and balanced include:

.1 TAB of domestic water systems (all piping extended from Municipal main) is to include:

.1 domestic hot water recirculation piping;

.2 tempered water piping flows.

.2 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities and flows.

3.2 TESTING, ADJUSTING, AND BALANCING

.1 Conform to following:

.1 as soon as possible after award of Contract, Agency is to carefully examine a set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;

.2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;

.3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing;

.4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;

.5 testing, adjusting and balancing is not to begin until:

.1 building construction work is substantially complete and doors have been installed;

.2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.

.6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;

.7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;

.8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;

.9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;

.10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;

.11 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;

.12 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;

.13 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of ±5% of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;

.14 Agency is to perform testing, adjusting and balancing to within ±5% of design values, and make and record measurements which are within ±2% of actual values;

.15 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;

.16 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.

.2 Prepare reports as indicated below.

.1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports and submit for review.

.2 Upon verification and approval of draft reports, prepare final reports organized and formatted as specified below. Use units of measurement (SI or Imperial) as used on Project Documents.

.3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Report forms complete with schematic systems diagrams and other data are to be consolidated in electronic format as a PDF. PDF file to be indexed and organized into sections, as it applies to the project, as follows:

.1 General Information and Summary;

.2 Air Systems;

.3 Temperature Control Systems;

.4 Special Systems.

.4 Agency is to provide following minimum information, forms and data in report:

.1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;

.2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;

.3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;

.4 Agency is to include report sheets indicating building comfort test readings for all rooms.

.3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.

.4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to Owner.

.5 After acceptance of final report, Agency is to perform post testing and balancing site visits in accordance with following requirements:

.1 post testing and balancing site visits are to be made:

.1 once during first month of building operation;

.2 once during third month of building operation;

.3 once between fourth and tenth months in a season opposite to first and third month visit.

.2 during each return visit and accompanied by Owner’s representative, Agency is to spot rebalance terminal units as required to suit building occupants and eliminate complaints;

.3 Agency is to schedule each visit with Contractor and Owner, and inform Consultant;

.4 after each follow-up site visit, Agency is to issue to Contractor and Consultant a report indicating any corrective work performed during visit, abnormal conditions and complaints encountered, and recommended corrective action.

End of Section

1 General

1.1 APPLICATION

.1 This Section specifies insulation requirements common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly.

1.2 DEFINITIONS

.1 "concealed" – means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.

.2 "exposed" – means exposed to normal view during normal conditions and operations.

.3 "mineral fibre" – includes glass fibre, rock wool, and slag wool.

.4 "domestic water" or "potable water" – means piping extended from building Municipal supply main.

1.3 SUBMITTALS

.1 Submit a product data sheet for each insulation system product.

.2 In accordance with Part 3 of this Section, submit a letter from fire rated duct wrap supplier to certifying duct wrap has been properly installed.

.3 Submit a colour chart for coloured lagging adhesive for canvas jacketed insulation.

1.4 QUALITY ASSURANCE

.1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.

.2 Do not apply insulation unless leakage tests have been satisfactorily completed.

.3 Ensure surfaces to be insulated are clean and dry.

.4 Ensure ambient temperature is minimum 13°C (55°F) for at least 1 day prior to application of insulation, and for duration of insulation work, and relative humidity is and will be at a level such that mildew will not form on insulation materials.

.5 Company with sub-contract for mechanical insulation work is to be a member in good standing of Thermal Insulation Association of Canada.

.6 Insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from site.

2 Products

2.1 FIRE HAZARD RATINGS

.1 Unless otherwise specified, insulation system materials inside building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.

2.2 THERMAL PERFORMANCE

.1 Unless otherwise specified, thermal performance of insulation is to meet or exceed values given in Tables entitled Minimum Piping Insulation Thickness Heating and Hot Water Systems and Minimum Piping Insulation Thickness Cooling Systems, as stated in ANSI/ASHRAE/IES Standard 90.1 version referenced in Ontario Building Code.

2.3 PIPE INSULATION MATERIALS

.1 Horizontal pipe insulation at hangers and supports are to be equal to Belform Insulation Ltd. "Koolphen K-Block" insulated pipe support inserts consisting of minimum 150 mm (6") long, pre-moulded, rigid, sectional phenolic

foam insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a captive galvanized steel saddle.

.2 Flexible foam elastomeric is to be closed cell, sleeve type, longitudinally split self-seal, foamed plastic pipe insulation with a water vapour transmission rating of 0.10 in accordance with ASTM E96, Procedure B, and required installation accessories. Acceptable products are:

.1 Armacell AP/Armaflex SS;

.2 IK Insulation Group K-Flex "LS" Self-Seal Pipe Insulation.

.3 Fire rated pre-moulded mineral wool is to be non-combustible, fire-rated, rigid, sectional, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket and compatible with ULC S115 and ULC-S101 firestopping. Acceptable products are:

.1 Roxul "Techton 1200";

.2 IIG (Johns Manville Inc.) MinWool-1200;

.3 Paroc 1200.

.4 Pre-moulded mineral fibre is to be rigid, sectional, sleeve type insulation to ASTM C547, with a factory applied vapour barrier jacket. Acceptable products are:

.1 Johns Manville Inc. "Micro-Lok AP-T Plus";

.2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;

.3 Manson Insulation Inc. "ALLEY K APT";

.4 Owens Corning “Fiberglas” Pipe Insulation.

.5 Blanket mineral fibre is to be blanket type roll insulation to CGSB 51-GP-11M, 24 kg/m3 (1-½ lb/ft^3) density, with a factory applied vapour barrier facing. Acceptable products are:

.1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;

.2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;

.3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;

.4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.

2.4 BARRIER-FREE LAVATORY PIPING INSULATION KITS

.1 Removable, flexible, reusable, white moulded plastic insulation kits for barrier-free lavatory drain piping and potable water supplies exposed under lavatory.

.2 Acceptable products are:

.1 Truebo "Lav-Guard 2" E-Z Series;

.2 Zeston "SNAP-TRAP";

.3 McGuire Manufacturing Co. Inc. "ProWrap".

2.5 EQUIPMENT INSULATION MATERIALS

.1 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m3 (1-½ lb/ft^3) density, with a factory applied vapour barrier facing. Acceptable products are:

.1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;

.2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;

.3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;

.4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.

.2 Semi-rigid mineral fibre board is to be roll form, moulded insulation to ASTM C1393, with a factory applied vapour barrier facing consisting of laminated aluminum foil and kraft paper. Acceptable products are:

.1 Knauf Fiber Glass Pipe and Tank Insulation;

.2 Manson Insulation Inc. "AK FLEX";

.3 Johns Manville Inc. Pipe and Tank Insulation “Micro-Flex”;

.4 Multi-Glass Insulation Ltd. "MULTI-FLEX MF";

.5 Owens Corning Pipe and Tank Insulation;

.6 Glass-Cell Fabricators Ltd. "R-Flex".

2.6 REMOVABLE/REUSABLE INSULATION COVERS

.1 Valve, etc. covers are to be NO SWEAT reusable insulation wraps with vapour barrier jacket and self-sealing ends and longitudinal seam, with a length to suit the application and an insulation thickness equal to adjoining insulation.

2.7 DUCTWORK SYSTEM INSULATION MATERIALS

.1 Rigid mineral fibre board is to be pre-formed board type insulation to ASTM C612, 48 kg/m3 (3 lb/ft^3) density, with a factory applied reinforced aluminum foil and kraft paper facing. Acceptable products are:

.1 Knauf Fiber Glass Insulation Board with FSK facing;

.2 Manson Insulation Inc. "AK BOARD FSK";

.3 Johns Manville Inc. Type 814 "Spin-Glas";

.4 Owens Corning 703.

.2 Semi-rigid mineral fibre board is to be roll form insulation to ASTM C1393, consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing. Acceptable products are:

.1 Multi-Glass Insulation Ltd. "Multi-Flex MKF";

.2 Glass-Cell Fabricators Ltd. "R-FLEX";

.3 Owens Corning Pipe and Tank Insulation;

.4 Johns Manville Inc. Pipe and Tank Insulation.

.3 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m3 (1½ lb/ft3) density, 40 mm (1-½") thick, with a factory applied vapour barrier facing. Acceptable products are:

.1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;

.2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;

.3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;

.4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.

.4 Pre-moulded calcium silicate is to be rigid block and sheet insulation. Acceptable products are:

.1 Johns Manville Inc. "Thermo-12 Gold";

.2 Industrial Insulation Group "Thermo-12 Gold".

.5 Flexible foam elastomeric sheet is to be sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A. Acceptable products are:

.1 Armacell "AP/Armaflex SA";

.2 IK Insulation Group "K-Flex Duct Wrap", S2S.

2.8 INSULATING COATINGS

.1 Equal to Robson Thermal Manufacturing Ltd. insulating coatings as follows:

.1 anti-condensation coating, "No Sweat-FX";

.2 thermal insulating coating, "ThermaLite".

2.9 INSULATION FASTENINGS

.1 Wire – minimum #15 gauge galvanized annealed wire.

.2 Aluminium Banding – equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.

.3 Stainless Steel Banding – equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (½") wide type 304 stainless steel strapping.

.4 Duct Insulation Fasteners – weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1-½") square plastic or zinc plated steel self-locking washers.

.5 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.

.6 Mineral Fibre Insulation Adhesive – clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.

.7 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.

.8 Lagging Adhesive – white, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.

.9 Screws – No. 10 stainless steel sheet metal screws.

2.10 INSULATION JACKETS AND FINISHES

.1 Canvas Jacket Material – ULC listed and labelled, 25/50 fire/smoke rated, roll form, minimum 170 g (6 oz.).

.2 Roll Form Sheet and Fitting Covers – minimum 15 mm (1/2") thick white PVC, 25/50 fire/smoke rated tested in accordance with ULC S102, complete with installation and sealing accessories. Acceptable products are:

.1 Proto Corp. "LoSMOKE";

.2 The Sure-Fit System "SMOKE-LESS 25/50";

.3 Johns Manville Inc. "Zeston" 300.

.3 Adhesive backed flexible aluminium is to be 3M "VentureClad 1577CW-E" roll form sheet material with an aggressive rubberized asphalt adhesive backing, high density polyethylene reinforcement, and an embossed aluminum facing.

.4 Flexible foam elastomeric insulation protective coating equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.

3 Execution

3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

.1 Unless otherwise specified, do not insulate following:

.1 factory insulated equipment and piping;

.2 branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except barrier-free lavatories;

.3 exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except barrier-free lavatories;

.4 manufactured expansion joints and flexible connections;

.5 acoustically lined ductwork and/or equipment;

.6 factory insulated flexible branch ductwork;

.7 piping unions, except for unions in "cold" category piping.

.2 Install insulation directly over pipes and ducts, not over hangers and supports.

.3 Install piping insulation and jacket continuous through pipe openings and sleeves.

.4 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.

.5 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect insulation jacketing from the action of condensation at its junction with metal.

.6 Insulate, vapour seal, and finish seismic restraints, braces, anchors, hanger rods, and similar hardware directly connected to "cold" piping and/or equipment, for a distance of 300 mm (12") clear of adjacent pipe or equipment finish, to match piping and/or equipment insulation.

.7 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above lowest pipe fitting, and thereafter at 4.5 m (14.7') centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.

.8 Where piping and/or equipment is traced with electric heating cable, ensure cable has been tested and accepted prior to application of insulation, and ensure cable is not damaged or displaced during the application of insulation.

.9 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover exposed end of insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.

.10 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and 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.

.11 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in insulation and provide a suitable grommet in the opening.

3.2 INSULATION FOR HORIZONTAL PIPE AT HANGERS AND SUPPORTS

.1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply insulation sections to piping installers for installation as pipe is erected.

3.3 PIPE INSULATION REQUIREMENTS – MINERAL FIBRE

.1 Insulate following pipe inside building and above ground with mineral fibre insulation of thickness indicated:

.1 domestic cold water piping, less than 100 mm (4") dia. – 25 mm (1") thick;

.2 domestic cold water piping, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;

.3 domestic hot water piping, less than 40 mm (1-½") dia. – 25 mm (1") thick;

.4 domestic hot water piping, greater than or equal to 40 mm (1½") dia. – 40 mm (1-½") thick;

.5 tempered domestic water piping, supply and return, less than 40 mm (1-½") dia. – 25 mm (1") thick;

.6 tempered domestic water piping, supply and return, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;

.7 storm drainage piping from roof drains to the point where main vertical risers extend straight down, without offsets, and connect to horizontal underground mains – 25 mm (1") thick;

.8 condensate drainage piping from fan coil unit or any other air conditioning system/unit drain pans to main vertical drain risers or to indirect drainage point – 25 mm (1") thick;

.9 low pressure (to 140 kPa [20 psi]) steam piping, less than 100 mm (4") dia. – 65 mm (2-½") thick;

.10 low pressure condensate piping, less than 40 mm (1-½") dia. – 40 mm (2-½") thick;

.2 Secure overlap flap of the sectional insulation jacket tightly in place. Cover section to section butt joints with tape sealant.

.3 Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.

.4 Unless otherwise specified, insulate unions, valves, strainers, and similar piping system accessories in "cold" piping with cut and tightly fitted segments of sectional pipe insulation with joints covered with tape sealant, or, alternatively, wrap piping union, valve, strainer, etc., with blanket mineral fibre and cover with PVC covers as for paragraph above.

.5 Terminate sectional insulation approximately 50 mm (2") from flange or coupling on each side of flange or coupling. Cover flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to ends of adjacent sectional insulation. Secure blanket insulation in place and cover with a purpose made PVC coupling cover.

.6 Take special care at concealed water rough-in piping at plumbing fixtures to ensure piping is properly insulated. If necessary due to space limitations, use 12 mm (½") thick sectional pipe insulation in lieu of 25 mm (1") thick insulation.

.7 Insulate seismic restraint hardware such as hanger rods, braces, anchors, etc., directly connected to "cold" category piping and equipment for a distance of 300 mm (12") from piping or equipment with insulation and finish to match pipe or equipment insulation. Coat seismic restraint hardware for a distance of 300 mm (12") from the termination of insulation with Robson Thermal "NO-SWEAT-FX" water based anti-condensation coating.

3.4 PIPE INSULATION REQUIREMENTS – FLEXIBLE FOAM ELASTOMERIC

.1 Install flexible elastomeric pipe insulation in strict accordance with manufacturer's published instructions to suit the application, and using adhesive, joint sealants and finish to produce a water-tight installation. Insulate following pipe with flexible elastomeric pipe insulation of thickness indicated:

.1 refrigerant suction and hot gas piping inside and outside building – 25 mm (1") thick.

3.5 PIPE INSULATION REQUIREMENTS – FIRE RATED INSULATION

.1 Where pipe (inside building and above ground) which is to be insulated as specified above penetrates fire rated construction, provide fire-rated, non-combustible sectional insulation on portion of pipe in fire barrier and for a distance of 50 mm (2") on either side of fire barrier. Insulation thickness is to be as specified, but in any case minimum 25 mm (1").

3.6 INSTALLATION OF BARRIER FREE LAVATORY INSULATION KITS

.1 Provide manufactured insulation kits to cover exposed drainage and water piping under barrier free lavatories.

3.7 EQUIPMENT INSULATION REQUIREMENTS – BLANKET TYPE MINERAL FIBRE

.1 Insulate following equipment with mineral fibre blanket type insulation of thickness indicated:

.1 roof drain sumps where inside the building – 25 mm (1") thick;

.2 water meter(s) – 40 mm (1-½") thick;

.2 Unless otherwise noted, wrap equipment to a thickness and insulating value equal to an equivalent thickness of rigid sectional pipe insulation. Laminate insulation in place with a full coverage of adhesive and secure with wire. Apply a jacket of insulation vapour barrier material secured in place with adhesive or sealant tape.

.3 Cover roof drain sumps with purpose made PVC fitting covers.

.4 Lay fibreglass blanket on radiant ceiling panels after testing is complete.

3.8 EQUIPMENT INSULATION REQUIREMENTS – SEMI-RIGID MINERAL FIBRE

.1 Insulate following equipment with semi-rigid mineral fibre board insulation of thickness indicated:

.1 uninsulated domestic hot water storage tank(s) – 40 mm (1-½") thick;

.2 Install insulation as required to fit shape and contour of equipment. Secure insulation in place with adhesive, and with aluminum straps on 450 mm (18") centres. Apply a 6 mm (¼") thick skim coat of insulating cement, then, when insulating cement has dried, apply a 6 mm (¼") thick coat of cement trowelled smooth.

.3 Provide removable and replaceable insulated metal covers for equipment with removable heads to permit heads to be removed and replaced without damaging adjacent insulation work.

3.9 DUCTWORK INSULATION REQUIREMENTS – MINERAL FIBRE

.1 Insulate following ductwork systems inside building and above ground with mineral fibre insulation of thickness indicated:

.1 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

.2 supply air ductwork outward from fans, except for supply ductwork exposed in area it serves – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

.3 any other ductwork, casings, plenums or sections specified or detailed on drawings to be insulated – thickness as specified.

.2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for round ductwork and concealed rectangular ductwork.

.3 Liberally apply adhesive to surfaces of exposed rectangular ducts and/or casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom and side surfaces. Secure and seal joints with 75 mm (3") wide tape sealant. Additional installation requirements as follows:

.1 at trapeze hanger locations, install insulation between duct and hanger;

.2 provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and any other area where insulation is subject to accidental damage, and secure in place with tape sealant.

.4 Liberally apply adhesive to surfaces of concealed rectangular or oval ductwork, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal joints with 75 mm (3") tape sealant. At each trapeze type duct hanger, provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between duct and hanger.

.5 Accurately cut sections of insulation to fit tightly and completely around exposed and concealed round or oval ductwork. Liberally apply adhesive to surfaces of duct, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Seal joints with tape sealant. At duct hanger locations install insulation between duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.

.6 Insulation application requirements common to all types of rigid ductwork are as follows:

.1 at duct connection flanges, insulate flanges with neatly cut strips of rigid insulation material secured with adhesive to side surfaces of flange with a top strip to cover exposed edges of the side strips, then butt the flat surface duct insulation up tight to flange insulation, or, alternatively, increase insulation thickness to depth of flange and cover top of flanges with tape sealant;

.2 installation of fastener pins and washers is to be concurrent with duct insulation application;

.3 cut insulation fastener pins almost flush to washer and cover with neatly cut pieces of tape sealant;

.4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;

.5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch vapour barrier damage by means of tape sealant.

3.10 DUCTWORK INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC

.1 Insulate exposed exterior ductwork (except fresh air intake ductwork) and associated plenums and/or casings outside building with minimum 40 mm (1-½") thick flexible elastomeric sheet insulation as required, applied in 2 minimum 20 mm (¾") thick layers with staggered tightly butted joints.

.2 Insulate following ductwork systems inside building and above ground with flexible elastomeric insulation of thickness indicated:

.1 outside 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 first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1-½") thick as required;

.2 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

.3 Install with adhesive in strict accordance with manufacturer's instructions to produce a weather-proof installation. Ensure sheet metal work joints are sealed watertight prior to applying insulation.

3.11 DUCTWORK INSULATION REQUIREMENTS – CALCIUM SILICATE

.1 Insulate following kitchen exhaust ductwork with minimum 40 mm (1-½") thick calcium silicate block insulation:

.1 kitchen exhaust ductwork from exhaust hood to masonry shaft – 2 hour rating;

.2 Secure insulation in place with adhesive and with wire on 450 mm (18") centres. Point gaps and joints with insulating cement. Where ductwork is exposed, cover insulation with wire mesh secured to wire and with edges laced together and apply a coat of finishing cement trowelled smooth. Use drywall type metal corner bead for duct edges where finishing cement is applied.

3.12 APPLICATION OF INSULATING COATINGS

.1 Apply, in accordance with manufacturer's instruction, insulating coatings to following bare metal surfaces:

.1 paint bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating;

.2 paint bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "ThermaLite" insulating coating.

.2 Apply coatings with a brush. Remove any splatter or excess coating from adjacent surfaces.

3.13 INSULATION FINISH REQUIREMENTS

.1 Unless otherwise shown and/or specified, jacket exposed mineral fibre insulation, and calcium silicate duct insulation work inside building with canvas secured in place with a full covering coat of lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent uninsulated surfaces.

.2 Unless otherwise shown or specified, jacket exposed mineral fibre insulation listed below with canvas jacket secured in place with a full covering coat of coloured lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent surfaces.

.3 Jacket exposed pipe insulation work inside building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by manufacturer’s instructions.

.4 Install adhesive backed flexible aluminum to cleaned and primed metal surfaces which are between -23°C and 74°C (-10°F and 165°F) in strict accordance with manufacturer’s published instructions and details, including shingle type overlap joints to shed water, and use of a hand roller to concentrate pressure on seams. Provide adhesive backed flexible aluminum jacket for all exterior insulation.

.5 Apply 2 coats (with 24 hr. between coats) of specified coating to flexible elastomeric insulation outside building and cover with adhesive backed flexible aluminum.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets to regulatory authority for review and approval prior to submitting to Consultant. Conform to following requirements:

.1 submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings;

.2 sprinklers shall be referred to on drawings and product submittals, and be specifically identified by the manufacturer's listed model or series designation. Trade names and other abbreviated listings are not allowed;

.3 submit complete CAD layout drawings indicating source of water supply with test flow and pressure, "head-end" equipment piping schematic, pipe routing and sizing, and zones, all signed and sealed by a qualified professional mechanical engineer registered in jurisdiction of the work as specified below;

.4 submit copies of all calculations, including hydraulic calculations, stamped and signed by same engineer who signs layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing, including occupancy-hazard design requirements;

.2 Submit a complete sprinkler system test certificate as specified in Part 3 of this Section.

1.2 QUALITY ASSURANCE

.1 Fire protection sprinkler system work is to be in accordance with following Codes and Standards:

.1 NFPA 13, Standard for the Installation of Sprinkler Systems;

.2 CSA B137.2, Polyvinylchloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications;

.3 CSA B137.3, Rigid Polyvinylchloride (PVC) Pipe for Pressure Applications;

.4 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless;

.5 ASTM A135, Standard Specification for Electric-Resistance-Welded Steel Pipe;

.6 ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service;

.7 ASTM A536, Standard Specification for Ductile Castings;

.8 ASTM A795, Standard Specification for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use;

.9 ANSI/ASME B16.4, Grey Iron Threaded Fittings (Classes 125 and 250);

.10 CAN/CSA B64.10, Backflow Preventers and Vacuum Breakers.

.2 Fire protection sprinkler work is to be performed by a sprinkler company who is a member in good standing of the Canadian Automatic Sprinkler Association. Site personnel are to be licensed in jurisdiction of the work and under the continuous supervision of a foreman who is an experienced fire protection system installer and a journeyman pipe fitter licensed in jurisdiction of the work.

.3 Check and verify dimensions and conditions at site and ensure work can be performed as indicated. Coordinate work with trades at site and accept responsibility for and cost of making adjustments to piping and/or spacing to avoid interference with other building components.

.4 System components must be ULC listed and labelled.

.5 All grooved couplings, and fittings, valves and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

.6 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.3 DESIGN REQUIREMENTS

.1 Fire protection sprinkler work is to be designed in accordance with NFPA 13 and Provincial Standards, and, where required, local building and fire department requirements and standards of Owner's Insurer. If water supply flow and pressure test data is not available, conduct Municipal main water flow and pressure tests at nearest fire hydrant to obtain criteria to be used in system design. Include hydrant location and flow and pressure test data with system design calculations.

.2 Include for a qualified mechanical professional engineer registered and licensed in the jurisdiction of the work to design the fire protection standpipe work. Refer to Section 20 05 10 – Mechanical Work General Instructions for requirements regarding Contractor retained engineers.

.3 Sprinkler /System Occupancy – Hazard Design requirements: In accordance with NFPA 13 occupancy-hazard density requirements, unless otherwise specified.

2 Products

2.1 PIPE, FITTINGS, AND JOINTS

.1 Pipe, fittings and joints are to be as follows, with exceptions as specified in Part 3 of this Section:

.1 Schedule 40 Steel – Grooved Coupling Joints

.1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and mechanical fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints. Strap type outlet fittings such as Victaulic "Snap-Let" are not acceptable.

.2 Schedule 40 Steel – Screwed and Welded Joints

.1 Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible.

.3 Schedule 10 Steel – Grooved Coupling Joints

.1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and fitings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints.

.4 Schedule 10 Steel – Screwed Joints

.1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with mill or site threaded ends, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.

.5 "Lightwall" Steel – Grooved Coupling Joints

.1 Commercial quality. "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, complete with a galvanized exterior, grooved ends, and fittings and couplings equal to Victaulic "Fire Lock" grooved fittings and Victaulic Style 009N QuickVic or 005 rigid coupling joints.

.6 "Lightwall" Steel – Screwed Joints

.1 Commercial quality, "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, ULC listed, mill or site threaded, complete with galvanized exterior, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.

.7 Flexible Pipe – Equal to Victaulic "VicFlex"

.1 The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel 1" NPT Male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a 1/2" or 3/4" NPT female thread for connection to the sprinkler head.

.2 Option: Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.

.3 The drop shall include a cULus/FM approved Series AH2 braided hose with a bend radius to 2" to allow for proper installation in confined spaces.

.4 The hose shall be listed for:

.1 (4) bends at 31" length;

.2 (5) bends at 36" length;

.3 (8) bends at 48" length;

.4 (10) bends at 60" length;

.5 (12) bends at 72" length.

.5 Union joints shall be provided for; ease of installation, prevention of hose torque stresses and on site changing of factory 5.75" straight reducing nipple in reduced spaces under obstructions (optional reducing nipples; 4.83" or 6.57" reducing 90 and 9" or 13" straight reducer x ½ or ¾" outlet) All VicFlex assemblies and related accessories to be installed as per the guidelines and listings in Victaulic submittal 10.85.

.6 On T Bar ceiling grid with drop in tile application, the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place.

.7 On T Bar ceiling grid designed for hard lid drywall application; the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB2 bracket. The bracket shall allow for the vertical adjustment of the reducer/head from below the drywall, post drywall installation.

.8 On Hat Furring Channel grid with hard lid drywall application; the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB4 bracket. The bracket shall allow for the vertical adjustment of the reducer/head from below the drywall, post drywall installation.

.9 The braided drop system shall be cULus listed and FM Approved for sprinkler services to 175 psi (1206 kPa).

.10 For dry sprinkler heads Victaulic VicFlex dry sprinkler model VS1. The sprinkler shall provide a vertical or horizontal flexible connection with a bend radius to 2”, and allow for up to 4 bends. The sprinkler body shall be die cast brass with brass deflector, supplied finished to match application and to architectural direction, and glass bulb with glycerin solution. The product shall consist of a braided type 300 stainless steel flexible hose with a swivel type branch line threaded connection, EPDM gasket seal, with PTFE-coated Beryllium Nickel and stainless-steel spring-seal assembly. The bracket shall be open gate or metal strap to provide for sprinkler placement and alignment. The flexible dry sprinkler and bracket system is UL listed for sprinkler services to 175 psi.

.8 CPVC Pipe

.1 Equal to IPEX BlazeMaster solvent weld, orange, SDR 13.5 pipe and Schedule 80 fittings, ULC listed for use in wet pipe automatic sprinkler systems, with a flame spread rating less than 25 and a smoke developed rating less than 50 when tested in accordance with CAN/ULC S102.2, and in accordance with NFPA 13 requirements.

.2 Victaulic Standard Mechanical Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183. Couplings shall comply with ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

.3 Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance

NFPA-13. Couplings shall be fully installed at visual pad-to-pad offset contact. Couplings that require exact gapping of bolt pads at specific torque ratings are not permitted.

.4 Flexible Type: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 177 (Quick-Vic™), Installation ready flexible coupling.

2.2 SERVICE MAIN DOUBLE CHECK VALVE ASSEMBLY

.1 Minimum 1205 kPa (175 psi) rated dual check valve backflow preventer assembly to CAN/CSA B64, complete with tight-closing resilient seated shut-off valves, test cocks and strainer.

.2 Acceptable manufacturers are:

.1 Watts Industries Canada;

.2 Zurn/Wilkins;

.3 Apollo Valves (Conbraco Industries).

2.3 SHUT-OFF VALVES

.1 Minimum 2070 kPa (300 psi) rated full port brass or bronze body screwed ball valves and lug body or grooved end type butterfly valves.

.2 Butterfly valves shall include a pressure responsive seat, and the stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.

.3 Standard of Acceptance: Victaulic Style 705.

.4 OS&Y Gate Valves: 1725 kPa (250 psi), grooved ends. Ductile iron body, yoke, and handwheel conforming to ASTM A-536; EPDM coated ASTM A-126-B cast iron disc; ASTM B16 brass rising stem; flanged and epoxy coated ductile iron bonnet; EPDM O-ring stem seals and body gasket. Victaulic Series 771H (Grooved ends) and Series 771F (Grooved x Flanged).

.5 Supervised closed applications standard of acceptance Victaulic Series 707C supervised closed butterfly valve.

2.4 CHECK VALVES

.1 Minimum 1725 kPa (250 psi) resilient seat check valves, suitable for vertical or horizontal installations. Standard of Acceptance: Victaulic Series 717.

.2 Check valves associated with Fire Department connections and fire pump test connection are to be tapped for site installation of a 20 mm (¾") diameter ball drip.

2.5 BALL DRIPS

.1 Equal to National Fire Equipment Ltd. Model #A58, 20 mm (¾") diameter automatic ball drip.

2.6 SHUT-OFF VALVE SUPERVISORY SWITCHES

.1 Tamper-proof supervisory switches, each arranged to activate a fire alarm system trouble alarm condition if the valve is closed or tampered with, each suitable in all respects for the application, and each complete with all required mounting and connection hardware.

.2 Actuator housings shall be weatherproof.

2.7 FIRE DEPARTMENT CONNECTION

.1 Wall mounting polished brass clapper type dual inlet Fire Department connection with 2, 65 mm (2-½") diameter inlets threaded to Fire Department hose requirements and equipped with caps and chains, an outlet sized as shown, and a faceplate.

.2 Faceplate is to be polished brass and complete with "AUTO-SPKR" cast-in raised lettering.

.3 Exposed metal parts of Fire Department connection are to be chrome plated.

.4 At the low point near each fire department connection, install a 90-degree elbow with drain connection to allow for system drainage to prevent freezing. Standard of Acceptance: Victaulic #10-DR.

2.8 WATER FLOW ALARM SWITCH

.1 Pipe mounting water flow alarm switch, minimum 1725 kPa (250 psi) rated, designed to actuate 2, 7 ampere rated (at 125/250 VAC) SPDT snap action switches when water flow exceeds 0.758 L/sec. (10 Imp gpm), complete with a tamper-proof cover with conduit connection opening, a piping saddle and U-bolt, and an automatic rest pneumatic retard device with field adjustable (0 to 70 second) switch actuation delay to reduce false alarms caused by a single or series of transient water flow surges.

2.9 ALARM CHECK VALVE

.1 Equal to Victaulic Series 751 FireLock, enamelled cast iron check valve assembly designed for either vertical or horizontal mounting and to actuate alarms when wet type sprinkler system is activated. Assembly is to be minimum 1205 kPa (175 psi) cold water rated with all moving parts constructed of brass, bronze, stainless steel or EPDM, and is to be complete with:

.1 pipe, fittings and accessories for site connection of an excess pressure pump;

.2 basic trim including piping materials and check valve for an external by-pass, potable water supply and system water supply pressure gauges with gauge test ports and shut-off valves, an angle type main drain valve, and fittings for mounting an alarm test by-pass;

.3 alarm test by-pass piping with ball valve to permit alarm testing without operation of alarm valve;

.4 alarm trim with pipe and fittings for connection to a water motor alarm, and an adjustable pressure switch for electrical connection to an alarm system upon flow through valve.

2.10 EXCESS PRESSURE PUMP

.1 Close coupled, 1750 RPM, all bronze gear pump sized to maintain sufficient pressure in fire protection main to prevent alarm check valve(s) from initiating flow alarms during fluctuations in pressure of Municipal water supply. Pump is to be complete with:

.1 stainless steel shaft with maintenance free seal;

.2 lifetime lubricated carbon bearings;

.3 TEFC motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, and secured to a mounting base;

.4 accessory package consisting of flexible suction and discharge connection hoses, a Monel inlet strainer, relief valve factory set at 862 kPa (120 psi), and a steel mounting plate designed to mount pump to alarm check valve flange;

.5 power and control panel.

.2 Factory pre-wired power and control panel, CSA certified, designed to automatically start and stop pump in response to water pressure variations in the main and consisting of a surface wall mounting NEMA 2 enamelled steel panel with hinged front door equipped with Corbin catch, and following:

.1 door interlock fused disconnect with HRC fuses;

.2 protected type pump starter;

.3 door mounted H-O-A rotary selector switch;

.4 fused control transformer;

.5 115 volt adjustable pressure switch to suit the application;

.6 set of NO/NC dry contacts for connection of lack of power availability alarm;

.7 door mounted "POWER ON" LED.

2.11 SPRINKLER HEADS

.1 Sprinkler heads, unless otherwise specified, are to be as scheduled in Part 3 of this Section.

.2 Sprinkler body shall be die-cast, with a hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss.

.3 For locations where corrosive resistant coatings are required, body shall be coated with UL listed and FM approved anti-corrosion VC-250 coating (silver coloring).

.4 Sprinkler heads for healthcare facilities are to be quick response type.

.5 Recessed sprinkler heads in finished areas are to be chrome plated unless otherwise specified. Concealed sprinkler head ceiling plates are to match ceiling colour.

.6 Where exposed pendent heads occurs in areas with suspended ceilings, they are to be complete with chrome plated escutcheon plates. Similarly, sidewall heads with concealed piping are to be complete with chrome plated escutcheon plates.

.7 Sprinkler heads which are exposed in areas where they may be subject to damage are to be complete with wire guards, chrome plated where in finished areas.

.8 Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

.9 Sprinkler heads located in areas or over equipment where high ambient temperature is present are to be, unless otherwise specified, 74°C (165°F) heads. All other heads, unless otherwise specified or required, are to be 57°C (135°F) rated.

.10 Acceptable manufacturers are:

.1 Victaulic Co.;

.2 Tyco Fire Suppression & Building Products;

.3 The Viking Corporation;

.4 The Reliable Automatic Sprinkler Co.

2.12 SPARE SPRINKLER HEAD CABINET

.1 Surface wall mounting, red enamelled steel, identified cabinet with hinged door, shelves with holes for mounting sprinkler heads, a wrench or wrenches suitable for each type of sprinkler head, and a full complement of spare sprinkler heads.

.2 Cabinet is to be sized to accommodate a minimum of 4 spare heads for each type of head used on the project, however, each cabinet is to be full of spare heads.

3 Execution

3.1 PIPING INSTALLATION REQUIREMENTS

.1 Provide required sprinkler system piping.

.2 Perform piping work in accordance with requirements of NFPA 13, governing regulations, and "Reviewed" shop drawings.

.3 Piping, unless otherwise specified, is as follows:

.1 for underground piping inside or outside building – Class 200, DR14 rigid PVC, braced and secured at bends and tees with concrete blocks in accordance with Municipal standards and details;

.2 for piping inside building and above ground except as noted below – Schedule 40 grooved end black steel with Victaulic or equal fittings and coupling joints, or, for piping to and including 50 mm (2") diameter, screwed fittings and joints, or, for piping 65 mm (2-½") diameter and larger, welding fittings and welded joints;

.3 for wet system piping inside building and above ground – at your option, CPVC sprinkler pipe and fittings;

.4 for piping downstream of "head end" alarm valve(s) and equipment – Schedule 10 or "Lightwall" black steel pipe with Victaulic or equal fittings and coupling joints or screwed fittings and joints;

.5 for branch piping to heads in suspended ceilings, etc. – at your option, flexible piping installed in accordance with manufacturer's instructions;

.6 for branch piping to heads in MRI suites – copper pipe, fittings, and sprinkler head adapters with stainless steel hangers and support hardware.

.4 Exceptions to piping requirements specified above are as follows:

.1 dry pipe zone steel piping, fittings, unions, couplings and flanges are to be galvanized;

.2 wet zone steel piping, fittings, unions, couplings and flanges for sprinkler work exposed to weather either inside or outside building (including parking garages), are to be galvanized;

.3 PVC piping is not to be used above grade;

.4 ferrous pipe hangers, supports, and similar hardware used for galvanized steel piping are to be electro-galvanized.

.5 Pipe sizes, pipe routing, sprinkler head quantities and locations, and layout of work shown on drawings are to assist during the tendering period. Ensure adequate head coverage, head quantities and pipe sizing as specified in Part 1 of this Section. Do not reduce size of sprinkler main or re-route the main unless approved by Consultant.

.6 Pipe, fittings, couplings, flanges and similar components are to be clean after erection is complete. Wire brush clean any ferrous pipe, fitting, coupling, flange, hanger, support and similar component which exhibits rust and carefully coat with suitably coloured primer.

.7 Where sprinklers are not protected by a dry system and may be subject to freezing, provide non-freeze, glycol-water solution filled sprinkler piping. Install piping complete with a CSA certified reduced pressure backflow preventer, valves and glycol solution fill facilities in accordance with requirements of Chapter 3 of NFPA 13. Fill piping with a solution of 50% Union Carbide Canada Ltd. "UCAR THERMO-FLUID 17" or Dow Chemical Co. "Dowtherm SR1" propylene glycol with corrosion inhibitors, and 50% clean water. Prior to filling piping, check the specific gravity of the solution using a hydrometer with proper scale. Specific gravity is to be approximately 1.069 at 15.6°C.

.8 When sprinkler work is complete, test system components and overall system(s) and submit completed test certificate and other documentation in accordance with Chapter 8 of NFPA 13.

.9 Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks. Gaskets shall be molded and produced by the coupling manufacturer, and shall be verified as suitable for the intended service. A factory-trained field representative of the mechanical joint manufacturer shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products.

3.2 INSTALLATION OF DOUBLE CHECK VALVE ASSEMBLY

.1 Provide a double check valve assembly in sprinkler main inside the building.

.2 Equip assembly with inlet and outlet shut-off valves with supervisory switches as specified below.

.3 Support each end of assembly from floor by means of flanged pipe supports with saddles.

3.3 INSTALLATION OF SHUT-OFF VALVES AND CHECK VALVES

.1 Provide shut-off valves and check valves in piping where shown and wherever else required.

.2 Locate valves for easy operation and maintenance.

.3 Confirm exact locations prior to roughing-in.

3.4 INSTALLATION OF SHUT-OFF VALVE SUPERVISORY SWITCHES

.1 Equip each shut-off valve with a supervisory switch.

.2 Identify each supervised valve with a 150 mm (6") square, engraved, laminated red-white plastic tag to correspond with supervised valve numbering specified and/or shown as part of the electrical work fire alarm system.

3.5 INSTALLATION OF FIRE DEPARTMENT CONNECTION

.1 Provide an exterior Fire Department connection. Confirm exact location prior to roughing-in. Confirm finish prior to ordering.

.2 Equip connection with a check valve. Equip check valve with a ball drip to drain piping between Fire Department connection and check valve, and extend drainage piping from outlet of ball drip to nearest suitable floor drain.

3.6 INSTALLATION OF FLOW ALARM SWITCHES

.1 Provide water flow alarm switches in accessible locations in zone piping.

.2 Adjust to suit site water pressure conditions. Check and test operation.

.3 Identify each switch with a 150 mm (6") square red-white laminated engraved plastic tag. Confirm wording prior to engraving.

3.7 INSTALLATION OF ALARM CHECK VALVES

.1 Provide alarm check valves, complete with trim, for wet zone fire protection sprinkler piping.

.2 Check and test operation of each valve and adjust as required to suit site water pressure conditions.

.3 Identify each valve with a 150 mm (6") square red-white laminated engraved plastic tag. Confirm wording prior to engraving.

3.8 INSTALLATION OF EXCESS PRESSURE PUMP AND CONTROL

.1 Provide an excess pressure pump in wet fire protection sprinkler system piping, arranged to prevent activation of alarm check valve water flow alarms during normal water pressure fluctuations in the main. Locate pump on a steel mounting plate assembly at alarm check valve(s) and install accessories supplied with pump. Provide a pressure gauge in valved tubing across pump suction and discharge connections.

.2 Supply a starter and control panel for pump and surface wall mount adjacent to pump. Connect panel pressure switch with copper tubing in accordance with pump manufacturer’s instructions. Adjust pressure switch to suit site conditions.

.3 Start-up the pump, test operation and adjust as required.

3.9 INSTALLATION OF SPRINKLER HEADS

.1 Provide required sprinkler heads in accordance with following schedule:

APPLICATION	SPRINKLER HEAD TYPE
Rooms/areas with a suspended ceiling	Victaulic V38/V39 or Tyco Series RFII "Royal Flush II" concealed pendent Victaulic V27 or Tyco Series TY-FRB recessed pendent Victaulic V27 or Tyco Series TY-FRB pendent with escutcheon plates
Rooms/areas without a suspended ceiling	Victaulic V27 or Tyco Series TY-FRB pendent
Elevator shafts	Victaulic V27 or Tyco Series TY-FRB horizontal sidewall
Unheated exterior service spaces and SCBA Scuba room.	Victaulic V36 or Tyco Series DS-1 dry pipe horizontal sidewall Victaulic V36 or Tyco Series DS-3 wet pipe horizontal sidewall
Heated apparatus bay	Victaulic V34 or Tyco Series EC-11 or EC-14 ECOH upright or Victaulic V27 or Series TY-FRB upright for wet piping

.2 Sprinkler head manufacturers indicated on schedule are for type indication purposes. Acceptable manufacturers are listed in Part 2 of this Section.

.3 Provide quick response type sprinkler heads.

.4 Coordinate sprinkler head locations with all drawings, including architectural reflected ceiling plan drawings, and, where applicable, electrical drawings. Coordinate sprinkler head locations in areas with suspended ceilings with the location of lighting, grilles, diffusers, and similar items recessed in or surface mounted on the ceiling as per the reflected ceiling plans. In areas with lay-in tile, centre the sprinkler head both ways in the lay-in tile wherever possible. Confirm locations prior to roughing-in.

.5 Maintain maximum headroom in areas with no ceilings.

.6 Provide guards for heads where they are subject to damage.

.7 Provide high temperature heads in equipment rooms and similar areas over heat producing or generating equipment.

3.10 INSTALLATION OF SPARE SPRINKLER HEAD CABINET

.1 Supply a full complement (to fill cabinet) of spare sprinkler heads of types used (minimum 4 of each type) and place in a wall mounting storage cabinet located adjacent to sprinkler system "head end" equipment where later directed.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit product data sheets for all products specified in this Section.

1.2 QUALITY ASSURANCE

.1 Fire extinguishers are to be in accordance with following Codes and Standards:

.1 National Fire Code of Canada;

.2 NFPA 10, Standard for Portable Fire Extinguishers;

.3 CAN/ULC S508, Standard for the Rating and Testing of Fire Extinguishers.

2 Products

2.1 GENERAL

.1 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 manufacturer's identification label indicating extinguisher model number, rating, and operating instructions;

.2 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 mounting extinguishers, a wall mounting bracket.

2.2 3A10B:C RATED DRY CHEMICAL EXTINGUISHERS

.1 Multi-purpose 3A10B:C dry chemical extinguishers are to be 100 mm (4") dia., 2.27 kg (5 lb.), each complete with a steel cylinder with a safety red baked enamel finish and a waterproof stainless steel pressure gauge.

2.3 FIRE EXTINGUISHER CABINETS

.1 Recessed: Rectangular cabinets sized to suit the extinguishers to be housed, with a #18 gauge corrosion resistant white enamelled 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.

2.4 FIRE BLANKETS

.1 Equal to National Fire Equipment Ltd. Model #FB-6078-MC 300 mm x 400 mm (12" x 16") red enamelled #16 gauge surface mounting steel cabinet identified "FIRE BLANKET" and "PULL TAB TO REMOVE", complete with non-combustible glass fibre fire blanket pressure fit into the cabinet and equipped with pull-back release straps.

3 Execution

3.1 INSTALLATION OF FIRE EXTINGUISHERS

.1 Provide fire extinguishers of type(s) in accordance with requirements of NFPA 10.

.2 Unless otherwise shown or specified, wall mount extinguishers using wall brackets supplied with extinguishers.

.3 Do not install extinguishers until after wall finishing work is complete.

.4 Be responsible for maintaining fire extinguishers until Substantial Completion of the Work.

.5 If extinguishers are indicated adjacent to a door, locate extinguishers at the strike side of the door.

3.2 INSTALLATION OF FIRE EXTINGUISHER CABINETS

.1 Provide wall cabinets for fire extinguishers where required.

.2 Unless otherwise shown or specified, locate cabinets so centerline is approximately 1.2 m (4') above finished floor.

.3 Confirm exact locations prior to installation.

3.3 INSTALLATION OF FIRE BLANKETS

.1 Provide fire blankets in wall mounted cabinets in the Kitchen. Confirm exact locations prior to installation.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe, fittings, and chlorine solution.

1.2 CLOSEOUT SUBMITTALS

.1 Submit laboratory water purity test results indicating chlorine residual prior to application for Substantial Performance of the Work.

.2 Prior Substantial Performance of the Work, submit a minimum of 3 identified keys for key operated hydrants.

.3 Submit signed test results and inspection and test log cards for each backflow preventer as specified in Part 3 of this Section.

.4 Submit anchor drawing(s) to detail fabrication and installation of water piping anchors. Drawing(s) are to be prepared and stamped by a professional structural engineer registered and licensed in jurisdiction of the work.

.5 As specified in Part 3 of this Section, submit a letter from anchor design engineer stating anchor installation has been examined at site and anchors are properly fabricated and installed.

1.3 QUALITY ASSURANCE

.1 Domestic water piping and valves are to comply with following codes, regulations and standards (as applicable):

.1 applicable local codes and regulations;

.2 CAN/CSA B125.1, Plumbing Supply Fittings;

.3 CAN/CSA B125.3, Plumbing Fittings;

.4 CAN/CSA B137 Series, Thermoplastic Pressure Piping Compendium;

.5 NSF/ANSI 14, Plastics Piping System Components and Related Materials;

.6 NSF/ANSI 61, Drinking Water System Components – Health Effects;

.7 NSF/ANSI 372, Drinking Water System Components – Lead Content.

2 Products

2.1 PIPE, FITTINGS, AND JOINTS

.1 PVC

.1 ULC listed, rigid, Class 150, DR18, 1035 kPa (150 psi) pressure rated bell and spigot pattern PVC pipe to CAN/CSA B137.3, and CSA certified fittings to CAN/CSA B137.2, and AWWA C900, complete with gasket joints, and Ford "Uni-Flange" or equal restraint collars as per Part 3 of this Section.

.2 Soft Copper

.1 Type "K" soft copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings.

.3 Copper - Solder Joint

.1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equal lead-free solder for cold water pipe, and 95% tin / 5% Antimony or "SILVABRITE 100" solder for other services.

.4 Copper - Grooved

.1 Type "L" hard drawn seamless copper to ASTM B88 with Victaulic QuickVic Style 607 non-reducing, bolted connection type suitable and approved for application intended, 2” - 8" for copper tubing consisting of

ductile iron cast housings, complete with a Grade P fluoroelastomer gasket of a pressure-responsive design, with plated nuts and bolts to secure unit together.

.5 Semi-Rigid Polyethylene Tubing

.1 Versa Fittings and Mfg. Inc. 12 mm (½") dia., high density, semi-rigid polyethylene tubing, 1380 kPa (200 psi) rated.

.6 CPVC

.1 Ipex "Aquarise" CPVC pipe and fittings to CAN/CSA B137.6, 25/50 flame spread and smoke developed rated in accordance with CAN/ULC S102.2, and complete with primer/solvent weld joints.

.2 Option: Fittings equal to Victaulic PGS-300 grooved piping system for schedule 40 and schedule 80 CPVC pipe per ASTM F441, 23447 minimum cell classification per ASTM D1784. Sizes 50-300 mm (2" - 12") consisting of ductile iron cast housings, complete with a grade "EHP" EPDM gasket of a pressure-responsive design, with plated nuts and bolts to secure unit together (Viictaulic Style 357).

.7 Cross-Linked Polyethylene (PEX) Tubing

.1 Non-barrier type PEX-A piping in accordance with CAN/CSA B137.5, ASTM F876 and tested for compliance by an independent third-party agency, 25/50 flame spread/smoke developed rated when tested to CAN/ULC S102.2 and complete with brass inserts and crimp-ring or cold-expansion joint fittings and couplings.

2.2 SHUT-OFF VALVES

.1 Ball Valves

.1 Class 600, 4140 kPa (600 psi) WOG rated, lead-free, full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, 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 Acceptable products are:

.1 Toyo Valve Co. Fig. 5049A-LF;

.2 Milwaukee Valve Co. #UPBA485B;

.3 Kitz Corporation Code 859;

.4 Apollo Valves #77LF-200;

.5 Watts Industries (Canada) Inc. #LFFBVS-3C.

2.3 CHECK VALVES

.1 Horizontal

.1 Lead-free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.

.2 Acceptable products are:

.1 Toyo Valve Co. Fig. 237A-LF;

.2 Milwaukee Valve Co. #UP1509;

.3 Kitz Corporation Code 823;

.4 Apollo Valves #61LF Series.

.2 Vertical

.1 Equal to Kitz Corp. Code 826, lead-free, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

2.4 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 Acceptable products are:

.1 Toyo Valve Co. Fig. 5046;

.2 Dahl Brothers Canada Ltd. Fig. No. 50. 430;

.3 Kitz Corporation Code 58CC;

.4 Apollo Valves #78-104-01;

.5 Watts Industries (Canada) Inc. #B6000.

2.5 DOMESTIC WATER PIPING BALANCING VALVES

.1 Equal to Victaulic Series 76X Low Lead Balancing Valve, lead-free and compliant with NSF-61 and NSF-372 for use in potable water applications, automatic flow limiting balancing valve (+/-5% over rated operating pressure range), complete with removable flow cartridge.

.2 Equal to Victaulic TA Series 78BL, solder or flange end type as required, ball valve style, lead-free and compliant with NSF-61 and NSF-372 for use in potable water applications, circuit balancing valves 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.

2.6 CHLORINE

.1 Sodium hypochlorite to AWWA B300.

2.7 INTERIOR HOSE BIBBS

.1 Flush-Concealed

.1 Recessed, 92 mm (3-5/8") deep, recessed, encased wall hydrant with lockable bronze or stainless steel box with hinged cover identified "WATER", bronze interior parts, a screwdriver operated stop in the supply, key operated control valve, 20 mm (¾") dia. hose connection, and a vacuum breaker.

.2 Acceptable products are:

.1 Watts Industries (Canada) Inc. #HY-330.

.2 Jay R. Smith #5509QT-CL-SAP;

.3 Zurn #Z1350;

.4 Mifab #MHY-55;

.2 Semi-Recessed - Finished Areas

.1 Anti-siphon type, 100 mm (4") deep hose bibb with stainless steel face with operating key, bronze interior parts, 20 mm (¾") dia. solder inlet, 20 mm (¾") dia. hose connection, and integral vacuum breaker.

.2 Acceptable products are:

.1 Watts Industries (Canada) Inc. #HY-430.

.2 Jay R. Smith #5619-SAP-98;

.3 Zurn #Z1333 "ECOLOTROL";

.4 Mifab #MHY-30;

.3 Surface – Exposed – Cold Water – Unfinished Areas

.1 Brass or bronze hose bibb with hose end vacuum breaker.

.2 Acceptable products are:

.1 Watts Industries (Canada) Inc. #SC8-1;

.2 Jay R. Smith #5609QT-SAP.

.3 Zurn/Wilkins # Z1341 with hose end vacuum breaker;

.4 Chicago Faucets #293-E27CP;

2.8 EXTERIOR NON-FREEZE WALL HYDRANTS

.1 Flush-Concealed

.1 Recessed, encased, self-draining hydrants, each complete with a copper casing, operating rod assembly to suit wall thickness, polished nickel bronze box with hinged locking cover, 20 mm (¾") dia. threaded hose connection outlet, vacuum breaker, and a loose tee handle operating key.

.2 Acceptable products are:

.1 Watts Industries (Canada) Inc. #HY-725.

.2 Jay R. Smith #5519-98;

.3 Zurn #Z1320;

.4 Mifab #MHY-26;

2.9 FLOOR DRAIN TRAP SEAL PRIMERS

.1 Electronic Type

.1 Precision Plumbing Products #MPB Series surface wall mounting, CSA certified, 115 volt, 1-phase, 60 Hz., electronic, automatic trap priming manifolds, each sized to suit up to four drain traps or interceptors serviced, and each complete with:

.1 galvanized steel cabinet with door;

.2 13 mm (1/2”) dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;

.3 solenoid valve, air gap, and for priming 2-4 traps from a single primer, a Model DU-2, DU-3, or DU-4, 2, 3 or 4 outlet distribution unit for priming 2, 3 or 4 traps to suit the number of items to be primed;

.4 control panel with circuit breaker, 2 ampere circuit breaker, 24 hour timer, and manual override toggle switch

.2 Precision Plumbing Products #PT Series 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 galvanized steel cabinet with door;

.2 20 mm (¾") dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;

.3 solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with 12 mm (½") dia. compression type copper tube connections on 40 mm (1-½") centres with quantity to suit the number of items to be primed;

.4 control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.

2.10 SHOCK ABSORBERS

.1 Type 304 stainless steel piping shock absorbers, each complete with a nesting type bellows and a casing of sufficient displacement volume to dissipate kinetic energy generated in piping system, and each sized to suit connecting potable water pipe and equipment it is provided for.

.2 Acceptable products are:

.1 Watts Industries (Canada) Inc. "SG" Series.

.2 Jay R. Smith 5000 Series "HYDROTROL";

.3 Zurn #Z1700 "SHOKTROL";

.4 Mifab "HAMMERGUARD" WHB Series;

2.11 WATER HAMMER ARRESTORS

.1 Piston type, sealed, all stainless steel construction, pressurized water hammer arrestors suitable for either vertical or horizontal installation, each complete with a pressurized compression chamber, welded nesting-type expansion bellows surrounded by non-toxic mineral oil, and a male treaded nipple connection.

.2 Acceptable products are:

.1 Jay R. Smith 5000 Series;

.2 Precision Plumbing Products "SS" Series.

2.12 BACKFLOW PREVENTERS

.1 Double Check Valve Assembly

.1 Minimum 1205 kPa (175 psi) rated lead-free dual check valve assembly backflow preventer to CAN/CSA B64 (including supplements), complete with tight-closing resilient seated shut-off valves, test cocks and strainer.

.2 Acceptable manufacturers are:

.1 Watts Industries Canada;

.2 Zurn/Wilkins;

.3 Apollo Valves (Conbraco Industries).

.2 Reduced Pressure Zone Assembly

.1 Lead-free reduced pressure zone assembly backflow preventer 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 Acceptable products are:

.1 Watts Industries #LF009QT-S for 12 mm (½") size, #LF909QT-S for 20 mm to 50 mm (¾" to 2") size, and #LF909-NRS-S for 65 mm (2-½") and larger size;

.2 Zurn/Wilkins 975XL2 and 375 Series;

.3 “Apollo” Valves manufactured by Conbraco Industries Inc. Series 4ALF;

.4 Danfoss Flomatic Corp. Series RPZ.

2.13 LAVATORY SUPPLY FITTING TEMPERING VALVES

.1 Equal to Powers "HydroGuard" Series 490, model LM490 12 mm (½") dia. or model LM491 20 mm (¾") dia. as required, each CSA B125 certified, forged brass, tamper-proof thermostatic mixing valves, adjustable for water supply between 29°C and 49°C (85°F and 120°F), sized to suit number of lavatories in grouping, and complete with a stop and check valve and a lockable handle.

.2 Each mixing valve is to be complete with a stainless steel flush wall mounting cabinet with vandal-proof hinged door.

2.14 AIR VENTS

.1 Equal to ITT Hoffman Specialty No. 78 cast brass, 1035 kPa (150 psi) rated, 20 mm (¾") straight water main vent valves, each tapped at the top for a 3.2 mm (1/8") safety drain connection.

2.15 DOMESTIC WATER THERMAL EXPANSION TANK

.1 Pre-charged domestic water thermal expansion tank in accordance with Section VIII of the ASME Boiler and Pressure Code, carbon steel outer shell construction and complete with fixed butyl rubber bladder to prevent water from contacting shell interior, top NPT stainless steel system connection, 7.6 mm to 813 mm (0.301" to 32") charging valve connection and prime painted exterior.

.2 Acceptable products are:

.1 Watts Industries (Canada) Inc. Series DETA;

.2 Zurn/Wilkins Model WTTA.

3 Execution

3.1 PIPING INSTALLATION REQUIREMENTS

.1 Provide required domestic water piping.

.2 Piping, unless otherwise specified, is as follows:

.1 for underground piping 100 mm (4") dia. and larger outside and/or inside the building – rigid PVC;

.2 for underground piping less than 100 mm (4") dia. inside building – Type "K" soft copper;

.3 for 12 mm (½") dia. trap seal primer tubing located underground or in concrete or masonry construction – semi-rigid polyethylene;

.1 for pipe inside building and aboveground in sizes to 100 mm (4") dia. – Type "L" hard copper with solder joints.

.3 pipe for defects before being lowered into trench.

.4 Slope piping so it can be completely drained.

.5 Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe or equipment.

3.2 INSTALLATION OF SHUT-OFF AND CHECK VALVES

.1 Refer to Part 3 of Section 20 05 00 – Common Work Results for Mechanical.

.2 For shut off valves installed on solder joint copper piping up to and including 75 mm (3") diameter, provide ball type valves, and for flanged joints copper or stainless steel piping larger than 75 mm (3") diameter provide butterfly type valves.

3.3 INSTALLATION OF DRAIN VALVES

.1 Provide a drain valve at the bottom of domestic water piping risers, at other piping low points, and wherever else shown.

.2 Locate drain valves so they are easily accessible.

3.4 INSTALLATION OF DOMESTIC WATER PIPING BALANCING VALVES

.1 Provide balancing valves in each domestic hot water recirculation piping connection to the domestic hot water supply and as shown:

.1 for pipe 19 mm (3/4”) dia. and less ground – equal to Victaulic Series 76X

.2 for pipe greater than 19 mm (3/4”) dia. – equal to Victaulic TA Series 78BL

.2 Locate each valve so it is easily accessible.

3.5 INSTALLATION OF HOSE BIBBS

.1 Provide hose bibbs.

.2 Unless otherwise shown, specified, or required, mount hose bibbs approximately 1 m (3') above floor. Confirm exact locations prior to roughing-in.

3.6 INSTALLATION OF EXTERIOR NON-FREEZE WALL HYDRANTS

.1 Provide non-freeze wall hydrants.

.2 Install hydrants level and plumb such that hose outlets are approximately 600 mm (2') above grade level. Confirm exact locations prior to roughing-in.

.3 Provide a shut-off valve inside building to each exterior non-freeze wall hydrant.

3.7 INSTALLATION OF TRAP SEAL PRIMERS

.1 Provide required accessible trap seal primers to automatically maintain a water seal in floor drain traps, whether shown on drawings or not.

.2 Provide 115 volt, electronic, surface wall mounting trap primer assemblies for traps. Include for a 115 volt 15 ampere panel breaker and wiring in conduit from closest panelboards to primer assembly, all to wiring standards of Electrical Division. Adjust primer water flow and timing to suit number of traps served.

.3 Ensure trap primer piping is secured to floor drain primer tappings and not terminated through the tapping in the throat of the drain.

3.8 INSTALLATION OF SHOCK ABSORBERS

.1 Provide accessible shock absorbers in domestic water piping.

.2 Ensure size of each shock absorber is properly selected to suit size of domestic water pipe and equipment pipe is connected to.

3.9 INSTALLATION OF 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 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 manufacturer’s instructions and details.

3.10 INSTALLATION OF BACKFLOW PREVENTERS

.1 Provide a reduced pressure zone assembly backflow preventer in each direct domestic water connection to equipment other than plumbing fixtures and fittings and at all interior hose-bibs.

.2 Provide a double check valve assembly backflow preventer on incoming DCW service. Provide a reduced pressure zone assembly backflow preventer in each direct domestic water connection to equipment other than plumbing fixtures and fittings.

.3 Locate each backflow preventer on floor or wall between 765 mm and maximum 1.5 m (30" and 60") above floor such that it is easily accessible for maintenance and testing. 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.

3.11 INSTALLATION OF LAVATORY SUPPLY FITTING TEMPERING VALVES

.1 Provide thermostatic water tempering valves for hot water supply to public washroom lavatory supply fittings. Conceal valves and piping.

.2 Provide a flush wall mount panel for each valve. Confirm exact location prior to roughing-in.

.3 Install in accordance with manufacturer's instructions and set mixing valves to deliver 32°C (90°F) tempered water.

3.12 INSTALLATION OF AIR VENTS

.1 Provide accessible air vents in domestic water piping to prevent air binding.

.2 Extend copper indirect drain piping from top drain connection of each vent to nearest suitable drain.

.3 Locate exact vent locations on as-built record drawings.

3.13 INSTALLATION OF DOMESTIC WATER THERMAL EXPANSION TANK

.1 Provide domestic water thermal expansion tanks.

.2 Unless otherwise specified, mount at least 450 mm (18") from cold water inlet to domestic water heater.

.3 Adjust pre-charge to match incoming water pressure after installation.

.4 Install in accordance with manufacturer's instructions and as per local governing Codes and Regulations.

3.14 FLUSHING AND DISINFECTING PIPING

.1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.

.2 Isolate new piping from existing piping prior to flushing and disinfecting procedures.

.3 Flush piping until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.

.4 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601.

.5 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill the systems.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for all equipment and associated hardware specified in this Section.

.2 Submit manufacturer/supplier installation certification letters as specified in Part 3 of this Section.

.3 Submit, prior to Substantial Performance of the Work, start-up or test data specified in Part 3 of this Section.

2 Products

2.1 HORIZONTAL IN-LINE CIRCULATING PUMPS

.1 All bronze construction centrifugal pumps in accordance with drawing schedule and complete with:

.1 lead free cast bronze casing with flanged pipe connections;

.2 alloy steel shaft with integral thrust collar, copper shaft sleeve, and oil lubricated bronze sleeve bearings;

.3 balanced lead free cast bronze impeller;

.4 motor conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical, connected to motor by means of a 4-spring coupling with guard;

.5 mechanical seal.

.2 Acceptable manufactures are:

.1 S.A. Armstrong Ltd.;

.2 ITT Bell & Gossett;

.3 Grundfos Canada Inc.;

.4 Patterson Pump Company.

2.2 CIRCULATING PUMP AUTOMATIC CONTROLS

.1 Equal to ITT Bell & Gossett Model TC-1 115 volt, programmable, Automatic Timer Kit to control circulating pump on and off at pre-set minimum 15 minute intervals, and equipped with ON (continuous run), OFF (at all times), and TIMER (run at programmed times) modes.

.2 Equal to ITT Bell & Gossett AQS Series 115 volt Aquastat to automatically control pump on and off in response to domestic water temperature and equipped with a stainless steel pipe clip, bimetal sensing element, and insulated #18 AWG 450 mm (18") wire leads.

3 Execution

3.1 INSTALLATION OF CIRCULATING PUMPS

.1 Provide horizontal in-line domestic hot water circulating pumps.

.2 Install pumps in place in vertical piping approximately 1.2 m (4') above floor in accordance with pump manufacturer's instructions.

.3 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.4 Include for 2 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.

3.2 INSTALLATION OF CIRCULATING PUMP CONTROLS

.1 Provide a programmable timer and an aquastat to automatically control pump on and off in response to pre-set times and domestic water temperatures. Install in accordance with manufacturer's instructions. Programme both devices in accordance with Consultant's instructions.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings.

1.2 CLOSEOUT SUBMITTALS

.1 Submit a copy of plumbing inspection certificate prior to application for Substantial Performance of the Work.

.2 Submit letters from product manufacturers/suppliers to certify correct installation of products as specified in Part 3 of this section.

2 Products

2.1 PIPE, FITTINGS, AND JOINTS

.1 PVC Sewer

.1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.

.2 DR35 rigid, PVC sewer pipe and fittings, with solvent weld joints, all certified to CSA B182.1 and colour-coded as per local governing codes, regulations and standards.

.2 PVC - DWV

.1 Equal to Ipex System XFR 15-50 rigid PVC drain, waste and vent pipe and fittings to CAN/CSA B181.2, complete with a flame spread rating less than 25 and a smoke developed rating less than 50 when tested to CAN/ULC S102.2, solvent weld joints, and, for fire barrier penetration, approved firestop conforming to CAN/ULC S115.

.3 Copper - Solder Joint

.1 Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.

.4 Cast Iron

.1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.

.5 Copper-Victaulic Coupling Joint

.1 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.

2.2 VENT STACK COVERS

.1 Equal to Lexcor Model "Flash-Tite" seamless, spun aluminum, insulated vent stack covers with caps and a factory applied asphalt primer coating on top and bottom of flange.

2.3 CLEANOUTS

.1 Horizontal Piping

.1 TY pipe fitting with an extra heavy brass plug screwed into the fitting.

.2 Vertical Piping

.1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.

.3 Urinal(s)

.1 Wall access cleanout assemblies, each complete with a tapered plug, threaded brass insert, urethane rubber seal, and polished stainless steel access cover with vandal-proof stainless steel securing screw.

.2 Acceptable products are:

.1 Watts Industries (Canada) Ltd. #CO-590-RD.

.2 Jay R. Smith #SQ4-1819;

.3 Zurn #ZSS-1666-1;

.4 Mifab #C1440-RD;

2.4 FLOOR CLEANOUT TERMINATIONS

.1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware.

.2 Acceptable products are:

.1 Watts Industries (Canada) Ltd. # CO-200-R-1.

.2 Jay R. Smith #4020-F-C Series;

.3 Zurn # ZN-1602-SP Series;

.4 Mifab # C1100-XR-1 or #C1000-R-3;

.3 Cleanout terminations in areas with a tile or sheet vinyl floor finish are to be as above but with a square top in lieu of a round top.

2.5 FLOOR DRAINS, FUNNEL FLOOR DRAINS, AND HUB DRAINS

.1 Unless otherwise specified or indicated, floor drains are to be vandal-proof drains in accordance with drawing symbol list, each complete with a cast iron body and a trap seal primer connection. Cast iron components are to be factory finished with latex based paint coating.

.2 Floor drains in areas with a tile or sheet vinyl floor finish are to be as above but with a square grate in lieu of a round grate.

.3 Acceptable manufacturers are:

.1 Watts Industries (Canada) Ltd.;

.2 Jay R. Smith Manufacturing Co.;

.3 Zurn Industries Ltd.;

.4 Mifab Inc.

2.6 ROOF DRAINS

.1 Unless otherwise specified or indicated, roof drains are to be cast iron body drains with aluminium domes, in accordance with the drawing symbol list. Cast iron components are to be factory finished with a latex based paint coating.

.2 Acceptable manufacturers are:

.1 Watts Industries (Canada) Ltd.;

.2 Jay R. Smith Manufacturing Co.;

.3 Zurn Industries Ltd.;

.4 Mifab Inc.

2.7 DRAINAGE TRENCH FRAMES AND GRATING

.1 Welded, hot dipped galvanized, 45 mm x 45 mm x 6.4 mm (1-¾" x 1-¾" x ¼") carbon steel angle frame, 300 mm (12") wide, with anchor straps and lengths as required, and baked epoxy coated cast iron slotted grating in 600 mm (24") long sections.

.2 Acceptable products are:

.1 Watts Industries (Canada) Ltd. #TD-910-B1-4;

.2 Jay R. Smith #2971VP.

.3 Zurn # Z796VP;

2.8 TRENCH DRAINS

.1 Modular, pre-sloped, ductile iron frame, UV stabilized talc-filled polypropylene construction interlocking sections of drainage channel with overlapping joints, 6” wide, 6x24x24 catch basin with trash basket, end caps and covers to suit the application, integral anchor tabs for grate anchoring and trench levelling, heavy-duty coated steel angle top frames, and heavy-duty ADA coated cast iron slotted grate supplied in 600 mm (24") long sections rated for minimum DIN Class E.

.2 Acceptable products are:

.1 Watts Industries (Canada) Inc. “Dead Level D” Series;

.2 Jay. R. Smith #9931 Series.

.3 Zurn "Z886-HDG" System;

2.9 TRENCH DRAINS

.1 Modular, pre-sloped, ductile iron frame, UV stabilized talc-filled polypropylene construction interlocking sections of drainage channel with overlapping joints, 6” wide, 6x24x24 catch basin with trash basket, end caps and covers to suit the application, integral anchor tabs for grate anchoring and trench levelling, heavy-duty coated steel angle top frames, and heavy-duty ADA coated cast iron slotted grate supplied in 600 mm (24") long sections rated for minimum DIN Class E.

.2 Acceptable products are:

.1 Watts Industries (Canada) Inc. “Dead Level D” Series;

.2 Jay. R. Smith #9931 Series.

.3 Zurn "Z886-HDG" System;

2.10 OIL INTERCEPTORS

.1 Epoxy coated steel construction automatic oil interceptor rated for 100 GPM with removable baffles, deep seal trap with cleanout, sediment bucket, heavy duty load rated cover, flow control fitting, and remote wall mounting indicating panel with status indicating lights, audible alarm, 115/24 volt control transformer, and NEMA 2 surface wall mounting enclosure.

.2 Acceptable products are:

.1 Mifab MI-O Series;

.2 Watts Industries (Canada) Inc.;

.3 Jay R. Smith.

.4 Zurn ;

2.11 LINT TROUGHS

.1 Type 304 stainless steel, 12’ long lint trough with removable stainless steel filter screens, perforated stainless steel dome bottom strainer, and 4"(102) no hub bottom outlet.

.2 Acceptable products are:

.1 Watts LI-LT;

.2 Jay. R. Smith SQ-9-3615 Series;

3 Execution

3.1 DRAIN AND VENT PIPING INSTALLATION REQUIREMENTS

.1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:

.1 for underground pipe inside building and to points 1.5 m (5') outside building lines – rigid PVC sewer pipe, minimum 75 mm (3") dia.;

.2 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;

.3 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;

.4 for pipe inside building and aboveground in lieu of type DWV copper and cast iron, at your option and where permitted by governing Codes and Regulations – rigid PVC DWV;

.2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').

.3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.

.4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').

.5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.

.6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.

3.2 INSTALLATION OF SHUT-OFF AND CHECK VALVES

.1 Provide a shut-off valve and a check valve in discharge piping of each drainage pump.

.2 Locate valves so they are easily accessible without the use of ladders or other such devices.

3.3 SUPPLY OF VENT STACK COVERS

.1 Supply a properly sized vent stack cover for each vent stack penetrating roof.

.2 Hand vent stack covers to roofing trade at site for installation and flashing into roof construction as part of roofing work. Coordinate installation to ensure proper locations. Provide waterproofing caps over vent stacks.

3.4 INSTALLATION OF CLEANOUTS

.1 Provide cleanouts in drainage piping in locations as follows:

.1 in building drain or drains as close as possible to inner face of outside wall, and, if a building trap is installed, locate cleanout on downstream side of building trap;

.2 at or as close as practicable to the foot of each drainage stack;

.3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;

.4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;

.5 in the wall at each new urinal or bank of urinals in a washroom;

.6 wherever else shown on drawings.

.2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.

.3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

3.5 INSTALLATION OF FLOOR CLEANOUT TERMINATIONS

.1 Where cleanouts occur in horizontal inaccessible underground piping, extend cleanout TY fitting up to floor, and provide a cleanout termination set flush with finished floor.

.2 In waterproof floors, ensure each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit floor finish.

.3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.

.4 Ensure cleanout termination covers in tiled floor are square in lieu of round.

3.6 INSTALLATION OF FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS

.1 Provide floor drains, funnel floor drains and hub drains.

.2 Coordinate location of floor drains, funnel floor drains and hub drains with equipment provided by Mechanical Division and Owner's supplied equipment. Install in accordance with manufacturer's instructions.

.3 Equip each drain with a trap.

.4 In equipment rooms and similar areas, exactly locate floor drains to suit location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.

.5 Confirm exact location of drains prior to roughing in. Where floor drains occur in washrooms coordinate locations with toilet partition installations.

.6 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final clean-up work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates, and refinish any areas of the drain where cast iron finish has been damaged or removed, including rusted areas.

3.7 INSTALLATION OF ROOF DRAINS

.1 Supply roof drains and place roof drain bodies in position for flashing into roof construction as part of roofing work. Connect with piping and provide accessories.

.2 Protect roof drains from damage and entrance of debris until roofing work is complete, and refinish any areas where cast iron factory finish has been damaged or removed, including rusted areas.

3.8 INSTALLATION OF DRAINAGE TRENCH FRAMES AND GRATING

.1 Supply frame and grating sections for drainage trench. Provide piping connections, traps, etc., as required.

.2 Hand frames to concrete trade forming and pouring trenches. Ensure frames are properly and accurately installed.

.3 Be present during concrete pour to ensure frames are not dislodged or damaged and remain straight and true. Immediately report any problems.

.4 Install grates and secure in place. Temporarily cover grates during construction procedures. Clean trenches when work is complete.

3.9 INSTALLATION OF TRENCH DRAINS

.1 Provide pre-sloped sections of drainage channel and install so top frames are level and plumb in relation to floor finishes. Provide accessories, traps, etc., as required.

.2 Be present during concrete pour to ensure trench drainage is not dislodged or damaged and remains straight and true. Immediately report any problems.

.3 Install grating and secure in place.

.4 Temporarily cover trench drainage openings during construction procedures. Clean trenches when work is complete.

3.10 INSTALLATION OF DRAINAGE INTERCEPTOR

.1 Provide an interceptor in drainage piping.

.2 Ensure unit is easily accessible for maintenance. Confirm exact location prior to roughing-in.

.3 Wall mount control panel and provide required 24 volt control wiring in conduit from control panel to interceptor.

.4 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.5 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements. Submit a copy of the letter prior to Substantial Performance of the Work.

.6 Include for 2 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.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for all equipment and associated hardware specified in this Section.

.2 Submit with delivery of heater(s) a copy of the factory inspection and test report for each heater, and include a copy of each report with O&M Manual project close-out data.

.3 Submit manufacturer/supplier installation certification letters as specified in Part 3 of this Section.

.4 Submit, prior to Substantial Performance of the Work, start-up or test data specified in Part 3 of this Section.

2 Products

2.1 SEALED COMBUSTION HOT WATER HEATER

.1 Bradford White EF-series with a Thermal Efficiency Rating of 94%. It shall be design certified by CSA International (formerly AGA and CGA) for 180°F (82°C) application, either with or without a separate storage tank. The tank shall be lined with Vitraglas® vitreous enamel and shall have a bolted hand hole cleanout. The tank shall have four extruded magnesium anode rods installed in separate head couplings.

.2 Water heater shall be equipped with stainless steel cold water inlet, Sediment Reduction System.

.3 The heater shall be insulated with Non-CFC foam. This water heater shall be equipped with an electronic ignition system, an ASME rated T&P relief valve and a premix closed combustion system for direct venting using 6" (152mm) PVC, CPVC, Polypropylene, or Stainless Steel vent pipe (ULC-S636 Standard).

.4 The water heater shall be factory assembled and tested.

.5 The water heater shall be approved for zero inch clearance to combustibles.

.6 A digital LCD display shall be integrated into the front and be an adjustable electronic thermostat to any temperature up to 180°F.

.7 A recycling Energy Cut Off (E.C.O.) shuts off all gas in the event of an overheat condition.

.8 The entire installation shall be made in compliance with provincial and local codes and ordinances

.9 Contacts, relays and any other hardware, compatible with building automation system protocol and required to connect heater(s) to BAS in accordance with BAS control points list.

.10 Acceptable manufacturers are:

.1 Bradford White Canada Inc.;

.2 A.O. Smith Water Products Co.;

.3 John Wood (GSW Water Heating Co.);

.4 Rheem-Ruud Canada Ltd..

2.2 CONDENSATE NEUTRALIZING KIT

.1 Refillable, low-profile condensate neutralizing kit, suitable for no less than 12 months continuous operation at full condensing rate, and suitable in all respects for associated condensing heater.

3 Execution

3.1 DRAINAGE COORDINATION

.1 Coordinate drain requirements of plumbing equipment provided by Mechanical Division and or Owner with location of drains specified in Section 22 13 00.

3.2 INSTALLATION

.1 Provide gas fired domestic hot water heaters. Secure each heater in place, level, and plumb, on a concrete housekeeping pad.

.2 Ensure housekeeping pad is keyed to structure and tank assembly is secured to structure by slack cable restraints. Refer to Section 20 05 48.16 - Seismic Controls for Mechanical.

.3 Pipe temperature/pressure relief valve outlet to drain. Pipe condensate drain connection to drain.

.4 Coordinate installation with electrical trade who will connect heater with power wiring.

.5 Set thermostat to produce 48.8°C (120°F) hot water.

.6 Provide combustion air and flue gas vent piping for each heater in accordance with requirements of Section 23 51 23 - Gas Vents.

.7 Install inlet and outlet manifolds supplied with heaters.

.8 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.9 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements. Submit a copy of the letter prior to Substantial Performance of the Work.

.10 Include for 2 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.

.11 Provide condensate neutralizing kit and install in accordance with manufacturer's instructions.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings.

2 Products

2.1 GENERAL RE: PLUMBING FIXTURES AND FITTINGS

.1 Fixtures and fittings, where applicable, are to be in accordance with requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including supplements, ASME A112.1.18.1/CSA B125.1, Plumbing Supply Fittings, and CSA B125.3, Plumbing Fittings.

.2 Barrier-free fixtures and fittings are to be in accordance with governing Code requirements.

.3 Unless otherwise specified, vitreous china, porcelain enamelled, and acrylic finished fixtures are to be white.

.4 Unless otherwise specified, fittings and piping exposed to view are to be chrome plated and polished.

.5 Fittings located in areas other than private washrooms are to be vandal-proof.

.6 Fixture carriers are to be suitable in all respects for the fixture they support and construction in which they are located.

.7 Floor flanges for floor mounted water closets are to be cast iron or brass, secured to floor to prevent movement and complete with a wax seal and brass or stainless steel bolts, nuts, and washers. Plastic floor flanges will not be acceptable.

.8 Proper seal to mate with fixture carrier flange and produce a water-tight installation.

.9 Exposed traps for fixtures not equipped with integral traps, such as lavatories, are to be adjustable chrome plated cast brass "P" traps with cleanouts, minimum #17 gauge chrome plated tubular extensions, and chrome plated escutcheons, all to suit fixture type and drain connection.

.10 Concealed traps for fixtures not equipped with integral traps, such as counter sinks, are to be adjustable cast brass with cleanout plugs, all to suit fixture type and drain connection.

.11 Exposed supplies for fixtures which do not have supply trim/fittings with integral stops, i.e. lavatories, are to be solid chrome plated brass angle vales with screwdriver stops for public areas, wheel handle stops for private areas, flexible stainless steel risers, and stainless steel or chrome plated steel escutcheons, all arranged and sized to suit fixture.

.12 Water piping as specified, complete with ball type shut-off valves as specified with water piping, or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.

2.2 PLUMBING FIXTURES AND FITTINGS

.1 Plumbing fixtures and fittings are to be in accordance with the following:

.1 WC-1 – WALL MOUNTED ELONGATED ELECTRONIC FLUSH VALVE WATER CLOSET

.1 American Standard 3351.511.020 Toilet Wall-mounted elongated flushometer valve toilet, Combination Flush Valve and Toilet, Vitreous china, White, Toilet, 1-1/2" inlet top spud, Elongated, Powerful direct-fed siphon jet action, Fully-glazed 2-1/8" trapway, 1,000 grams of miso @ 1.1gpf, 660 x 356 x 381mm (26" x 14" x 15"), High Efficiency.

.2 American Standard 6065.111 Flush valve, Factory-Installed CR-P2 Lithium 10-year Battery, Self-Cleaning Piston with integral wiper spring significantly reduces clogging and maintenance, Selectronic® Proximity System with universal sensor, Dezincification Resistant, Fully Mechanical Manual Override Button, Fail-Safe, Adjustable Sanitary Flush, Chemical Resistant EPDM Seals, installed left or right handed, Operates in the range of 1.1 gpf to 1.6 gpf (4.2 Lpf to 6.0 Lpf), 25gpm (94.6 L/min.).

.3 Watts ISCA-101-D Carrier - Industry Standard Back-to-Back Horizontal Adjustable Closet Carrier, patented compression seal faceplate assembly, epoxy coated cast iron, 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, plated hardware, neoprene bowl gasket, adjustable ABS nipple, integral test cap, 2"(51) no hub vent connections, 4"(102) no hub waste, Adjustable for standard and wheelchair height, chrome cap nuts, Carrier complies with requirements of ASME A112.6.1M up to a 500 lb.(227 kg.) static load.

.4 Centoco AMFR1500STSCCSSFE-001 Seat - Polypropylene, Commercial, Elongated, 2" (51mm), White, Open front, less cover, Commercial, 18 5/8" (473mm), 14 1/2" (368mm), Antimicrobial, Fire Retardant.

.5 Waste outlet seal ring neoprene or graphite-felt.

.2 WC-2 – WALL-MOUNTED ELONGATED ELECTRONIC FLUSH VALVE WATER CLOSET – BARRIER FREE

.1 American Standard 3351.511.020 Toilet Wall-mounted elongated flushometer valve toilet, Combination Flush Valve and Toilet, Vitreous china, White, Toilet, 1-1/2" inlet top spud, Elongated, Powerful direct-fed siphon jet action, Fully-glazed 2-1/8" trapway, 1,000 grams of miso @ 1.1gpf, 660 x 356 x 381mm (26" x 14" x 15"), High Efficiency.

.2 American Standard 6065.111 Flush valve, Factory-Installed CR-P2 Lithium 10-year Battery, Self-Cleaning Piston with integral wiper spring significantly reduces clogging and maintenance, Selectronic® Proximity System with universal sensor, Dezincification Resistant, Fully Mechanical Manual Override Button, Fail-Safe, Adjustable Sanitary Flush, Chemical Resistant EPDM Seals, installed left or right handed, Operates in the range of 1.1 gpf to 1.6 gpf (4.2 Lpf to 6.0 Lpf), 25gpm (94.6 L/min.).

.3 Watts ISCA-101-L/R-BF Carrier - Industry Standard Single Horizontal Carrier for Floor Mounted Back Outlet Bowl, 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, plated hardware, neoprene bowl gasket, ABS nipple, integral test cap, 2"(51) no hub vent connections, 4"(102) no hub waste, chrome cap nuts.

.4 Franke Commercial CM-16104-WM Backrest - wall mounting, back rest, solid core plastic laminate panel back, antique white, 12" (305 mm), 4" (102 mm), 5 3/8" (137 mm), 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.

.5 Centoco AMFR1500STSCCSSFE-001 Seat - Polypropylene, Commercial, Elongated, 2" (51mm), White, Open front, less cover, Commercial, 18 5/8" (473mm), 14 1/2" (368mm), Antimicrobial, Fire Retardant.

.6 Waste outlet seal ring neoprene or graphite-felt.

.3 L-1 – WALL HUNG LAVATORY

.1 American Standard 90240955.001EC w/0059.020EC Basin, Vitreous china, Wall-hung, White, Center hole only, 5" (127 mm) bowl depth, 343mm (13-1/2") front to back, 394mm (15-1/2") wide, 20 1/2" (520mm) bowl length, 21 1/4" (540mm) bowl width, 520mm (20.5") deep, 540mm (21-1/4") wide, 0059.020EC Shroud/Knee Contact Guard, Everclean Anti-microbial, Recessed self-draining deck, With Overflow, Top of front rim mounted 864mm (34") from finished floor., ASME A112.19.2 for Vitreous China Fixtures, For concealed arm or wall support

.2 American Standard 7075.100.002 Faucet - COLONY, Manual, Counter Mounted, single hole, metal body, Lavatory, Polished Chrome, 1.2 gpm/4.5 L/min. maximum flow rate., No Deck Plate, Fixed Spout, 4-5/16" (111 mm), 24" Color-coded braided flexible supply hoses with 3/8" compression connections, Ceramic Disc Valve Cartridge, Metal pop-up drain, Meets the Americans with Disabilities Act Guidelines and ANSI A117.1, Lead Free: Faucet contains less than

or equal to 0.25% total lead content by weighted average, Metal lever handle, Single Handle, ASME A112.18.1, CSA B125.1, NSF 61/NSF 372.

.3 McGuire LFH170LK Supply - Lead Free, Chrome plated, Convertible loose key handle, Lavatory Supply

.4 McGuire PRODRAIN Fixture Drain - Patended Grid drain, Straight Drain, Lavatories without overflows, Heavy cast brass, Chrome plated, 17 gauge 1-1/4" (32 mm)Ø tailpiece diameter, 17 gauge 6" (152 mm) long tailpiece, Brass locknut, Heavy rubber basin washer Fiber friction washer, CSA compliant

.5 McGuire 8872C P-Trap - Heavy cast brass, Adjustable p-trap, 11-1/2" (292 mm) distance, With cleanout plug, Steel shallow flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

.6 Watts WCA-411-D- Carrier - Back-to-back Floor Mounted Lavatory Carrier with Concealed Arms, plated hardware

.4 L-2 - COUNTERTOP LAVATORY – BARRIER FREE

.1 American Standard 90240955.001EC w/0059.020EC Basin - BARRIER FREE, Vitreous china, Wall-hung, White, Center hole only, 5" (127 mm) bowl depth, 343mm (13-1/2") front to back, 394mm (15-1/2") wide, 20 1/2" (520mm) bowl length, 21 1/4" (540mm) bowl width, 520mm (20.5") deep, 540mm (21-1/4") wide, 0059.020EC Shroud/Knee Contact Guard, Everclean Anti-microbial, Recessed self-draining deck, With Overflow, Top of front rim mounted 864mm (34") from finished floor., ASME A112.19.2 for Vitreous China Fixtures, For concealed arm or wall support

.2 Chicago Faucets 116.122.AB.4 Faucet - Automatic, Deck mounted, Single Hole Centerset, ECAST construction with less than 0.25% lead content weighted, Single hole, HyTronic electronic faucet, Polished Chrome, 0.35 GPM (1.3 LPM) flow rate, Contemporary style integral spout, 5-1/8" (130 mm) projection from wall, Optional 1.5 GPM(5.7 LPM) flow rate aerator insert, Econo-flo non-aerating spray, Hardwired Operated, 12 volt AC transformer required, Stainless steel hose included, Dual-beam infrared sensor, Less Drain, ANSI/ICC A117.1,NSF/ ANSI 61,NSF/ANSI 372 Low Lead Content,ASME A112.18.1/CSA B125.1, CALGreen, 40-140° F operating temperature range, 20-125 PSI operating pressure range.

.3 Chicago Faucets 240.630.00.1 Transformer - 120 VAC 60Hz, Plug-in single use class 2A transformer, 115V Standard 2-prong outlet, 12 VAC, 50 mA, Short-circuit protection

.4 McGuire LFH170LK Supply - Lead Free, Chrome plated, Convertible loose key handle, Lavatory Supply

.5 McGuire PRODRAIN Fixture Drain - Patended Grid drain, Straight Drain, Lavatories without overflows, Heavy cast brass, Chrome plated, 17 gauge 1-1/4" (32 mm)Ø tailpiece diameter, 17 gauge 6" (152 mm) long tailpiece, Brass locknut, Heavy rubber basin washer Fiber friction washer, CSA compliant

.6 McGuire 8872C P-Trap - Heavy cast brass, Adjustable p-trap, 11-1/2" (292 mm) distance, With cleanout plug, Steel shallow flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant

.7 Watts WCA-411-D- Carrier - Back-to-back Floor Mounted Lavatory Carrier with Concealed Arms, plated hardware

.5 S-1 - DOUBLE COMPARTMENT SELF RIMMING DROP-IN SINK WITH FAUCET LEDGE

.1 Franke Commercial LBD6408-1/1 Sink - Self Rimming, Stainless Steel, 302, 20 gauge, #4 Satin finish, Topmount Commercial Sinks, Double compartment, 1 faucet hole; 1 1/2" diameter, 1 1/2" (DN38) brass tailpiece, and standpipe with guard, 8" (203 mm), 16" (406 mm), 14" (356 mm), 8" (203 mm), 31 1/4" (794 mm), With faucet ledge, 3 1/2" crumb cup strainer, Center back waste location, Undercoated to reduce condensation and resonance, Factory applied rim seal, Certified to ASME A112.19.3-2008, Certified to CSA B45.4-08, factory installed EZ TORQUE™ fasteners

.2 American Standard 4433.300.075.F15 Faucet - QUINCE, Manual, Counter Mounted, single hole, metal body, Sink, Stainless Steel, 1.5 GPM (5.7 LPM) maximum flow rate, High arc swivel spout, Adjustable spray pattern with Washerless 40mm ceramic disc valve cartridge, 8 3/4", Braided flexible Stainless Steel supply hoses with 3/8" compression connections, Ceramic Disc Valve Cartridges, Less Drain, Meets the American Disabilities Act Guidelines and ANSI A117.1, Lead Free: Faucet contains less than or equal to 0.25% total lead content by weighted average, metal handle, Single Handle, Integral Check Valves, ASME A112.18.1, CSA B125

.3 McGuire LFCK165LK Supply - Lead Free, Pipe to compression, Integral Check Supply Kit, Chrome plated, 3/8" I.P.S x 3/8" O.D, 12" (305 mm) chrome plated risers, Loose key, Faucet, Shallow wall flange

.4 McGuire 8903C P-Trap - Heavy cast brass, Adjustable p-trap, 13-3/4" (349 mm) length, With cleanout plug, Shallow steel flange, Seamless tubular brass bend, Slipnuts

.6 S-2 – WALL HUNG SINK WITH FAUCET LEDGE

.1 Franke Commercial WSS6713/2 Sink - Wall Hung, Stainless Steel, 1.4301 Chrome Nickel steel V2A, 304, 14 gauge, #4 Satin finish, Satin finish, Service Sink, Single compartment, 2 faucet holes, 1 1/4" diameter, 8" centerset, no, 12" (305 mm), 13" (330 mm), 16" (406 mm), 17" (432 mm), 25" (635 mm), 20" (508 mm), With faucet ledge, 3 1/2" crumb cup strainer, Center waste location, Radius coved bowl corners, Certified to ASME A112.19.3-2008 / CSA B45.4-08

.2 American Standard 7293.172H.002 Faucet - Manual, Wall Mounted, 8" centerset spread, Cast Brass Construction, Mop Sink, Polished Chrome, 1.5 GPM (5.7 LPM) maximum flow rate., Rigid/swivel gooseneck spout, 8-1/2" (216 mm), Less Supply, Ceramic Disc Valve Cartridge, Less Drain, Lead Free: Faucet contains less than or equal to 0.25% total lead content by weighted average, Metal wrist blade handles, Two Handles, ANSI A117.1 ASME A112.18.1 CSA B125 NSF 61/Section 9

.3 McGuire LFCK165LK Supply - Lead Free, Pipe to compression, Integral Check Supply Kit, Chrome plated, 3/8" I.P.S x 3/8" O.D, 12" (305 mm) chrome plated risers, Loose key, Faucet, Shallow wall flange

.4 McGuire 8903C P-Trap - Heavy cast brass, Adjustable p-trap, 13-3/4" (349 mm) length, With cleanout plug, Shallow steel flange, Seamless tubular brass bend, Slipnuts

.7 S-1 - SINGLE COMPARTMENT SELF RIMMING DROP-IN SINK WITH FAUCET LEDGE

.1 Franke Commercial LBS7312P-1/1 Sink - Countertop, Stainless Steel, 304, 18 gauge, #4 Satin finish, Topmount Commercial Sinks, Single compartment, 1 faucet hole; 1 1/2" diameter, 1 1/2" (DN38) brass tailpiece, and standpipe with guard, 12" (305 mm), 17 1/2" (444 mm), 23 1/2" (597 mm), 12" (305 mm), 25 5/8" (651 mm), With faucet ledge, 3 1/2" crumb cup strainer, Center waste location, Undercoated to reduce condensation and resonance, Factory applied rim seal, Certified to ASME A112.19.3-2008, Certified to CSA B45.4-08, factory installed EZ TORQUE™ fasteners

.2 American Standard 4433.300.075 Faucet - QUINCE, Manual, Counter Mounted, single hole, metal body, Sink, Stainless Steel, 1.5 GPM (5.7 LPM) maximum flow rate, High arc swivel spout, Adjustable spray pattern with Washerless 40mm ceramic disc valve cartridge, 8 3/4", Braided flexible Stainless Steel supply hoses with 3/8" compression connections, Ceramic Disc Valve Cartridges, Less Drain, Meets the American Disabilities Act Guidelines and ANSI A117.1, Lead Free: Faucet contains less than or equal to 0.25% total lead content by weighted average, metal handle, Single Handle, Integral Check Valves, ASME A112.18.1, CSA B125

.3 McGuire LFCK165LK Supply - Lead Free, Pipe to compression, Integral Check Supply Kit, Chrome plated, 3/8" I.P.S x 3/8" O.D, 12" (305 mm) chrome plated risers, Loose key, Faucet, Shallow wall flange

.4 McGuire 8903C P-Trap - Heavy cast brass, Adjustable p-trap, 13-3/4" (349 mm) length, With cleanout plug, Shallow steel flange, Seamless tubular brass bend, Slipnuts

.8 MS-1 - MOP SINKS

.1 Stern-Williams #HL-1810 HiLow, 24” x 24" x 12" (610 mm x 610 mm x 305 mm) floor mounted pre-cast terrazzo mop sink with cast brass drain assembly, stainless steel strainer, one-piece integral stainless-steel cap on all four (4) sides, Hose and wall hook, Mop hanger, Splash Catcher panel, 20 gauge, type 304 stainless steel.

.2 American Standard 8344.212.004 Faucet - Manual, Wall Mounted, 8", Cast Brass Construction, Mop Sink, Rough Chrome, 15 GPM at 60 PSI, 6" cast brass spout with vacuum breaker, 10-1/4" (259 mm), Less Supply, Ceramic Disc Valve Cartridge, Less Drain, Metal lever handles, Two Handles, ASME A112.18.1, CSA B125

.3 Trap - 3" (75 mm) diameter cast iron or rough copper "P" trap.

.9 SH-1 - PRESSURE BALANCING SHOWER SYSTEM WITH SHOWER HEAD

.1 Chicago Faucets SH-PB1-07-000 Complete Shower Trim - Polished Chrome, Pressure balancing shower system with shower head and valve trim options, 1.5 GPM (5.7 LPM) flow rate @ 80 PSI, Showerhead with adjustable spray

.2 Watts #FD-100-A Floor Drain, 2" outlet, epoxy coated cast iron, anchor flange, adjustable round nickel bronze strainer, reversible clamping collar with primary and secondary weepholes

.3 Trap – provide P-Trap, same material as the connecting pipe drain.

.10 SH-2 - PRESSURE BALANCING SHOWER SYSTEM WITH SHOWER HEAD, HAND SPRAY, AND DIVERTER – BARRIER FREE

.1 Chicago Faucets SH-PB1-17-042 Complete Shower Trim - Polished Chrome, Pressure balancing shower system with shower head, hand spray, and valve trim options, 1.5 GPM (5.7 LPM) flow rate @ 80 PSI, Showerhead with adjustable spray, With Hand Shower, 1.5 GPM (5.7 LPM) flow rate, Diverter valve with indexed wall flange

.2 Watts #FD-100-A Floor Drain, 2" outlet, epoxy coated cast iron, anchor flange, adjustable round nickel bronze strainer, reversible clamping collar with primary and secondary weepholes

.3 Trap – provide P-Trap, same material as the connecting pipe drain.

.11 EW-1 - EYE/FACE WASH, WALL MOUNTED, STAINLESS STEEL BOWL

.1 Guardian G1750TPG3600LF Emergency Equipment - Thermostatic mixing valve blends hot and cold water, 1-1/2" (38 mm) outer diameter chrome plated brass tailpiece, Eye/face wash with stainless steel bowl, Wall mounted, Corrosion resistant powder coated finish, 11-1/8" (283 mm) Ø bowl size, Two FS-Plus spray heads with flip top dust cover each, 1/2" (13 mm) Ø IPS Chrome plated brass stay open ball valve, 1/2" (13 mm) Ø NPT female inlet, 1-1/4" (32 mm) Ø NPT female outlet, Heavy duty cast aluminum wall bracket, ANSI compliant

2.3 ACCEPTABLE MANUFACTURERS

.1 Subject to compliance with requirements, manufacturers that may be incorporated into the Work include, but are not limited to, following:

.1 Flush Valves:

.1 Sloan;

.2 Delta Commercial;

.3 Zurn Industries;

.4 American Standard;

.5 Moen Commercial.

.2 Plumbing Brass:

.1 Sloan;

.2 Acorn Engineering;

.3 American Standard;

.4 Delta Commercial;

.5 Chicago Faucet;

.6 Moen Commercial.

.3 Stainless Steel Sinks:

.1 Franke Commercial;

.2 Novanni Commercial;

.3 Aristaline;

.4 Arch Metal Ind.

.4 Mop Sinks:

.1 Stern Williams;

.2 Acorn Engineering;

.3 Zurn Industries.

.5 Drain Fittings, Angle Supplies, and Traps:

.1 McGuire;

.2 American Standard;

.3 Delta Commercial;

.4 Zurn Industries.

.6 Fixture Carriers:

.1 Watts Industries;

.2 Jay R. Smith;

.3 Zurn Industries.

.7 Water Closets, Lavatories, and Urinal:

.1 American Standard;

.2 Zurn Industries;

.3 Kohler.

.8 Thermostatic Mixing Valves:

.1 Lawler;

.2 Delta Commercial;

.3 Leonard.

.9 Shower and Associated Trim:

.1 American Standard;

.2 Delta Commercial;

.3 Zurn Industries;

.4 Moen Commerical.

.10 Toilet Seats:

.1 Olsonite;

.2 Centoco;

.3 Bemis Commercial.

2.4 CAULKING

.1 General Electric Series SCS-1200 Silicone Construction Sealant or Dow Corning 780 silicone rubber sealant with primers as recommended by sealant manufacturer. Caulking colour(s) for coloured fixtures other than white, if any, will be selected by Consultant from sealant manufacturer's standard colour range.

3 Execution

3.1 INSTALLATION OF PLUMBING FIXTURES AND FITTINGS

.1 Provide required plumbing fixtures and fittings.

.2 Connect plumbing fixtures and fittings with piping sized in accordance with drawing schedule. Refer to manufacturer's published connection (rough-in) requirements. Where manufacturer requires piping connection larger than shown below, provide piping accordingly:

FIXTURE AND/OR FITTING	DRAIN SIZE MM (IN.)	VENT SIZE MM (IN.)	DHW SIZE MM (IN.)	DCW SIZE MM (IN.)	TEMP WATER SIZE MM (IN.)
Water Closets Tank Type	75 (3)	38 (1-½)	----------	12 (½)	----------
Urinals	75 (3)	38 (1-½)	----------	25 (1)	----------
Lavatories	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	----------
Counter Sinks	38 (1-½)	32 (1-¼)	12 (½)	12 (½)	----------
Shower Valves and Heads	----------	----------	12 (½)	12 (½)	12 (½)
Shower Stalls	50 (2)	38 (1-½)	12 (½)	12 (½)	12 (½)
Prefab. Mop Sinks with Drain	75 (3)	38 (1-½)	20 (¾)	20 (¾)	----------

.3 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.

.4 When installation is complete, check, and test operation of each fixture and fitting. Adjust or repair as required.

.5 For barrier-free fixtures, comply with mounting height and other requirements of governing Code(s).

.6 Supply templates for counter mounted fixtures and trim and hand to trades who will cut the counter. Ensure openings in counter are properly located.

.7 Protect shower bases from damage during construction and finishing work.

.8 Confirm exact mixing valve and shower head locations prior to roughing-in.

.9 Install refrigerated drinking fountains in accordance with manufacturer’s instructions. Plug into a wall receptacle provided as part of electrical work. Coordinate receptacle installation with electrical trade on site.

.10 For emergency showers, install so bottom of shower head is approximately 2 m (82") above floor, and approximately 400 mm (16") out from the wall. Wall mount mixing valve approximately 1.5 m (5') above floor and adjacent shower head. Set valve temperature limit stop to 35°C (95°F). Ensure valve is open and exposed piping is chrome plated or stainless steel.

.11 Install eye wash fixtures in accordance with manufacturer’s instructions. Ensure exposed piping is painted.

.12 Wall mount mixing valves for emergency fixtures approximately 1.5 m (5') above floor and secure in place. Check and confirm valve operation and temperature of tempered water supply. Provide cabinets. Identify each cabinet and hand 3 identified cabinet keys to Consultant prior to Substantial Performance of the Work.

.13 Set mop service basins on floor over drain piping and connect to roughed-in service. Install wall supply trim and any accessories specified.

3.2 CAULKING AT PLUMBING FIXTURES AND FITTINGS

.1 Caulk around plumbing fixtures and fittings where they contact walls, floors, and any other building surface.

.2 Clean areas/surfaces to be caulked and prime in accordance with sealant manufacturer's instructions. Where damage to a building surface may occur, mask surface to prevent damage and ensure a clean exact edge to the caulking bead.

.3 Apply caulking using a gun with proper size and shape of nozzle and force sealant into joints to ensure good surface contact and a smooth and even finished bead of sealant.

.4 If joints have been masked sealant may be tooled in a continuous stroke to obtain complete void filling. Remove masking tape immediately after tooling and before sealant begins to skin.

3.3 DISHWASHER CONNECTIONS

.1 Provide roughed-in water and drain connections for Owner supplied dishwasher consisting of:

.1 15 mm (½") dia. domestic hot water connection with a Dahl "Mini-Ball" valve with hose end and water hammer arrestor;

.2 40 mm (1-½") dia. DWV copper drain connection with "P" trap and cleanout plug.

3.4 CLOTHES WASHER CONNECTIONS

.1 Provide roughed-in water and drain connections for Owner supplied clothes washer consisting of:

.1 15 mm (½") dia. piping connection for both hot and cold water, each terminated in a Dahl "Mini-Ball" Valve with hose end and water hammer arrestor;

.2 40 mm (1-½") dia. standing waste with a height to suit the washer drain and complete with a "P" trap.

3.5 GEAR EXTRACTOR CONNECTIONS

.1 Provide roughed-in water and drain connections for Owner supplied clothes washer consisting of:

.1 20 mm (¾") dia. piping connection for both hot and cold water, each terminated in a Dahl "Mini-Ball" Valve with hose end and water hammer arrestor; include for additional connection to hot water inlet for soap chute.

.2 75 mm (3") dia. drain down to trench.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data for all products specified in Part 2 of this section except for pipe, fittings, and unions. Indicate performance criteria, conformance to appropriate reference standards, and limitations.

.2 For each gas pressure regulating station, submit:

.1 a selection sheet for each PRV, indicating connected equipment, heating loads, design allowance, meter model, body size, spring range and orifice size;

.2 a selection sheet for each relief valve(s) serving a PRV.

1.2 QUALITY ASSURANCE

.1 All gas system work is to be in accordance with requirements of CAN/CSA-B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.

.2 All gas system work is to be performed only by licensed gas pipe fitters (holding Gas Technician 1 Certificate) authorized under the TSSA Act.

.3 Apply for, on TSSA forms, approval of the gas system design by the TSSA prior to work beginning at the site and prior to ordering any equipment. Submit the completed TSSA Form and copies of shop drawings/product data sheets as required to the TSSA and obtain an approval certificate. Pay all costs for the TSSA review and approval process. If the TSSA requires revisions to the system and the revisions result in an extra cost, a Notice of Change will be issued by the Consultant for the revision.

2 Products

2.1 PIPE, FITTINGS AND JOINTS

.1 Coated Black Steel - Welded Joints: "Yellow Jacket" Schedule 40 mild black carbon steel, ASTM A53, Grade B, factory coated with yellow plastic, mill or site bevelled, and complete with forged steel butt welding fittings and welded joints. All bare metal surfaces are to be cleaned and corrosion protected with a suitable Denso primer and tape corrosion protection system.

.2 Polyethylene: Safety yellow coloured polyethylene pipe, fittings, and joints to CSA-B137.4.

.3 Coated Copper: Type "K" soft temper copper with a factory applied external yellow plastic coating and flare fittings with forged brass nuts to CAN/CSA-B149.1. Nuts are to be stamped with the designation C37700 to indicate that they are forged brass.

.4 Uncoated Black Steel - Screwed Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings to ANSI B2.1, and screwed joints.

.5 Uncoated Black Steel - Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site bevelled, complete with factory made forged steel butt welding fittings and welded joints.

.6 Copper-Uncoated: Type "G" seamless copper tubing to ASTM B837, hard temper with wrought copper capillary brazed joint type fittings to ASTM B.61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45º flare type, forged or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.

.7 Flexible Stainless Steel: Flexible, CSA certified, 860 kPa (125 psi) rated, gas-tight, convoluted stainless steel tubing factory jacketed with a bright yellow PVC coating which is continuously identified. The tubing is to be supplied in coils and is to be complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps. Acceptable products are:

.1 Tru-Flex Metal Hose LLC. "Pro-Flex";

.2 Titeflex Corp. "Gastite";

.3 Omega Flex Canada "TracPipe".

2.2 PIPING UNIONS

.1 Screwed Piping: Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).

.2 Flanged Piping: Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.

.3 Copper to Steel: Equal to Kamco Products "Copper Stopper".

2.3 EARTHQUAKE ACTIVATED AUTOMATIC SHUT-OFF VALVE

.1 Equal to KAS International or Nihon Koso Model 315 HPF earthquake activated, flanged, high pressure automatic shut-off valve suitable for both natural gas and propane, ULC listed and in accordance with ANSI Z21.70, Earthquake Actuated Automatic Gas Shutoff Valves.

2.4 SHUT-OFF VALVES

.1 Ball Type: CSA certified, minimum 3100 kPa (450 psi) WOG rated, 1/4 turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends. Acceptable products are:

.1 Neo Valves Inc. #425;

.2 Kitz Corp. Code 58;

.3 Toyo Valve Co. Fig. 5044A.

2.5 PRESSURE REGULATORS

.1 CSA certified pressure regulators as follows:

.1 non-vented type: lever action, dead end lockup type, each complete with a vent limiter, self-aligning valve, die-cast aluminium housing, and synthetic rubber compound diaphragm;

.2 vented type: spring-loaded self-operated design, tight closing, selected for the facility gas pressure and piping pressure loss, and connected equipment load at full firing rate plus 20% spare, and complete with:

.1 1035 kPa (150 psi) rated cast iron body finished with corrosive resistant epoxy enamel;

.2 aluminum diaphragm and spring case with Nitrile diaphragm, disc, and body o-ring;

.3 throttling type, high flow rate, tight shut-off relief valve selected to protect equipment downstream of the regulator in coordination with regulator capacity.

.2 Acceptable manufacturers are:

.1 Maxitrol Co.;

.2 Fisher Controls;

.3 Leslie Controls Inc.;

.4 Lakeside Process Controls.

3 Execution

3.1 NATURAL GAS SERVICE

.1 Make all required arrangement with the natural gas supply utility on behalf of the Owner for installation of natural gas service piping with gas pressure regulator and meter assembly.

.2 Provide an earthquake activated automatic shut-off valve in gas service piping outside the building in accordance with the valve manufacturer's installation instructions. Provide an angle iron framed wire mesh enclosure around the valve and bolted to the wall.

3.2 NATURAL GAS PIPING INSTALLATION REQUIREMENTS

.1 Provide all required natural gas distribution piping and connect gas fired or operated equipment, and provide all required vent piping to atmosphere, including vent piping from pressure regulators. Do all piping work in accordance with requirements of CAN/CSA-B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.

.2 Piping is to be as follows:

.1 for underground piping, coated Schedule 40 black steel, coated soft copper, or polyethylene;

.2 for above ground piping, uncoated Schedule 40 black steel, hard temper or soft copper, or, if permitted, flexible stainless steel.

.3 Install flexible stainless-steel pipe in strict accordance with the pipe manufacturer's printed instructions.

.4 Slope gas piping in the direction of flow to low points.

.5 Ensure that supports for roof mounted piping are sized (height) to accommodate the roof slope and the required piping slope, and to permit the installation of low point dirt pockets.

.6 Provide full pipe diameter 150 mm (6") long drip pockets at the bottom of all vertical risers, at all piping low points, and wherever else shown and/or required.

.7 Identify all natural gas piping above ground with two coats of safety yellow enamel applied over primer, and SMS Ltd. or equal coil type vinyl identification makers with arrows.

.8 For all underground gas piping, provide continuous 75 mm (3") wide yellow PVC warning tape with "CAUTION - GAS LINE BURIED BELOW" wording at 750 mm (30") intervals located above the pipe approximately 250 mm (10") below grade.

.9 Rough-in all required natural gas piping for kitchen and laundry equipment in accordance with drawing plans and schedules. Obtain accurately dimensioned rough-in drawings for the equipment and confirm exact locations prior to roughing-in. When the equipment has been installed, connect the equipment from the roughed-in Work. Provide shut-off valves in all piping connections to the equipment.

.10 Include for mounting only of a solenoid valve in the gas piping to kitchen cooking equipment.

3.3 INSTALLATION OF SHUT-OFF VALVES

.1 Provide CSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.

.2 Ensure that valves are located for easy accessibility and maintenance.

3.4 INSTALLATION OF NATURAL GAS CONVENIENCE OUTLETS

.1 Provide natural gas convenience outlets and wall mount.

.2 Provide a shut-off valve in connecting piping, confirm exact location prior to roughing-in, and ensure that the outlet is rigidly secured in place.

3.5 INSTALLATION OF PRESSURE REGULATORS

.1 Provide pressure regulators in gas distribution piping where indicated and/or required.

.2 For indoor appliances, use lever acting design vent limiter type, sized as shown and mounted in a horizontal upright position in strict accordance with the manufacturer's instructions. Note that these pressure regulators do not require vent piping.

.3 Use vented type pressure regulators for all other applications.

.4 Install regulating stations in accordance with requirements of CAN/CSA-B149.1.

.5 Provide 6 mm (¼") diameter test ports upstream and downstream of each regulator assembly.

.6 Locate outdoor regulating stations a minimum of 300 mm (12") away from walkways, and 3 m (10') away from equipment air intakes and building openings. Provide all required vent piping and terminate vents in a turn-down elbow fitting with bronze bug screen secured in place.

.7 Locate indoor regulating stations in locations accessible without the use of ladders or lifts. Combine vents where permitted and increase vent pipe size accordingly. Extend vent piping up through the roof 3 m (10') away from equipment air intakes and building openings and terminated in a turn-down elbow fitting with bronze bug screen secured in place.

.8 Indicate operating set-points, relief settings and vent arrangements for each regulating station on as-built record drawings.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for all products specified in Part 2 of this section except for pipe and fittings.

.2 Submit, in shop drawing form, a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties. Piping schematics must be reviewed, approved, and signed by refrigeration equipment manufacturers prior to being submitted to Consultant for review.

.3 Submit letters from equipment suppliers certifying proper installation and start-up of piping systems and equipment as specified in Part 3 of this section.

1.2 QUALITY ASSURANCE

.1 Refrigerant piping systems are to be in accordance with CSA B52, Mechanical Refrigeration Code, and any applicable local Codes and Regulations.

.2 Refrigerant piping installing contractor is to be certified by Technical Standards and Safety Authority (TSSA). Installing contractor is to install refrigerant piping in accordance with manufacturer's installation instructions and in accordance with local codes. Contractor is responsible for all regulatory approvals, if required. Upon completion of installation, documentation of refrigerant amount, test certificates and verification documentation, etc., is to be provided in a binder, in accordance with requirements of local authorities having jurisdiction.

.3 Refrigerant piping and direct expansion refrigeration equipment must be installed by or under direct on site supervision of a licensed journeyman refrigeration mechanic.

2 Products

2.1 PIPE, FITTINGS AND JOINTS

.1 Type ACR hard drawn seamless copper refrigerant tubing to ASTM B280, factory degreased, dehydrated and capped or nitrogen filled and capped, complete with factory washed and bagged wrought copper soldering fittings to ASME B16.22, and brazed joints made with high melting point silver brazing alloy conforming to AWS Classification BcuP-5.

2.2 PIPING LINE SETS

.1 Equal to Great Lakes Copper Inc. "EZ-Roll" soft annealed copper to ASTM B280, suitable for use with refrigerant involved, factory cleaned and capped, and with sizes and lengths as required.

2.3 GENERAL RE: VALVES AND PIPING SPECIALTIES

.1 Refrigerant valves and piping specialties specified below are to factory cleaned, degreased, and supplied to site with capped ends.

2.4 SHUT-OFF VALVES

.1 Ball Valves

.1 ¼ turn, CSA certified forged brass ball valves, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with carbon filled Teflon ball seals, 2 O-ring stem seals, a gasketed seal cap, a flow direction arrow cast into body, a ball position indicator on stem, and extended copper tube connections to permit brazing the valve into line without disassembling valve.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

.2 Diaphragm Valves

.1 Forged brass, frost-proof, Type 1 Series, CSA certified packless diaphragm valves, each suitable for a 3445 kPa (500 psi) working pressure and complete with an O-ring to prevent moisture from entering diaphragm chamber, one phosphor bronze and 2 stainless steel diaphragms, and extended copper tube brazing connections.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.5 CHECK VALVES

.1 Straight through type for valves 6.4 mm to 16 mm (¼" to 5/8") diameter, globe type for valves 22 mm (7/8") diameter and larger, each complete with extended tubing for brazing connections, and as follows:

.1 straight through type check valves complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat;

.2 globe type check valves complete with a cast bronze body, forged brass cap, phosphor bronze spring, Teflon seat disc, and neoprene O-ring seal.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.6 PIPING TRAPS

.1 Mueller Industries Inc. Style No. WE-554P brazing end copper "P" traps.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.7 PRESSURE VESSEL RELIEF VALVES

.1 Factory set pressure relief valves, straight through or angle type as required, each constructed in accordance with requirements of ANSI B9.1 and the ASME Code for Unfired Pressure Vessels, and each complete with a brass body, neoprene seat disc, and lead seal and locking wire.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.8 REFRIGERANT LIQUID MOISTURE INDICATORS

.1 Forged brass, triple sealed, CSA certified liquid moisture indicators, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with a liquid indicator which shows "FULL" when system is fully charged with refrigerant and remains blank when there is a restriction or shortage of refrigerant in liquid line, a moisture indicator which changes colour from blue to pink when moisture is present in system, a plastic dust cover, and extended copper tube brazing connections.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.9 LIQUID LINE FILTER-DRIER

.1 Mueller Industries Inc. "Drymaster" CSA certified filter-driers, each suitable for a maximum 3445 kPa (500 psi) working pressure and complete with a combination of desiccants in a fluted briquette for drying, and a fluted briquette type filter.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.10 FLEXIBLE PIPING CONNECTIONS

.1 Senior Flexonics Canada "VIBRA-SORBERS" phosphor bronze construction, factory cleaned, dried, and sealed flexible piping connections with copper tube brazing ends.

.2 Acceptable manufacturers are:

.1 Senior Flexonics Canada;

.2 The Metraflex Co.

3 Execution

3.1 INSTALLATION OF REFRIGERANT PIPING, VALVES AND SPECIALTIES

.1 Provide required refrigerant piping. Piping is to be type ACR copper with wrought copper fittings. Install piping in accordance with requirements of reviewed refrigerant piping schematics referred to in Part 1 of this section.

.2 Make refrigerant piping joints using a light coat of approved brazing flux applied to both pipe and fitting. Do not use acid flux. During brazing process, ensure pipe and fittings are kept full of nitrogen or carbon dioxide to prevent scale formation inside pipe and fitting.

.3 Where shown or specified, use soft copper refrigerant piping line sets.

.4 Provide shut-off valves to isolate each piece of equipment if shut-off valves are not supplied integral with equipment. Provide ball or diaphragm type shut-off valves inside building. Provide diaphragm shut-off valves outside building.

.5 Provide a refrigerant charging valve for each system if such a valve is not supplied integral with equipment.

.6 Provide refrigerant piping accessories shown and/or required and install in accordance with manufacturer’s recommendations.

.7 Provide required refrigerant.

.8 Provide flexible connections at piping connections to roof mounted condensing units. Install in accordance with manufacturer’s instructions.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for all products specified in this section except shop fabricated ductwork and fittings.

.2 Include capacity, throw and terminal velocity, noise criteria, and pressure drops with grille and diffuser shop drawing/product data sheet submission.

.3 With shop drawing/product data sheet submission, supply evidence that fire rated duct manufacturer is ULC listed to size requirements shows on drawings.

.4 Submit duct leakage test data prior to ductwork being covered from view.

.5 Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.

.6 Submit proper installation certification from fire rated duct manufacturer as specified in Part 3 of this section.

.7 Submit a site inspection and start-up report from fan filter diffuser manufacturer's representative as specified in Part 3 of this section.

.8 Supply and hand to Owner at Substantial Performance of the Work, a minimum of 10 identified (with tags) grille/diffuser volume control damper adjustment keys.

.9 Supply reviewed copies of ventilator/curb assembly shop drawings or product data sheets to trade who will cut roof openings for ventilators, and ensure openings are properly sized and located.

1.2 QUALITY ASSURANCE

.1 Grilles and diffusers are to be tested and performance certified to ANSI/ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.

2 Products

2.1 GALVANIZED STEEL DUCTWORK

.1 Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. G60 galvanizing for bare uncovered duct to be finish painted. G90 for all other galvanizing.

.2 Rectangular

.1 Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.

.3 Round

.1 Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.

2.2 FLEXIBLE DUCTWORK

.1 Acoustic Flexible Ducting: CEH – Type HPB by Peppertree Air Solutions Inc. The core will be constructed of a spirally wound strip of acoustic rated CPE interlocked with an external helix; wrapped in Owens Corning GREENGUARD Children & Schools Certified FIBERGLAS® insulation; and sleeved by a black flame retardant low-density antistat polyethylene vapor barrier. CEH-HPB is ULC-S110 Listed as a 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 Elbow Brace: Equal to Titus, FlexRight brace to provide support for 90 degree elbows.

2.3 FLEXIBLE CONNECTION MATERIAL

.1 Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber. Acceptable products are:

.1 Duro Dyne Canada Inc. "DUROLON";

.2 Dyn Air Inc. "HYPALON".

.2 Waterproof, flameproof, high temperature flexible connection material meeting requirements of NFPA 90A, consisting of a woven glass fibre fabric coated on both sides with silicone rubber. Acceptable products are:

.1 Duro-Dyne Canada Inc. "THERMAFAB";

.2 Dyn Air Inc. "SILICON HI-T".

2.4 METAL DUCT SYSTEM JOINT SEALANT

.1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 tested maximum flame spread rating of 5 and smoke developed rating of 0.

.2 Acceptable manufacturers are:

.1 Johns Manville;

.2 Manson Insulation;

.3 Knauf Insulation.

2.5 ACOUSTIC LINING

.1 Minimum 25 mm (1") thick acoustic lining material meeting NFPA 90A requirements and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102, flexible for round ducts, board type for rectangular ducts, consisting of a closed cell, elastomeric, nitrile rubber insulation.

.2 Acceptable manufacturers are:

.1 Johns Manville;

.2 Manson Insulation;

.3 Knauf Insulation.

2.6 KITCHEN EXHAUST DUCT EXPANSION JOINT

.1 Hyspan Precision Products Inc. Series 2500 flanged, carbon steel, rectangular expansion joints sized to suit ductwork.

2.7 FACTORY INSULATED RECTANGULAR/SQUARE KITCHEN GREASE EXHAUST DUCT

.1 Equal to DuraSystems "DuraDuct KEX" kitchen exhaust duct, 2 hour rated kitchen exhaust listed and labelled to CAN/ULC S144, and meeting requirements of NFPA 96. Duct is constructed of minimum #16 gauge black sheet steel inner liner, high temperature fibre insulation and a minimum #24 gauge galvanized steel outer jacket, and complete with required fittings and accessories, including access and cleanout fittings where required. Factory-fabricated grease duct assembly is to not require additional wraps or enclosures to achieve required fire resistance rating.

2.8 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.

2.9 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.

2.10 AIR TURNING VANES

.1 For square elbows, multiple-radius turning vanes interconnected with bars, adequately reinforced to suit pressure and velocity of system, constructed of same material as duct they are associated with, and in accordance with ANSI/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° opposed blade volume control damper, constructed of same material as duct it is associated with and in accordance with requirements and details in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.11 MANUAL BALANCING (VOLUME) DAMPERS

.1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of same material as connecting ductwork unless otherwise specified, each designed to maintain internal free area of connecting duct, and each complete with:

.1 hexagonal or square shaft extension through frame;

.2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;

.3 blade stops for single blade dampers, designed to prevent blade from moving more than 90°;

.4 linkage for multiple blade dampers;

.5 locking hand quadrant damper operator with, for insulated ducts 50 mm (2") standoff mounting.

.2 Rectangular Dampers: Nailor Industries Inc. 1800 Series, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.

.3 Round Dampers: Nailor Industries Inc. Model 1890, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.

.4 Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of same material as damper and designed for tight and secure mounting of individual dampers.

.5 Acceptable manufacturers are:

.1 Nailor Industries Inc.;

.2 T.A. Morrison & Co. Inc. "TAMCO";

.3 NCA Manufacturing Ltd.;

.4 Greenheck Fan Corp.;

.5 Ruskin Co.

2.12 BACKDRAFT DAMPERS

.1 Nailor Industries Model 1370CB counterbalanced backdraft dampers, vertical or horizontal mounting, 50 mm (2") wide, sized as shown and complete with:

.1 extruded 6063-T5 aluminum frame, 2.3 mm (0.090") nominal wall thickness, with mitred corners;

.2 extruded 6063-T5 aluminum blades, 1.3 mm (0.050") nominal wall thickness on 92 mm (3-5/8") centres, and with extruded PVC blade seals;

.3 corrosion-resistant synthetic bearings;

.4 adjustable plated steel counterweights mounted internally in the airstream;

.5 concealed blade linkage located out of the airstream.

.2 Acceptable manufacturers are:

.1 Nailor Industries Inc.;

.2 T.A. Morrison & Co. Inc. "TAMCO";

.3 NCA Manufacturing Ltd.;

.4 Greenheck Fan Corp.;

.5 Ruskin Co.

2.13 FUSIBLE LINK DAMPERS

.1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to CAN/ULC S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1-1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link.

.2 Fusible link dampers are to be Type "B" or Type "C" (as required) with folded curtain blade out of air stream except where damper size or location requires use of type "A" dampers with curtain blade in air stream.

.3 Acceptable manufacturers are:

.1 Nailor Industries Inc.;

.2 Greenheck Fan Corp.;

.3 NCA Manufacturing Ltd.;

.4 Ruskin Co.;

.5 Price Industries (E.H. Price).

.6 Alumavent.

2.14 DUCT ACCESS DOORS

.1 In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for purpose for which they are provided, and, unless otherwise specified, constructed of same material as duct they are associated with.

2.15 DUCTWORK DRAIN POINTS

.1 Equal to Ductmate Canada Ltd. "Moisture Drain", 20 mm (¾") diameter moisture drains with galvanized sheet metal funnel, and chrome plated brass threaded drain, nut and cap.

2.16 INSTRUMENT TEST PORTS

.1 Equal to Duro-Dyne of Canada Ltd. #IP1 or #IP2 (to suit insulation thickness where applicable) gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

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 Price Industries Inc. DE439 or DE635, 100 mm (4") or 150 mm (6") deep (to suit wall thickness) factory assembled stationary, drainable, louvres sized as indicated on drawings, each AMCA water penetration and air performance certified, constructed of welded, extruded, alloy 6063-T5 aluminum with drainable blades, mounting and securing hardware to suit the application, and 12 mm (½") mesh aluminum birdscreen in an aluminum frame.

.2 Louvres are to be factory finished with a finish equal to PPG Industries "Duranar" fluoropolymer powder coating over primer with colour as selected from manufacturer's standard colour range.

.3 Acceptable manufacturers are:

.1 Price Industries Inc.;

.2 The Airolite Co. LLC;

.3 Construction Specialities;

.4 Nailor Industries Inc.;

.5 Kinetics Noise Control Inc.

.6 Greenheck Fan Corp.

.7 Alumavent.

.8 Ventex.

2.19 WALL BOXES

.1 Equal to Reversomatic SWBLM wall boxes leakproof seamless construction, extruded aluminum grille, sized as shown, complete with stainless steel fasteners, neoprene backdraft damper, and all required accessories to suit the application.

.2 Vent(s) to be factory finished with a finish equal to a baked "Kynar 500-XL" colour coat and a clear coat over cleaned and primed metal with colour as selected from manufacturer's standard colour range.

2.20 GRILLES AND DIFFUSERS

.1 Grilles and diffusers of type, size, capacity, finish, and arrangement as shown on drawings and in accordance with drawing schedule, each equipped with all required mounting and connection accessories to suit mounting location and application.

.2 Acceptable manufacturers are:

.1 Price Industries Inc.;

.2 Anemostat;

.3 Krueger Division of Air System Components Inc.;

.4 Titus;

.5 Nailor Industries Inc.;

.6 Tuttle & Bailey.

3 Execution

3.1 CLEANLINESS REQUIREMENTS FOR HANDLING AND INSTALLATION OF DUCTWORK

.1 Handle and install ductwork in accordance with SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

3.2 FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK

.1 Provide required ductwork, rectangular, round and/or flat oval. Where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.

.2 It is to be understood that all duct dimensions shown on drawings are clear internal dimensions.

.3 Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct pressure class designation of minimum 500 Pa (2" w.c.) positive or negative as applicable, a minimum velocity of 10 m/s (2000 fpm), and so ductwork does not "drum".

Flat surfaces of rectangular ductwork are to be cross-broken. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.

.4 Confirm routing of all ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by Consultant. Duct routing and/or dimension revisions to suit conditions at site are not grounds for a claim for an extra cost.

.5 Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, ductwork shown on mechanical drawings is schematic only and is to be altered as required to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.

.6 Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install ductwork only after fireproofing work is complete and do not compromise fire rating of sprayed fireproofing.

.7 Install (but do not connect) duct system mounted automatic control components supplied as part of the automatic control work.

.8 Where indicated, provide duct connections to fan powered heat transfer equipment with integral coils.

.9 Flange connect ductwork to hot water reheat coils in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Coils will be suspended independent of connecting ductwork as part of the heat transfer work.

.10 Support horizontal rectangular ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm (20"). Support hardware constructed of same material as duct for metal duct, and, unless otherwise specified, type 316 stainless steel for non-metal duct. Supports for "heavy" duct such as cementitious core duct is to be suitable in all respects for the application and approved by Consultant.

.11 Support round and flat oval ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at top of duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If duct is insulated, size strap to suit diameter of insulated duct. Unless otherwise specified, duct support hardware for metal duct is constructed of same material as duct, and for non-metal duct, type 316 stainless steel.

.12 Where flanged duct joints are used, do not locate joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.

.13 Where watertight horizontal ductwork is required, construct ducts without bottom longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for:

.1 ductwork outside building or otherwise exposed to the elements;

.2 shower exhaust ducts from grilles to duct main or riser;

.3 minimum of 3 m (10') upstream and downstream of duct mounted humidifiers or humidifier manifolds;

.4 fresh air intakes;

.5 wherever else shown.

.14 Seal all ductwork in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings which does not require site applied sealant. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.

.15 Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.

.16 Clean exterior exposed (uninsulated) ducts and coat with a heavy full coverage of Bakor #410-02 black metal paint.

.17 Where dissimilar metal ducts are to be connected, isolate ducts by means of flexible duct connection material.

.18 Equip ducts with a dimension of 600 mm (24") and larger and located in mechanical equipment rooms of any kind with hanger rods equipped with double deflection neoprene rod isolation hangers properly sized for associated load. Also refer to Section 20 05 48.16 - Seismic Controls for Mechanical Systems.

3.3 INSTALLATION OF FLEXIBLE DUCTWORK

.1 Provide maximum 3 m (10') long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers. Do not install flexible ductwork through walls, even if shown on drawings.

.2 At rectangular galvanized steel duct, accurately cut holes and provide flanged or "Spin-in" round flexible duct connection collars. Seal joints with duct sealer.

.3 Install flexible ducts as straight as possible and support in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, and secure at each end with nylon or stainless steel gear type clamps, and seal joints. Provide long radius duct bends where they are required.

.4 Do not penetrate fire barriers with flexible duct.

3.4 INSTALLATION OF ACOUSTIC LINING

.1 Provide acoustic lining in ductwork in locations as follows:

.1 wherever shown and/or specified on drawings;

.2 all transfer air ducts.

.2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel in accordance with detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

3.5 INSTALLATION OF SHEET STEEL KITCHEN GREASE EXHAUST DUCTWORK

.1 Provide welded sheet steel kitchen grease exhaust ductwork from exhaust hood(s) to roof mounted exhaust fans, all in accordance with requirements of NFPA 96. Construct ductwork watertight with continuous externally welded seams and joints, cleanouts, duct expansion provisions, riser residue traps, etc.

.2 Clean and prime coat ground welds in black steel ducts.

.3 Support ductwork at not greater than 1.5 m (5') intervals and ensure fasteners at hangers do not penetrate duct. Install without forming dips, sags or traps where grease reside might collect, and locate access door/cleanouts for ease of maintenance.

.4 Slope horizontal ductwork 25 mm per 300 mm (1" per foot) back to exhaust hood.

3.6 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.

3.7 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 drawings. Install splitter dampers so they cannot vibrate and rattle and so damper

operation mechanisms are in an easily accessible and operable location. Ensure operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

3.8 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.

3.9 INSTALLATION OF MANUAL BALANCING (VOLUME) DAMPERS

.1 Provide manual balancing dampers as required to provide a fully balanced system, including but not limited to in all open end ductwork, in all duct mains, and wherever else shown and/or specified.

.2 Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers cannot move or rattle. Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.

.3 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing 5 additional dampers at no additional cost.

3.10 INSTALLATION OF BACKDRAFT DAMPERS

.1 Provide backdraft dampers.

.2 Install and secure dampers so they cannot move or rattle.

3.11 INSTALLATION OF FUSIBLE LINK DAMPERS

.1 Provide fusible link dampers. Ensure damper rating (1-½ or 3 hr.) is suitable for fire barrier it is associated with.

.2 Do not use Type ‘A’ dampers where duct height is less than or equal to 300 mm (12”).

.3 Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer’s instructions and details, and Code requirements.

.4 Provide expansion clearance between damper or damper sleeve and opening in which damper is required. Ensure openings are properly sized and located, and all voids between damper sleeve and opening are properly sealed to maintain rating of fire barrier.

3.12 INSTALLATION OF FLEXIBLE CONNECTION MATERIAL

.1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans, and wherever else shown or specified.

.2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of flexible fabric and to fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure connections to flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.

3.13 INSTALLATION OF DUCT ACCESS DOORS

.1 Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

.2 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure doors are properly located for damper maintenance.

.3 When requested, submit a sample of proposed duct access doors for review.

.4 Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce ductwork to suit access door installed.

3.14 INSTALLATION OF INSTRUMENTS TEST PORTS

.1 Provide instrument test ports in all main ducts at connections to fans, plenums or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing.

.2 Locate test ports where recommended by personnel performing air quantity testing and balancing work.

3.15 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.

3.16 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.

3.17 INSTALLATION OF WALL BOXES

.1 Supply brick or block vents for installation in exterior walls.

.2 Hand assemblies to masonry trade for installation.

.3 Accurately mark exact locations and coordinate installation.

3.18 INSTALLATION OF GRILLES AND DIFFUSERS

.1 Provide grilles and diffusers. Wherever possible, grilles and diffusers are to be product of same manufacturer.

.2 Unless otherwise specified connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

.3 Exactly locate grilles and diffusers to conform to final architectural reflected ceiling plans and detailed wall elevations, and to conform to final lighting arrangement, ceiling layout, ornamental and other wall treatment.

.4 Equip supply diffusers having a basic 4-way or all round air pattern for operation in 1-, 2-, or 3-way pattern where indicated on drawings.

.5 Provide sheet metal plenums, constructed of same material as connecting duct, for linear grilles and/or diffusers where shown. Construct and install plenums in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible. Where individual sections of linear grilles or diffusers are not equipped with a volume control device, equip duct connection collar(s) with volume control device(s).

.6 Confirm grille and diffuser finishes prior to ordering.

3.19 SUPPLY OF DOOR GRILLES

.1 Supply door grilles as shown and scheduled.

.2 Hand grilles to appropriate trade at site for installation.

3.20 DUCT SYSTEM PROTECTION, CLEANING AND START-UP

.1 Temporarily cover all open ends of ducts during construction.

.2 Remove all dirt and foreign matter from entire duct systems and clean duct system terminals and interior of air handling units prior to operating fans.

.3 Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.

.4 Provide cheesecloth over duct system inlets and outlets and run system for 24 hours, after which remove cheesecloth and construction filters, and install new permanent filters.

.5 Include all labour for a complete site walk-through with testing and balancing personnel following route of all duct systems to be tested, adjusted and balanced for the purpose of confirming proper position and attitude of dampers, location of pitot tube openings, and any other work affecting testing and balancing procedures. Perform corrective work required as a result of this walk-through.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for fans and accessories. Include following:

.1 certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;

.2 certified sound power data that conforms to specified levels;

.3 product data sheets for all accessories;

.4 product data sheets for fan motors.

.2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O&M Manual project close-out data.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

.4 Supply reviewed copies of fan/curb assembly shop drawings or product data to trade who will cut roof openings for fans, and ensure openings are properly located.

.5 Submit a signed copy of destratification fan manufacturer's 5 year extended parts and labour warranty.

1.2 QUALITY ASSURANCE

.1 Fan manufacturers, as applicable, are to be current members of the Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:

.1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;

.2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;

.3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;

.4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;

.5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

2 Products

2.1 ROOF MOUNTED EXHAUST FANS

.1 Centrifugal, ULC listed, factory run tested roof mounted exhaust fans in accordance with drawing schedule.

.2 Spun aluminium housing with deep venturi inlet, aluminium curb cap with continuously welded corners, pre-punched mounting holes, galvanized steel or aluminium birdscreen, and EMT conduit chase to the motor compartment.

.3 Centrifugal, non-overloading aluminum wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.

.4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and one-piece grease lubricated pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours at maximum catalogue operating speed and equipped with a lubrication fitting, and a heavy-gauge galvanized steel adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.

.5 Motors are to conform to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, mounted on vibration isolation in a compartment outside of the airstream, and factory pre-wired to a NEMA 4 disconnect switch.

.6 Prefabricated, minimum 300 mm (12") high heavy-duty aluminum roof mounting curb with factory installed wood nailer, 40 mm (1-½") thick insulation, continuously welded seams, and damper tray.

.7 For fans as scheduled, factory supplied accessories as follows:

.1 non-corrosive low leakage Class A motorized damper with linkage, end switch, and motor with voltage to match fan motor;

.2 continuous non-corrosive piano type curb hinge to permit access to fan, damper and connecting duct, complete with retaining chain and a security hasp to prevent removal of unit from curb cap and prevent building entry through connecting ductwork;

.3 factory secured seismic restraint connection hardware.

.8 Acceptable manufacturers are:

.1 Twin City Fan and Blower;

.2 Loren Cook Co.;

.3 Greenheck Fan Corp.;

.4 JencoFan;

.5 Carnes Company Inc.

.6 Penn Barry.

2.2 CEILING MOUNTED DESTRATIFICATION FANS

.1 Big Ass Fan Co. Powerfoil X3.0, down-blowing, extra heavy-duty industrial grade, CSA certified direct drive ceiling mount destratification fans in accordance with drawing schedule, each meeting the following:

.1 Regulatory Requirements:

.1 The entire fan assembly shall be Intertek/ETL-certified and built pursuant to the construction guidelines set forth by UL standard 507 and CSA standard 22.2 No. 113.

.2 The controller shall be compliant with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) The device may not cause harmful interference, and (2) The device must accept any interference received, including interference that may cause undesirable operation.

.2 Onboard Fan Control

.1 The onboard fan controller shall be constructed using a variable frequency drive (VFD) that is pre-wired to the motor and factory-programmed to minimize the starting and braking torques for smooth and efficient operation. The onboard controller shall be prewired to the motor using a short run of flexible conduit with a dedicated ground conductor to minimize electromagnetic interference (EMI) and radio frequency interference (RFI). A 15-ft incoming power cord shall be pre-wired to the controller with one of the following plugs: NEMA L6-20P Twist-Lock Plug, NEMA L6-30P Twist-Lock Plug, NEMA L15-20P Twist Lock Plug, NEMA L16-20P Twist-Lock Plug.

.3 Airfoil System

.1 The fan shall be equipped with eight (8) airfoils of precision extruded aluminum alloy. The airfoils shall be connected by means of two (2) high strength locking bolts per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers.

.2 The fan shall be equipped with eight (8) winglets (standard) on the ends of the airfoils and eight (8) air fences positioned on the airfoils at the optimum location for performance. Both the winglets and air fences shall be molded of a polypropylene blend. The standard color of the winglet and air fence shall be “Safety Yellow.”

.4 Motor

.1 The fan motor shall be an AC induction type inverter/

.2 The motor shall be totally enclosed, fan cooled (TEFC) with an IP44 NEMA classification. A NEMA 56C standard frame shall be provided for ease of service. The motor shall be manufactured with a double baked Class F insulation and be capable of continuous operation in 32°F to 122°F (0°C to 50°C) ambient conditions.

.3 The motor shall have a C-face attachment that shall enable technicians to detach the motor for easy field service. The C-face motor adapter shall be designed to work with the gearbox.

.5 Gearbox

.1 The fan gearbox shall be a sealed drive designed specifically for the airfoils series being used. The gearbox shall include a high-efficiency, hermetically sealed, nitrogen-filled, offset helical gear reducer with two-stage gearing, a hollow output shaft, cast iron housing, double lip seals, high quality SKF Explorer Series bearings with crowned cages for optimal lubrication flow, and precision machined gearing to maintain backlash less than 11 arc-minutes over the life of the unit. Lubrication shall be high-grade, low-foaming synthetic oil with extreme pressure additives and a wide temperature range and shall be lubricated for the life of the product (no oil changes required).

.2 The gearbox shall be equipped with a hollow shaft threaded to accept a ¾" NPT fitting in which wiring, piping, etc., can be routed to below the fan. A standard junction box can be affixed to this hollow shaft to allow for installing optional features such as lights or cameras. The inclusion of the hollow shaft shall be specified at the time of order.

.6 Mounting Post

.1 The fan shall be equipped with a mounting post that provides a structural connection between the fan assembly and extension tube. The mounting post shall be formed from A36 steel, contain no critical welds, and be powder coated for corrosion resistance and appearance.

.7 Mounting System

.1 The fan mounting system shall be designed for quick and secure installation on a variety of structural supports. The design of the upper mount shall provide two axes of rotation. This design shall allow for adjustments to be made after the mount is installed to the mounting structure to ensure the fan will hang level from the structure.

.2 The upper mount shall be of ASTM A-36 steel, at least 3/16" thick, and powder coated for appearance and corrosion resistance. No mounting hardware or parts substitutions, including cast aluminum, are acceptable.

.3 All mounting hardware shall be SAE Grade 8 or equivalent.

.8 Hub

.1 The fan hub shall be 19" (48 cm) in diameter and shall be made of precision cut aluminum for high strength and light weight. The hub shall consist of two (2) aluminum plates, eight (8) aluminum spars, and one (1) aluminum spacer fastened with a pin and collar rivet system. The overall design shall provide a flexible assembly such that force loads experienced by the hub assembly shall be distributed over a large area to reduce the fatigue experienced at the attachment point for the fan blade.

.2 The hub shall be secured to the output shaft of the gearbox by means of ten (10) high strength bolts. The hub shall incorporate four (4) safety retaining clips made of 1/4" (0.6 cm) thick steel that shall restrain the hub/airfoil assembly.

.9 Advanced Digital Fan Controller

.1 The digital controller user interface shall be a wall-mounted touchscreen with a 5-inch (127-mm) display and an 800 (RGB) x 480 pixel resolution.

.2 The digital controller shall be mounted to a standard rectangular or square outlet box.

.3 A 150-ft (45.7-m) CAT5 cable shall be provided for connecting the digital controller to the fan's VFD, allowing for seamless communication between controller and VFDs. The cable shall provide power to the digital controller.

.4 The digital controller shall not require a 120 V power supply at the controller mounting location.

.5 The digital controller shall support up to eight Powerfoil X3.0 or Powerfoil X3.0 Plus fans controlled as a group or individually.

.6 The digital controller shall provide fan start/stop, speed, and direction control functions.

.7 The digital controller shall provide diagnostic and fault history information for each connected fan as well as the ability to configure fan parameters with the assistance of Manufacturer Customer Service.

.8 The digital controller shall include Smart Sensing functionality to maximize energy savings. Smart Sensing shall provide the capability to automatically control the speed of the fans using information from user-determined settings and built-in temperature and humidity sensors.

.9 The digital controller shall include a scheduling feature that shall provide the ability to create up to four fan schedules for turning fans on/off and turning Auto mode on/off.

.10 The digital controller interface shall be able to be secured with user and admin passcodes to prevent unauthorized access to fan controls and settings.

.11 The digital controller shall include Bluetooth® functionality for receiving firmware updates from a mobile app. The app shall be supported by iOS® and Android™ mobile devices. The digital controller's Bluetooth functionality can be disabled if not needed or permitted.

.12 Multi-Fan Accessory Kit

.1 The kit shall include a two-screw RJ45 terminal block, a ¼ Watt, 120 Ohm termination resistor, RJ45 pass through splitters, and split-gland cord grips for connecting multiple fans to the controller.

.10 Fire Control Panel Integration

.1 Includes a 10–30 VDC pilot relay for seamless fire control panel integration. The pilot relay can be wired Normally Open or Normally Closed in the field.

.11 Factory secured seismic restraint connection hardware.

.12 Safety Cables

.1 The fan shall be equipped with an upper safety cable that provides an additional means of securing the fan assembly to the building structure. The upper safety cable shall have a diameter of Ø3/8" (1 cm).

.2 The fan shall be equipped with two lower safety cables pre-attached to the fan hub that shall provide an additional means of securing the fan to the extension tube. The lower safety cables shall have a diameter of 1/4" (0.6 cm).

.3 The safety cables shall be fabricated out of 7 x 19 galvanized steel cable. The end loops shall be secured with swaged Nicopress® sleeves, pre-loaded and tested to 3,200 lbf (13,345 N).

.4 Field construction of safety cables is not permitted.

.2 Acceptable manufacturers are:

.1 Big Ass Fan Co.;

.2 Northwest Envirofan;

.3 Marley Engineered Products "Leading Edge".

3 Execution

3.1 INSTALLATION OF ROOF MOUNTED EXHAUST FANS

.1 Provide roof mounted exhaust fans.

.2 Supply a roof mounting curb with each fan and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of roofing work. Secure fans in place on curbs.

.3 Install dampers in curb damper tray and secure in place.

.4 Brace and secure each unit in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Systems.

.5 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.6 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.7 Include for a 4 hour 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 abnormal events.

3.2 INSTALLATION OF CEILING DESTRATIFICATION FANS

.1 Provide ceiling destratification fans.

.2 Secure each fan in place at the ceiling from structure in accordance with manufacturer's instructions and drawing details. Confirm exact locations prior to roughing-in. Install safety chains and fan blade guards.

.3 Plug each fan motor into an adjacent receptacle.

.4 Supply controller for fans as indicated and hand to electrical trade at site for wall mounting and connection to fan motor controllers. Confirm exact speed controller locations prior to installation, and include for identification of each speed controller. Controller must not be mounted adjacent to or above a radiant heat source, near HVAC ventilation intakes/exhausts, on a poorly insulated exterior wall, or in a different temperature/humidity environment than the fans it will control. Additional mounting guidelines can be found in the Installation Guide.

.5 Brace and secure each unit in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Systems.

.6 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.7 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.8 Include for a 1/2 day 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 abnormal events.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for the exhaust fan and accessories. Include following:

.1 certified fan performance curves;

.2 product data for all accessories;

.3 product data for fan motors.

.2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O&M manual project close-out data.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

.4 Supply reviewed copies of appropriate fan assembly shop drawings or product data to trade who will cut roof opening or provide wall opening for fan, and ensure openings are properly located.

1.2 QUALITY ASSURANCE

.1 Kitchen exhaust fan manufacturers are to be current members of Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:

.1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;

.2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;

.3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;

.4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;

.5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans;

.6 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations;

.7 ULC-S645, Power Ventilators for Commercial and Institutional Kitchen Exhaust Systems.

.2 Acceptable manufacturers are:

.1 CaptiveAire;

.2 Twin City Fan and Blower;

.3 Loren Cook Co.;

.4 Greenheck Fan Corp.;

.5 JencoFan;

.6 Carnes Company Inc.

.7 SpringAir.

2 Products

2.1 KITCHEN EXHAUST FANS

.1 Centrifugal, ULC listed and labelled, factory run tested up-blast type kitchen exhaust fans in accordance with drawing schedule.

.2 Spun aluminium housing with a rolled bead edge, aluminium curb cap and inlet venturi with continuously welded corners, pre-punched mounting holes, aluminum birdscreen, and EMT conduit chase to motor compartment.

.3 Centrifugal, non-overloading aluminium wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.

.4 ECM direct drive motors are to conform to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, mounted on vibration isolation in aluminum housing, and factory pre-wired to an NEMA 4 disconnect switch.

.5 Prefabricated, minimum 300 mm (12") high heavy-duty aluminum roof mounting curb with factory installed wood nailer, 40 mm (1-½") thick insulation, continuously welded seams, damper tray, and a continuous non-corrosive piano type curb hinge to permit access to the fan, damper and connecting duct, complete with retaining chain and a security hasp to prevent removal of unit from curb cap and prevent building entry through connecting ductwork.

.6 For fans as scheduled, factory supplied accessories as follows:

.1 gravity backdraft damper with #20 gauge galvanized steel frame and #26 gauge aluminum blades with felt edge blade seals;

.2 non-corrosive motorized damper with linkage, end switch, and motor with voltage to match fan motor;

.3 2-speed switch and 2-speed double winding 1-phase motor in accordance with Section 20 05 00 – Common Work Results for Mechanical;

.4 factory secured seismic restraint connection hardware.

3 Execution

3.1 INSTALLATION OF KITCHEN EXHAUST FANS

.1 Provide kitchen hood exhaust fans.

.2 Supply a roof mounting curb with each fan and hand curb to roofing trade on roof for mounting and flashing into roof construction as part of the roofing work. Secure fan curb cap in place on curb. Test hinge operation and make any required adjustments.

.3 Install damper in curb damper tray and secure in place.

.4 Brace and secure the unit in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls or Mechanical Systems.

.5 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.6 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements. Include for supervising fan operation during hood performance testing.

3.2 DEMONSTRATION AND TRAINING

.1 Include for two, 4 hour on-site operation demonstration and training sessions for two groups of six people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration.

End of Section

1 GENERAL

1.1 SUMMARY

.1 Provide all labour, materials, and equipment necessary to put in working operation a complete turnkey system to remove both diesel and automotive exhaust gases and particulate of operating vehicles within the confines of specified fire station(s). All necessary controls, motors, fittings, ductwork, blower(s), labor and all other equipment and materials specified shall be part of the work.

.2 All items of equipment and materials described in these specifications are to be furnished installed and placed into proper operating condition in accordance with good practice and manufacturer's written or published instructions.

.1 The exhaust removal system shall provide virtually 100 percent complete evacuation of all diesel fumes at the source from start up to exit of the apparatus from the fire station. The diesel exhaust removal system shall be capable of delivering complete coverage for bays up to 120 feet (36.5 m) in length. The system must be able to accommodate drive through and back-in bays to meet all the needs of the fire department.

.2 System must be designed and installed to NIOSH recommendation, specifying that occupational exposures to carcinogens be limited to the lowest feasible concentration. Exposure in the human breathing zone should be limited to lowest feasible level, without any time delay required for the system to effectively capture the diesel fumes.

.3 System must also be capable to provide virtually complete capture and evacuation of carbon monoxide emitted as part of the vehicle exhaust.

.4 Systems that solely use filters, in which diesel particulate may accumulate, and that would potentially have to be treated as hazardous materials, will not be accepted.

.5 System must meet the guidelines for the International Mechanical Code for Source Capture Systems. Such system is defined as a mechanical exhaust system designed and constructed to capture air contaminants at their source and to exhaust such contaminants to the outdoor atmosphere.

.6 The system shall not affect personnel boarding the apparatus. Hose loops shall not hang any lower than six feet from the bay floor. The hose assembly shall not come into contact with the vehicle other than one connection point to the vehicles tailpipe. The hose assembly shall not touch or drag on the bay floor.

.7 The exhaust system shall not block doorways, exits, and aisles in the apparatus bay, which could endanger the welfare of fire personnel or visitors.

.8 The exhaust system shall not need to be disconnected from the vehicle while shore lines are connected, during battery charging, or washing of the vehicle, as with other types of systems.

.9 To protect the apparatus electrical system from possible damage, the system bid shall not incorporate any type of electromagnetic device that requires the apparatus to be utilized as an electrical ground for systems operation.

.10 Due to the harmful effects of diesel exhaust, the system must be designed and capable of capturing virtually 100% of the exhaust gas and virtually 100% of the particulate even in the event of a complete power failure. The system shall not detach itself from the apparatus for any reason during a power failure other than normal exiting of the apparatus bay. System shall discharge exhaust outside the station even in the event of a power failure.

.11 The system shall capture the exhaust gases and particulate directly from the tailpipe of the apparatus by a direct connected "visible" high temperature rated hose. Particulates emitted from the apparatus are known to be heavier than air and therefore must be captured by a directly connected hose with a tight seal, as loose nozzles or air filters cannot capture these heavy particulates. The particulates have been documented to be the main respirable carcinogen in diesel exhaust, and therefore are the primary concern of the fire department to capture virtually 100% of these particulates.

1.2 SUBMITTALS

.1 Product Data: Indicate manufacturer's model number, technical data including description of components and static pressure/air flow chart, and installation instructions.

.1 Details of wiring for power differentiating between manufacturer-installed and field-installed wiring.

.2 Closeout Submittals: Operation and Maintenance data manual including spare parts list.

1.3 QUALITY ASSURANCE

.1 Engage a factory certified installer to perform work of this Section who has completed installations similar in design and extent to that indicated for this Project, and who has a record of successful in-service performance. No Exceptions.

.2 The manufacturer must be a ISO 9001:2008 certified www.iso.org manufacturer with certification issued to a United States facility, this shows a commitment to delivering the highest quality service and products to the end user. Manufacturer shall be UL and CUL Certified www.ul.com/database/ and certified by the Air Movement and Control Association (AMCA) www.amca.org/search.htm to ensure quality, consistency and reliability of products. All certification documents shall be provided and attached to the bid proposal. No exceptions. Where the requirement calls for a packaged exhaust system to be provided, all items shall be the product of the manufacturer. The product offering must be a product that has been offered by that manufacturer for a minimum period of fifteen (15) years. No prototypes or private label products by other manufacturers will be allowed. System bid shall have a life of service of no less than 10 years to establish proof of quality, longevity and service. No exceptions.

.3 Engage a firm experienced in manufacturing vehicle exhaust systems similar to that indicated for this Project and with a record of successful in-service performance.

.4 Conduct conference at Project site. Review methods and procedures related to vehicle exhaust system installation.

.1 Review access requirements for equipment delivery.

.2 Review equipment storage and security requirements.

.3 Inspect condition of preparatory work performed by other trades.

.4 Review structural loading limitations.

.5 Review that all components specified in this Section and related components specified in other Sections are accounted for.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Packing, Shipping, Handling and Unloading: Deliver components with protective packaging. Store in original protective crating and covering and in a dry location.

1.5 PROJECT/SITE CONDITIONS

.1 Existing Conditions: Verify dimensions installation areas by field measurements.

1.6 COORDINATION

.1 Coordinate layout and installation with other work, including light fixtures, fixed equipment and work stations, HVAC equipment, and fire-suppression system components.

.2 Coordinate location and requirements of service-utility connections.

1.7 REFERENCES

.1 Air Movement & Control Association International, Inc.

.1 AMCA Standard 500-D-98, "Laboratory Methods of Testing Dampers for Rating".

.2 ASTM International.

.1 Stainless Steel:

.1 A240/A240M-04ae1 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

.2 Bright, Directional Polish: No. 4 finish.

.3 Aluminum:

.1 B209/209M-04 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

.2 Powder-Coated Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

.4 Galvanized Steel:

.1 A653/A653M-04a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.8 BIDDER QUALIFICATIONS

.1 Bids will only be accepted from companies that have an established reputation in the business of system design, turnkey installation and long-term service of Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than five (5) years. Bidder shall be a registered corporation, partnership or sole proprietorship within the State where the installation is to take place. Bidder must have a current and valid state contractor's license, if required by the state for the work that is being bid. Bidder shall show proof that the system specified in this Bid Document has been field tested and proven by supplying a list of references with no less than 50 fire stations with systems installed by bidder (with comparable emergency and non-emergency run rates) within a 200 mile radius of municipality seeking bid. References shall be submitted with the Bid Document and shall include phone numbers and contact names.

1.9 MANUFACTURER QUALIFICATIONS

.1 Bids shall only be accepted by bidders supplying equipment from manufacturers that have an established reputation in the business of manufacturing Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than fifteen (15) years. The manufacturer must be a ISO 9001:2008 Certified in the United States www.iso.org, UL and CUL Certified www.ul.com/database/ and certified by the Air Movement and Control Association (AMCA) www.amca.org/search.htm to ensure quality, consistency and reliability of products. Certification documents shall be provided and attached to the bid proposal. No exceptions. Where the requirement calls for a packaged exhaust system to be provided, all items shall be the product of the manufacturer. The product offering must be a product that has been offered by that manufacturer for a minimum period of fifteen (15) years. No prototypes or private label products by other manufacturers will be allowed. System bid shall have a life of service of no less than 10 years to establish proof of quality, longevity and service. No exceptions.

1.10 SYSTEM OPERATION

.1 The auto-disconnect exhaust system shall be a 24-volt **electromagnetic** release type that captures 100% of the exhaust emissions directly from the tail pipe and discharges those emissions to a specific location by means of an exhaust fan. Upon emergency dispatch of the vehicle, the exhaust fan shall automatically start prior to the engine being energized. The exhaust fan shall remain in the "on" position for as long as any engine is running. Upon vehicle exit, the hose assembly remains connected to the tail pipe and automatically disconnects at a specified distance outside the door by de-energizing the electromagnet. The nozzle and hose assembly shall smoothly separate from the vehicle and safely retract to the stored position ready to connect to the vehicle upon reentry. Upon disconnection, the hose assembly shall not be permitted to swing wide or touch the floor, possibly endangering personnel or apparatus. The hose shall remain at the door, ready for reconnection. Once the apparatus has left the building, the fan will automatically shut down after a preset time interval. Upon return, the fan is automatically activated prior to vehicle entry and the nozzle is connected to the tail pipe in a standing position**. Bending over to connect the exhaust system and expose the operator to harmful exhaust fumes is not**

permitted. No positive locking device or moving parts shall be permitted to be connected to the tail pipe. After the vehicle has been turned off, the fan can continues to operate for a preset time interval, normally two minutes.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Nederman.

2.2 SUCTION RAIL ASSEMBLY

.1 The Suction Rail shall be a polished aluminum extrusion that is formed in a configuration such that the extrusion serves not only as a suction duct, but also as the guide rail that the extraction trolley travels in. The wall thickness of the aluminum extrusion shall be no less than 2.381 mm (0.09375”). The weight of the aluminum extrusion is 6.8 kg/m (4.6 lbs. per lineal foot). The area of the aluminum extrusion, in a cross-sectional view, shall have the minimum equivalent area of 189 cm^2 (0.2035 sq. ft.) with an overall length as specified and indicated on the drawings. Each open end of the suction rail shall be covered with an end cap that can also be used as a round duct outlet for 15 cm (6”) diameter exhaust duct. As an alternate outlet, one or more rectangular-to-round transitions can be mounted on the topside of the suction rail after the cutout has been made per the manufacturer’s specified size. A pair of EPDM rubber seals is installed at the bottom of the extrusion opening. The rubber seals have a Teflon strip on the inside surface which enables the trolley to travel smoothly and unhindered. The rubber seals close tightly during fan operation for an airtight seal, but open evenly around the trolley during trolley travel. The suction rail shall be supplied with internal rubber bumpers installed at both ends that serve as secondary stops to the trolley. The suction rail shall be supplied with suspension attachments that are specifically designed for fastening to the configuration of the suction rail. Spacing of the suspension attachments shall not exceed 16 feet center-to-center.

2.3 EXTRACTION TROLLEY ASSEMBLY

.1 The Extraction Trolley Assembly serves as the component in the Rail System that travels in the suction rail, carries and supports the vertical hose assembly, balancer, current collectors, shock absorber and trolley stop mechanism. The Extraction Trolley body shall be made of light weight composite with a low friction surface on each side to enable the trolley to travel smooth through the rubber seal. Also, on a formed bracket mounted to the composite body, shall be a Disconnection box, acting as a circuit breaker for the Electro Magnet. The rail design must be capable of handling up to 4 vehicles parked in tandem.

2.4 BALANCER

.1 Integrated to the Extraction Trolley Assembly is a Balancer. The adjustable tension Balancer shall retract the hose and nozzle away from the vehicle as it leaves the building and safely suspend the assembly off the floor in the storage position when not in use. The Balancer shall have a spring characteristics that ensure that the cord is wound onto the drum at a safe and constant speed.

2.5 VERTICAL HOSE

.1 The Upper Vertical Suction Hose shall be 16 cm (6.2") in diameter, and of suitable flexibility to have a compression ratio of minimum 8:1. The hose material shall be Trevira fabric covered with HYPALON (CSM, Chloro-sulfonated polyethylene). The hose shall be fire resistant according to DIN 4102 B1. The lower hose shall be designed to withstand a 260° C (500° F) engine temperature in conjunction with induced ambient air for cooling. The hose shall be capable of withstanding temperatures of 171° C (340° F) continuously, up to 188° C (370° F) on an intermittent usage basis. (NOTE: If a ‘closed type sealed system’ is being used, the temperature ratings must be 360° C [680° F] and 393° C [740° F] respectively.) The helix shall be external and made of aluminum. The helix shall have high flexibility and the fabric able to withstand oil, chemical, ozone and weather resistance.

2.6 NOZZLE

.1 The Nozzle shall be a minimum of 20cm (8”) diameter and designed to capture 100% of the vehicle exhaust fumes generated at the vehicle tail pipe and is held in place by spring tension in conjunction with the electromagnet connection. The nozzle permits an ambient air mix in the air stream to immediately reduce exhaust emission temperatures up to 50% at the point of capture. The reduced air stream temperatures prolong component life by

not permitting thermal breakdown of materials. The Nozzle shall be designed so as not to cause or create back pressure on any vehicle engine, nor draw raw diesel- or gasoline fumes into the exhaust hose while connected to a non-operating vehicle, nor create the possibility of spinning a non-lubricated turbo which could result in bearing failure.

.2 In a 'closed type sealed system', a pressurized container is created presenting an explosive potential when drawing raw fumes from a non-operating vehicle and all system electrical components must be of explosion proof design. **No closed system will be considered.** These conditions are non-existent with an ambient air mix nozzle design.

.3 The operator never has to touch the Nozzle for connection, but can position the Nozzle over the tail pipe while the operator grips the hose handle and simultaneously connects the electromagnet to the anchor plate. Tension will be automatically applied to the Nozzle created by an internal leaf spring assembly, which holds the Nozzle firmly in place over the tail pipe. The positioning of the electromagnet on the vehicle, combined with the tension created at the Nozzle, shall not allow the Nozzle to come away from the tail pipe until the electromagnet is either automatically or manually de-energized. The Nozzle shall be constructed of both metal and rubber, with no internal movable parts related to the connection of the Nozzle to the tail pipe. The Nozzle Hose shall be a minimum of 16 cm (6.2") in diameter. The hose material shall be lightweight coated fiberglass with a smooth bore. The galvanized steel helix shall be completely rubber covered. The inlet diameter at the Nozzle is oversized to allow maximum airflow capacity for large engines and/or pump tests. The inlet boot of the Nozzle is to be made of EPDM rubber, and bonded to a sturdy 24 gauge steel conical reducer. The design of the nozzle shall allow for maximum flexibility to accept a variety of tail pipe configurations, which typically terminate at 90° to the side of the vehicle. **Tail pipe adapters are not permitted nor required. No positive locking devices or a concept of a positive locking device, pneumatics, internal or external air hoses, wires, airbags, valves or precautionary devices for pneumatic bursting pressure, magnetic (earth magnet type) shall be permitted or allowed**.

2.7 ELECTROMAGNETIC ASSEMBLY

.1 **An electromagnet shall be used as the means of keeping the nozzle and hose assembly attached to the vehicle**, whether at rest or as it moves to the point of exit. The electromagnet shall be 24 volts, DC with power supplied via an insulated conductor encapsulated within the helix of the upper hose. The electromagnet assembly shall consist of a nitro carburized electromagnet disc, a manual override switch, and an anchor plate. The electromagnet disc assembly shall be slightly recessed to serve as a guide for ease of connection to the anchor plate mounted on the vehicle and serve as the energized contact point. The formed collar shall be of a smooth and rounded configuration to prevent hooking or catching on external devices of the vehicle.

.2 A manual override switch shall be easily accessible to disconnect the hose assembly while accessing storage compartments or performing vehicle maintenance. The manual override switch shall be conveniently mounted facing the operator. The purpose of the switch shall be to manually de-energize the electromagnet, allowing the hose and nozzle assembly to come away unrestrained from the vehicle when in the parked position within the building. The 24-volt UL switch shall be surrounded and mounted in a closed cell water resistant neoprene jacket.

.3 The Anchor Plate shall be mounted on the vehicle to allow the operator, in an upright position, to connect the electromagnet. The Anchor Plate shall have an outer circular isolated holder made of hard resilient plastic. Recessed in the center of the holder shall be a finished, Nedox treated steel disc to receive the electromagnet. The Anchor Plate shall be positioned on the vehicle in relation to the vertical and horizontal centerlines of the tail pipe outlet.

2.8 DISCONNECTION SWITCH

.1 Affixed to the Rail near the exit door, shall be a permanent magnet, which in conjunction with the disconnection box causes a 24-volt electromagnet to disconnect the hose assembly from the vehicle. The separation of the entire hose assembly from the vehicle is a one step process whereby no stress or strain is transferred from the vehicle to the exhaust hose or overhead brackets. Numerous mechanical functions to achieve nozzle separation such as valve activation, pneumatic deflation, and pulling forces to remove the nozzle from the tail pipe are not permitted. The disconnection switch shall be adjustable to create a nozzle release point at a specified distance as the vehicle exits the building. If a proper disconnect does not occur, the electromagnet has a built-in safety disconnection feature, which releases it with a 50-pound shear force. Then the hose and nozzle assembly remains intact. With

other systems utilizing a mechanical or pneumatic direct connection to the tail pipe, a breakaway system is required to prevent the entire hose assembly from leaving the building with the vehicle.

2.9 END STOP

.1 The Rail shall be equipped with an End Stop, one for each Trolley, which is designed to stop the travel of the entire hose, nozzle, and balancer assembly. The stopping action itself must be spring cushioned to prevent the assembly from coming to an abrupt and immediate halt at an exit speed of up to 24 km/h (15 mph). The End Stop consists of a coiled spring hydraulic oil damper, which is located in the front end of the each Suction unit.

2.10 FAN AUTO-START

.1 The Fan Auto-Start serves to act as a remote control for fan start up to ensure the exhaust system is always running whenever an emergency vehicle is in operation. Upon dispatch, the exhaust fan shall automatically start and be running at full rpm prior to engine start up via a radio frequency transmitter mounted within the vehicle. The fan stays on as long as any vehicle is in operation. Upon vehicle exit or shut down, a variable timer then activates and the fan automatically turns off after a variable timed cycle. Upon vehicle return, the transmitter shall automatically activate the exhaust fan prior to the vehicle entering the building. The fan remains in operation until all vehicles are turned off and the timer then activates. The Control unit shall be FCC-approved and shall not interfere with radio communications garage doors or on board computers.

2.11 CENTRIFUGAL FANS

.1 The fan shall be a direct drive centrifugal type, high pressure, single width, single inlet as required or indicated. Impeller wheels shall be of a modified radial tip design, with top forward curve and airfoil thickness configuration characteristics. Impeller wheels shall be spark resistant and made of aluminum to prevent static electricity build up. The impeller shall be dynamically and static balanced, and of the non-overloading type to provide maximum efficiency while achieving quiet, vibrations free operation. The fan housing shall be manufactured from cast aluminum. The fan and motor assembly shall be mounted on a galvanized steel frame, which shall protect the motor, while also serving as a mounting platform for field installation.

.2 For fans 5 HP and larger, centrifugal fans shall be fully enclosed, single-width, single-inlet steel construction as required or indicated. Impeller wheels shall have backward inclined or backward curved blades of the non-overloading type. The bearings shall be self-aligned ball bearing type permanently sealed and lubricated. Fan shafts shall be steel and rotate in a non-sparking aluminum rubbing ring. Fans shall be accurately finished, and shall be provided with key and key seats for impeller hubs and fan pulleys. The fans shall be furnished with factory finish protective weather coating and a drain kit. The motor shall be totally enclosed fan cooled (TEFC). Motor starters shall be magnetic with general-purpose enclosures. The fan shall be structurally supported and provided with vibration isolators as specified to ensure quiet and smooth operation. The exhaust discharge outlet shall be in compliance with ACGIH recommendations and EPA requirements. Air intakes, windows, cascade systems, prevailing currents, communications equipment and building aesthetics will be considered in the final location of the fan. Exhaust filtration systems will be provided upon request and silencers will be provided when needed. All fans are tested in accordance with AMCA Standards in an AMCA approved test facility.

2.12 AIR FLOW PERFORMANCE

.1 Fan capacity shall be sized as such as to deliver a **650 cfm** (or as otherwise specified) at each hose drop to the vehicle being served. The exhaust system shall pull exhaust into the nozzle also inducing ambient air. The system shall be designed entirely for a negative pressure vacuum method of exhaust extraction. At no point in exhaust system will ducting be under positive pressure. Exhaust system hose drops shall be sized to maintain equal or larger cross sectional diameters than vehicle tailpipe. Exhaust systems, which do not size hose drops in accord with the vehicle engine capacity, as well as vehicle tailpipe diameter, shall not be accepted. The purpose of this portion of the specification is to insure that the exhaust system is designed to cool down exhaust as they are conveyed to the outside of fire station. This type of exhaust extraction keeps exhaust temperatures well below their designed temperature tolerances. This also prevents thermal break down of hose material thus adding years to system life. Exhaust systems that size exhaust drops without dilution ventilation and also down size the exhaust connection hose, unnecessarily put the vehicle engine warranty at risk. The delivered volume shall take into account all lengths

of ductwork, elbows, and branches, shut off, wyes, etc., which accumulate the static pressure at the fan inlet. Manufacturer provided fans shall be performance guaranteed.

2.13 DUCTWORK SYSTEM

.1 Ducts, unless otherwise specified or approved, shall be round and conform to the dimensions as shown on the drawings. Ducts shall be straight and smooth on the inside with airtight joints. Wherever ducts are used with crimped ends, the joint shall have crimp and bead arrangement. The bead shall provide a rigid stop for the mating open end to seat. Ducts shall be constructed of galvanized steel and sealed in accordance with standard SMACNA methods, for the system designed negative pressure in inches w.g. All duct joints to sealed and air tight.

.2 Ductwork Type and Materials: UMC Class 2 or SMACNA Class II product conveying duct, meet or exceed criteria for construction and performance as outlined in Round Industrial Duct Construction Standards, SMACNA. Materials of construction unless otherwise specified for all ductwork and fittings shall be a minimum G-90 galvanized sheet metal (ASTM A653/A653M). Only when specified, Type 304 stainless steel (ASTM A240/A240M) shall be provided.

.3 Ductwork Sizing and Gauges: Round pipe construction, with the range of available sizes not to exceed 10 inches (254 mm) in diameter. Duct gauge shall depend on diameter and a minimum operating pressure of 8 inches water gauge (1990 Pa). Acceptable Gauge and Reinforcement Requirements: Inner duct diameter 4 inches (101.6 mm) through 11 inches (279.4 mm) diameter shall be 22 gauge standard pipe (International Mechanical Code).

.4 Ductwork Fittings: Round and have a wall thickness 2 gauges (one even gauge number) heavier than the lightest allowable gauge of the downstream section of duct to which they are connected (International Mechanical Code). Air Duct Branch Entrances: Factory fabricated fittings or factory fabricated duct /tap assemblies. Fittings: Constructed so that air streams converge at angles no greater than 45 degree (International Mechanical Code). All Seams: Continuous stitch welded and if necessary internally sealed to ensure air tightness. Turning elbows shall be stitch-welded and used for all diameters and pressures. They shall be fabricated of 24 gauge galvanized steel and constructed as two piece with continuous welded seam construction fittings similar to those provided by Lindab Inc. Tapered Body Fittings: Used wherever particular fallout is anticipated and where air flow is introduced to the transport duct manifold. Reducing fittings shall have a minimum of 2.54 cm (1") graduating increase in diameter per 20 cm (8") in length. Elbows up to 30 cm (12") in diameter shall have a centerline radius of not less than 1.5 times the diameter. Elbows beyond 30 cm (12") in diameter shall have a centerline radius of not less than 2.5 times the diameter. Branches shall enter the mains at a specified angle of not less than 30° with the centerline of the main duct in the direction of airflow, unless otherwise indicated or approved. Flexible connections to the main or branch duct shall be braced with approved metal straps or members.

.5 Where duct of dissimilar metals are connected, or where sheet metal connections are made to fan inlet and outlet, only an approved fireproof flexible connection shall be used. The connection shall be installed and securely fastened by zinc coated steel clinch type draw bands for round ducts.

.6 Ductwork Design Velocities: Minimum of 3500 FPM (20.3 M/Second) to 4000 FPM (23.2 M/Second) transport velocity. Capture Velocity: 5500 FPM (31.9 M/Second) to 6000 FPM (34.8 M/Second) to extract virtually 100 percent of the exhaust gases.

.7 External Ductwork: Sized for the exact inlet and outlet of the exhaust fan blower. An exhaust rain cap shall be supplied and manufactured in accordance with EPA standard for free draft rain cap requirements. Included as an integral part of this rain cap shall be a back draft damper to provide protection from rain and other inclement weather.

.8 Exhaust Penetrations: The core drilling shall be properly sized to reduce the diameter of the opening to the smallest possible size.

2.14 FRAMED OPENINGS AND DUCT SLEEVES

.1 Duct sleeves shall be provided for all round ducts ≤ 38 cm (15") diameter that pass through floors, walls, ceilings, or roofs. Sleeves in non-load bearing walls shall be fabricated of 20-gauge steel conforming to ASTM A 525. Sleeves in load bearing walls shall be fabricated of standard weight galvanized steel pipe conforming to ASTM A 53. Collars for round ducts ≤ 38 cm (15") " shall be fabricated from 20 gauge galvanized steel. Round ducts > 15" in diameter passing through floors, walls, ceilings, or roofs shall be installed through framed openings. Structural

steel members for framed openings shall conform to ASTM A 36. Framed openings shall provide a 2.54 cm (1") clearance between the duct and the opening. A closure collar of galvanized steel ≥ 10 cm (4") wide shall be provided on each side of the walls or floors where sleeves or framed openings are provided.

2.15 STACKHEAD

.1 The exhaust discharge stack head will be a no loss type as recommended by ACGIH or as otherwise specified. The stack head design will protect against weather elements or introduction of debris.

2.16 DUCT TEST HOLES

.1 Test holes with covers shall be provided where indicated or directed, in the duct and plenum to insert Pitot tubes to take air measurements for balancing the air moving system if required.

3 EXECUTION

3.1 EXHAUST SYSTEM

.1 The exhaust removal system shall be installed as indicated and recommended by the manufacturer. Welding and brazing shall conform to ASME-17. Slip joints shall be sealed. Riser duct shall be supported to the structure as indicated on the drawings. Main duct shall be attached to building structural members.

3.2 BUILDING SURFACE PENETRATIONS

.1 All penetrations shall be sealed. Sleeves or framed openings shall be utilized where duct penetrates building surfaces. The space between the sleeve or framed opening and the duct shall be packed with mineral wool or approved material. Closure collars shall be installed around the duct on both sides of the penetrated surface. Collars shall fit tight against the building surfaces and snug around the duct.

3.3 GUIDE TRACK

.1 Installation height of Guide Track shall be between 3 m (10 ft.) to 4.6 m (16 ft.) range or as otherwise indicated on the drawings. The Guide Track shall be installed approximately 36 cm (14”) from the side of the vehicle and ≥ 30 cm (12”) away from the side edge of the exit door. The Guide Track for the exhaust system shall include corrosion resistant brackets for ease of mounting to structural channel, trusses, or angle iron. Brackets shall be a minimum of 0.318 cm (0.125") thickness. Mounting bolts to be no less than 0.953 cm (0.375") diameter (structural grade 8) for connection to steel frame. Bolts required for masonry installation shall be 0.5" x 3.5" expansion bolts, or 0.375" x 4" sleeve anchors for wall mount masonry connection.

.2 Recommendation: Unistrut 1 5/8” or Angle Iron 2”x 2”x 3/16”.

3.4 TESTS

.1 Each exhaust system and inlet shall be balanced to produce the indicated air quantities within 10 percent at the conditions shown. Any fans with bearings shall be lubricated, and the speed, direction and rotation of each fan shall be checked and verified as running correctly. The running current of each motor shall be checked and verified as correct. Upon completion and prior acceptance of the installation, the exhaust system shall be tested at the operating conditions to demonstrate satisfactory functional and operating efficiency. The Contractor shall provide all instruments, facilities, and labor required to properly conduct the tests.

3.5 EXAMINATION

.1 Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.6 PREPARATION

.1 Provide surface/substrate preparation as required by the manufacturer's printed installation instructions. Do not proceed with installation is in proper condition to receive vehicle exhaust system installation.

3.7 INSTALLATION

.1 Install vehicle exhaust system in accord with manufacturer's written instructions, original design and referenced standards.

3.8 ADJUSTING

.1 Adjust vehicle exhaust system for proper operation. Replace any parts that prevent the system from operating properly.

3.9 CLEANING

.1 Remove all debris caused by installation of the vehicle exhaust system. Clean all exposed surfaces to as fabricated condition and appearance.

3.10 PROTECTION

.1 Provide protection of the completed installation until completion of the project. Repair any damage at no additional cost to Owner.

3.11 TRAINING

.1 Provide training to fire department personnel in the daily use and maintenance of the vehicle exhaust removal system that has been installed and specified herein. The fire department shall be notified at least 7 days prior to the date scheduled for the training course. Training shall be for all personnel involved with the operation of the exhaust removal system to include all shifts required to man the particular facility. The Training session shall be performed in person by a recognized representative of the manufacturer of the exhaust removal system, in addition a training video shall be provided to the fire department.

.1 Provide training to all shifts during their normal shift period.

3.12 WARRANTY

.1 Provide a written warranty for a period of 1 year from date of shipment for all components.

END OF SECTION

1 GENERAL

1.1 SUBMITTALS

.1 Provide submittals in accordance with Division 01.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for inlets, hoses, ducts, and fans, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings.

.1 Indicate following:

.1 Fan performance curves.

.2 Filtering details.

.3 Control details.

.4 Installation details.

1.2 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for incorporation into O&M manual.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit list of manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

2 Products

2.1 DIESEL EXHAUST CAPTURE SYSTEM

.1 General

.1 Provide where shown on Drawing Airmation Diesel exhaust capture units. The air filtration units and activation systems shall work together to eliminate, capture, reduce the vehicle exhaust produced by apparatus in addition to contaminants generated from other sources. Sources of apparatus bay contamination may consist of airborne engine vapors, apparatus leaking seals, diesel and gas exhaust, soot, gases, carbon monoxide, nitrous dioxide, turn-out gear out gassing, power saw or any other on board emergency gasoline or diesel powered equipment. The system must be capable of the capture of intermittent exhaust migration due to apparatus or other internal combustion equipment being run on the facility tarmac or apron. Additional toxins to be captured must include Volatile Organic Compounds (VOCs), particulate, and lung damaging dust.

.2 System

.1 The air filtration system must be a totally automatic activated system that also contains a manual override system. It must be hands free, to allow emergency personnel to respond to the emergency at hand. The system must automatically activate when bay doors open, when apparatus egress and ingress the fire station or by means of several other optional means, as stated within this specification. The filtration system must operate for a minimum of twenty (20) minutes to complete station air cleaning. The system must have the capability to increase this time to a maximum of 9 hours on an initial activation.

.2 Additional manual override switches must allow for each individual unit to operate on a 24/7 basis as deemed necessary by the end user; initiate all units to operate on a predetermined set time; a reset to bypass the timer and terminate activation with a cascading down of units as they turn off. The timer

control should allow for selective units to run in continuous low speed operation (700cfm), while still maintaining high speed operation (2700 – 2800cfm) when bay door are activated for vehicle entry/exit.

.3 The timer control must be designed to sequentially start and stop the exhaust capture air filtration units to avoid power surges and contain only UL/CSA approved components. The timer control box must be 100% low voltage (24V max.) to eliminate shock hazards to personnel.

.3 Test Data

.1 The system must have documented evidence of having been successfully tested to meet regulatory health and safety standards in no less than two different active Fire / EMS departments. Each test to be conducted by a different qualified independent environmental engineering firm. One of the submitted test results must show, with NO EXCEPTIONS, as a matter of personnel health and safety, that the system meets and/or surpasses federal regulatory standards for ACGIH, NFPA, BOCA4, ASHRAE3, EPA, OSHA, PEL (short term), TLV/STEL, and NIOSH. Test parameters must include VOCs, NO2, SO2, CO, Particulates and Diesel Exhaust Particulates as one of the standards of measurement. The testing must have been performed by a certified Industrial Hygienist and must verify performance standards with fire apparatus idling in bays, on the tarmac, and entering/exiting bays as would occur during normal station operation.

.4 Equipment

.1 The filtration system shall be delivered and installed as a turnkey project with no requirement for station personnel involvement. The exhaust capture equipment will be of a self-contained three stage progressive filtration designed system. The system filtration media must be verified by the manufacturer to be capable of capturing vehicle exhaust with a blower and with a motor capable of a delivered volume of 2700 cfm (cubic feet per minute) meeting NFPA and OSHA Standards. Clean, filtered air must be returned to the apparatus bay areas from the rear of the same system. The system must not contain a catalytic oxidizer so as to eliminate/avoid excess water and carbon dioxide by-products within apparatus bays.

.5 Equipment Features

.1 The following features and capabilities must exist as part of the system:

.1 Ceiling suspended design evenly distributing unit weight

.2 115V or 230V power with no less than a 3000 cfm blower driven by 1 hp single phase ECM 6 speed motor 4.7 amps. *note an ECM motor is up to 75% more energy efficient than a standard blower motor, providing significant energy cost savings.

.3 Utilization of horizontal pull-through design for optimum exhaust elimination

.4 Dual V-Bank 99% DOP, MERV 16a (rated for 3000cfm), and Gas Phase carbon blended with alumina 50/50

.5 Relocation or re-positioning capabilities, not a permanent fixture type system

.6 Access internally sealed filter replacement compartment door from either side of the unit utilizing two (2) swell latch handles to ensure safety in filter access and replacement

.7 Compartment door with swell latch handles, no bolts, to open on the door for safety in height access and expediency in filter replacement

.8 Rear LED filter change indicator to be visible from the floor level and at the control Panel

.9 Visible breaker switch light

.10 Capability of 24/7 operation

.11 Maximum 60 db sound level when in operation, adjustable to 50 dba at low speed.

.12 Front directional grille intake direction must force the entering exhaust into the filtration media

.13 Filter access door must be adjustable to either left or right side to ensure proper service clearance and allow for proper location of units without compromise.

.14 Units with no intake louvers are unacceptable due to lack of directional filtration intake

.15 Must have rear baffle box to exhaust clean air back into bay areas through a minimum of more than 300 directional ports so as to evenly distribute return clean air and provide a fan sound control system for apparatus bay areas. Adjustable direction louver, so that the air flow pattern can be adjusted to fix the work space and properly mix air.

.6 Equipment Activation

.1 The air filtration system must work in tandem with and include an automatic, hands free, activation system featuring:

.2 Operation engineered through a wall mount Timer Control Maintenance Monitor (TCSMM)

.1 Completely low voltage (24 VAC max) for personnel safety

.2 No maintenance will be required over the entire life of the system

.3 Housed in a NEMA1 enclosure complying with UL and CSA specifications

.4 TCSMM must have 3-speed program capability.

.5 TCSMM to contain a 90 minute/ 9 hour timer adjustable to operate in 10 minute increments from 10-90 minutes, and 1 hour to 9 hours.

.6 TCSMM switches to allow individual unit manual bypass opting for 24/7 operation.

.7 TCSMM must be capable of running at continuous low speed operation and auto kick into high speed mode on demand.

.8 TCSMM to have an external timer bypass switch for immediate system shutdown. System to automatically reactivate under any normal activation inputs.

.9 A photoelectric-eye to span up to 200 contiguous feet of bay doors and be able to operate at least 7' off the floor. Doors not in-line with other doors or having obstructions with over 4' of wall or barrier protrusions eliminating a clear line of site will require a separate photoelectric-eye beam.

.10 Emergency Shutdown Circuit, to shut down system in the event of a fire.

.11 Filter change lights.

.12 Allows for remote activation switches.

.13 4 individual zone inputs. Used to isolate front door activation/ rear door activation / gas phase sensor activation, etc.

.14 Additional Auxiliary input for future activation modes, such and chronographic timer, etc.

.15 System off switch. This turns off system to prevent activation, for time of building maintenance such as painting, drywall etc. Or system maintenance while changing filters.

.16 Door opening, closing, apparatus egress or ingress must activate all units within the apparatus bays.

.17 TCSMM MUST have the capability to accommodate up to sixteen filtration units per control unit, for future system expansion

.18 System must have automatic shut down and restart if station has a fire alarm within the bays.

.19 Be able to accept up to three alternate methods of activation including 1) Response to the station's tone alert, 2) Apparatus ignition activation, Kussmaul MODEL # 091133 or equivalent, 3) Activation in response to signal from CO/NO2 monitor utilizing Vulcain Model VA301M or equivalent.

.7 Equipment Safety

.1 Station personnel safety being a top priority, the system will include the following safety features:

.1 All TCSMM control wiring shall be low voltage (24VAC max) to eliminate electrical hazard.

.2 TCSMM will house internal visible LED indicators for all ON units.

.3 All components must be UL/CSA registered.

.4 Filtration units must have an integral overload breaker switch to work in tandem with electrical panel breakers.

.5 Filtration unit blower and wiring to be contained in a single blower box compartment, inaccessible to personnel.

.6 TCSMM must have an input to disable all filtration units during a building fire alarm and then return the filtration units to normal operation after the alarm situation is resolved or turned off.

.7 System must be capable of cycling down or up when turned on or off to avoid power surges

.8 Filter tracks to ensure safe filter replacement.

.9 System must not house a catalytic converter to avoid excess carbon dioxide and water by products in the bay areas.

.10 Factory secured seismic restraint connection hardware.

.8 Equipment Filters

.1 The filters are a critical component of the system and MUST comply with the following criteria. All filtration media must be separately housed in a self contained compartment with sealing on the filter door to avoid gas/particulate bypass, tight fit, slide track, filter compartment to eliminate diesel and contaminant bypass of the individual filters. Each filter must be have its own rail. The filter door closure must contain seals to avoid bypass air. Pre-filter for normal fire station use, last 18month to 24 months.

.1 Pre-Filter panel:

.1 Must be capable of providing a minimum efficiency reporting value of MERV 8a when evaluated under the guideline of ASHRAE Std. 52.2.19.

.1 Placement follows the front directional louver grille and fits snugly within a track.

.2 To be no less than 24" x 24" x 4" (nominal), including frame, incorporating filtration media of no less than 26.6 ft^2.

.3 Initial resistance must be .25 using 22 radial pleats.

.4 Air flow capacity at 300 fpm must be 1200.

.5 Air flow capacity at 500 fpm must be 2000 @ .25.

.6 Filter frame must be composed of moisture resistant heavy duty beverage board frame.

.7 Must have two piece frame construction with double wall thickness around the outer edge and integral die cut cross member.

.8 Pleats must have individual die cut fingers.

.9 The adhesive used must be highly water repellent and cover the entire inside of the die cut frame.

.10 Pleats supports must be composed of galvanized steel.

.11 Shall be classified by Underwriters Laboratories as UL Class 2.

.12 Designed to perform up to 18-24 months and longer, based on environmental conditions and use. Typically 24 month for normal fire station use.

.2 High Efficiency Particle Filter Second Stage:

.1 NO LESS than 99% DOP MERV 16a ASHRAE rating, V-bank formation DOP design to encompass a minimum surface area of 200 ft2 and capable of removing particulate as small as 0.3µ in size. 5 Star Energy Rated.

.2 Be enclosed in a heavy-duty, moisture resistant die cut frame to eliminate warping, cracking, or distortion under normal operation conditions.

.3 Integral pleat separators to provide pleat stabilization. Must not contain any aluminum or steel separators in between filter strata of each V-Bank section.

.4 Effective at 100% relative humidity, turbulent air flow, intermittent exposure to water and repeated fan shutdowns.

.5 Air flow resistance at 500 fpm must be .80.

.6 Must be rated to work from 0°F to 180°F.

.7 Must be able to handle air flow volumes up to 3000 cfm.

.8 Perimeter header must be secured by standard latches or clamping devices.

.9 Must be leak free around the entire perimeter of the filter.

.10 Each mini-pleat pack must be sealed within the heat resistant plastic end panels and galvanized steel support struts.

.11 Mini-pleats are to be separated by continuous beads of thermo-setting adhesive, not steel separators between mini-pleats.

.12 Must measure no less than 24" x 24" x 12" (nominal), including frame and fit snugly into the track.

.13 Cannot be a flat face filter to avoid intense filter blockage.

.14 Virtually all lung damaging diesel particulate to be captured.

.15 Shall be classified by Underwriters Laboratories as UL 900 Class 2.

.16 Designed to perform up to 24-48 months and longer, based on environmental conditions and use.

.3 Gas Phase Carbon/Alumina Filter:

.1 Must contain a minimum of 26 lbs. of carbon blend with alumina, to include 50% active premium grade coconut shell carbon with 50% active alumina.

.2 Filter frame weight to be separately calculated.

.3 To measure no less than 24" x 24" x 12" (nominal), including filter frame.

.4 Must have V-bank design, not flat face surface, to provide extensive capture, extended life and fit snugly into the track.

.5 Must have galvanized steel support struts on both sides of the filter.

.6 End caps must be made from resilient ABS plastic.

.7 The honeycomb panels containing the carbon granules must be water resistant

.8 Non-volatile hot melt glue must be used to bond the carbon panels, end caps and steel support members.

.9 Initial resistance at 500 fpm must be .38" w.g.

.10 Cannot show evidence of air pockets between absorbent carbon/alumina.

.11 The gas phase filter must be capable of controlling and eliminating VOCs, chemicals and gas of diesel contamination within the apparatus bays.

.12 Manufacturer shall provide evidence of facility certification to ISO 9001:2000.

.13 Designed to perform for up to 24-48 months to longer, depending on environmental conditions and use.

.4 Automatic Roll Filter:

.1 Shall act as a preliminary filter, capable of capturing and containing particulate in the 8-10µ size.

.2 Filter face must measure as a minimum 40" x 40" and provide a 600' flat sheet polyester REEMAY roll.

.3 To advance based on air pressure measured by a photohelic gauge.

.4 The photohelic gauge automatically controls the indexing motor for filter advance. As the air pressure drops, the photohelic gauge stops the indexing motor.

.5 The motor and controls to be 120 VAC and a separate power circuit and fuse must be provided to power all of the circuits.

.6 All wiring and components to be UL approved.

.7 Designed to perform for up to 5-6 years or longer, depending on environmental conditions and use.

.5 Automatic Activation Equipment:

.1 The vendor to provide automatic activation options for the purchaser selection.

.1 Carbon Monoxide/Nitrogen Dioxide (CO/NO2) Activation:

.2 The Vulcain Model VA301M, or equivalent, shall be integrated into the system for additional safety operation. The CO/NO2 monitor must be connected to the TCSMM to engage the air filtration units automatically once the gas detector measures unsafe levels of CO and/or NO2 in the apparatus bays. The air filtration units are to operate until these gases are reduced to OSHA acceptable levels. These are two separate monitor sensors. The CO monitor will be installed 5" off the floor. The NO2 monitor sensor will be installed a minimum of 5' below the ceiling.

.3 Ignition Activation.

.9 Warranty

.1 Include a warranty of at least two (2) years on all system parts and labor, excluding filters. Warranty can be voided when equipment is damaged by customer’s negligence or misuse. The warranty will remain in effect only when installations and repairs are performed by a qualified licensed electrician who is contracted by the equipment vendor.

.10 Alternate Equipment

.1 Manegrip

.2 ACS

.3 or Approved Equivalent

2.2 MANUFACTURERS

.1 Airmation.

.2 No substitutions.

3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 Provide vehicle exhaust removal system.

.2 Install in accordance with NFPA 91, and to manufacturers instructions.

.3 Make joints watertight and airtight when subjected to 1.5 kPa pressure.

.4 Install duct supports to manufacturer's recommendations.

.5 Install unit above the exhaust of truck.

.6 Coordinate final location with truck locations and fire station team.

.7 Provide all necessary accessories and parts required for complete installation.

.8 Provide door sensor for activating the unit.

.9 Brace and secure each unit in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Equipment.

.10 Coordinate power wiring connection and provision of a disconnect switch for each ventilator in accordance with electrical work Specification where power wiring is specified.

.11 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.12 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

3.3 TESTING

.1 Test units with the manufacturer. Provide testing report.

3.4 CLEANING

.1 Clean in accordance system and filters prior to start.

3.5 DEMONSTRATION AND TRAINING

.1 Include for a ½ day on-site heat recovery ventilator operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full heat recovery ventilator internal inspection, construction details, operation, maintenance, abnormal events, and setting up controls.

END OF SECTION

1 GENERAL

1.1 SUMMARY

.1 Provide all labour, materials, and equipment necessary to put in working operation a complete turnkey system to remove both diesel and automotive exhaust gases and particulate of operating vehicles within the confines of specified fire station(s). All necessary controls, motors, fittings, ductwork, blower(s), labor and all other equipment and materials specified shall be part of the work.

.2 All items of equipment and materials described in these specifications are to be furnished installed and placed into proper operating condition in accordance with good practice and manufacturer's written or published instructions.

.1 The exhaust removal system shall provide virtually 100 percent complete evacuation of all diesel fumes at the source from start up to exit of the apparatus from the fire station. The diesel exhaust removal system shall be capable of delivering complete coverage for bays up to 120 feet (36.5 m) in length. The system must be able to accommodate drive through and back-in bays to meet all the needs of the fire department.

.2 System must be designed and installed to NIOSH recommendation, specifying that occupational exposures to carcinogens be limited to the lowest feasible concentration. Exposure in the human breathing zone should be limited to lowest feasible level, without any time delay required for the system to effectively capture the diesel fumes.

.3 System must also be capable to provide virtually complete capture and evacuation of carbon monoxide emitted as part of the vehicle exhaust.

.4 Systems that solely use filters, in which diesel particulate may accumulate, and that would potentially have to be treated as hazardous materials, will not be accepted.

.5 System must meet the guidelines for the International Mechanical Code for Source Capture Systems. Such system is defined as a mechanical exhaust system designed and constructed to capture air contaminants at their source and to exhaust such contaminants to the outdoor atmosphere.

.6 The system shall not affect personnel boarding the apparatus. Hose loops shall not hang any lower than six feet from the bay floor. The hose assembly shall not come into contact with the vehicle other than one connection point to the vehicles tailpipe. The hose assembly shall not touch or drag on the bay floor.

.7 The exhaust system shall not block doorways, exits, and aisles in the apparatus bay, which could endanger the welfare of fire personnel or visitors.

.8 The exhaust system shall not need to be disconnected from the vehicle while shore lines are connected, during battery charging, or washing of the vehicle, as with other types of systems.

.9 To protect the apparatus electrical system from possible damage, the system bid shall not incorporate any type of electromagnetic device that requires the apparatus to be utilized as an electrical ground for systems operation.

.10 Due to the harmful effects of diesel exhaust, the system must be designed and capable of capturing virtually 100% of the exhaust gas and virtually 100% of the particulate even in the event of a complete power failure. The system shall not detach itself from the apparatus for any reason during a power failure other than normal exiting of the apparatus bay. System shall discharge exhaust outside the station even in the event of a power failure.

.11 The system shall capture the exhaust gases and particulate directly from the tailpipe of the apparatus by a direct connected "visible" high temperature rated hose. Particulates emitted from the apparatus are known to be heavier than air and therefore must be captured by a directly connected hose with a tight seal, as loose nozzles or air filters cannot capture these heavy particulates. The particulates have been documented to be the main respirable carcinogen in diesel exhaust, and therefore are the primary concern of the fire department to capture virtually 100% of these particulates.

1.2 SUBMITTALS

.1 Product Data: Indicate manufacturer's model number, technical data including description of components and static pressure/air flow chart, and installation instructions.

.1 Details of wiring for power differentiating between manufacturer-installed and field-installed wiring.

.2 Closeout Submittals: Operation and Maintenance data manual including spare parts list.

1.3 QUALITY ASSURANCE

.1 Engage a factory certified installer to perform work of this Section who has completed installations similar in design and extent to that indicated for this Project, and who has a record of successful in-service performance. No Exceptions.

.2 The manufacturer must be a ISO 9001:2008 certified www.iso.org manufacturer with certification issued to a United States facility, this shows a commitment to delivering the highest quality service and products to the end user. Manufacturer shall be UL and CUL Certified www.ul.com/database/ and certified by the Air Movement and Control Association (AMCA) www.amca.org/search.htm to ensure quality, consistency and reliability of products. All certification documents shall be provided and attached to the bid proposal. No exceptions. Where the requirement calls for a packaged exhaust system to be provided, all items shall be the product of the manufacturer. The product offering must be a product that has been offered by that manufacturer for a minimum period of fifteen (15) years. No prototypes or private label products by other manufacturers will be allowed. System bid shall have a life of service of no less than 10 years to establish proof of quality, longevity and service. No exceptions.

.3 Engage a firm experienced in manufacturing vehicle exhaust systems similar to that indicated for this Project and with a record of successful in-service performance.

.4 Conduct conference at Project site. Review methods and procedures related to vehicle exhaust system installation.

.1 Review access requirements for equipment delivery.

.2 Review equipment storage and security requirements.

.3 Inspect condition of preparatory work performed by other trades.

.4 Review structural loading limitations.

.5 Review that all components specified in this Section and related components specified in other Sections are accounted for.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Packing, Shipping, Handling and Unloading: Deliver components with protective packaging. Store in original protective crating and covering and in a dry location.

1.5 PROJECT/SITE CONDITIONS

.1 Existing Conditions: Verify dimensions installation areas by field measurements.

1.6 COORDINATION

.1 Coordinate layout and installation with other work, including light fixtures, fixed equipment and work stations, HVAC equipment, and fire-suppression system components.

.2 Coordinate location and requirements of service-utility connections.

1.7 REFERENCES

.1 Air Movement & Control Association International, Inc.

.1 AMCA Standard 500-D-98, "Laboratory Methods of Testing Dampers for Rating".

.2 ASTM International.

.1 Stainless Steel:

.1 A240/A240M-04ae1 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

.2 Bright, Directional Polish: No. 4 finish.

.3 Aluminum:

.1 B209/209M-04 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

.2 Powder-Coated Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

.4 Galvanized Steel:

.1 A653/A653M-04a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.8 BIDDER QUALIFICATIONS

.1 Bids will only be accepted from companies that have an established reputation in the business of system design, turnkey installation and long-term service of Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than five (5) years. Bidder shall be a registered corporation, partnership or sole proprietorship within the State where the installation is to take place. Bidder must have a current and valid state contractor's license, if required by the state for the work that is being bid. Bidder shall show proof that the system specified in this Bid Document has been field tested and proven by supplying a list of references with no less than 50 fire stations with systems installed by bidder (with comparable emergency and non-emergency run rates) within a 200 mile radius of municipality seeking bid. References shall be submitted with the Bid Document and shall include phone numbers and contact names.

1.9 MANUFACTURER QUALIFICATIONS

.1 Bids shall only be accepted by bidders supplying equipment from manufacturers that have an established reputation in the business of manufacturing Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than fifteen (15) years. The manufacturer must be a ISO 9001:2008 Certified in the United States www.iso.org, UL and CUL Certified www.ul.com/database/ and certified by the Air Movement and Control Association (AMCA) www.amca.org/search.htm to ensure quality, consistency and reliability of products. Certification documents shall be provided and attached to the bid proposal. No exceptions. Where the requirement calls for a packaged exhaust system to be provided, all items shall be the product of the manufacturer. The product offering must be a product that has been offered by that manufacturer for a minimum period of fifteen (15) years. No prototypes or private label products by other manufacturers will be allowed. System bid shall have a life of service of no less than 10 years to establish proof of quality, longevity and service. No exceptions.

1.10 SYSTEM OPERATION

.1 The auto-disconnect exhaust system shall be a 24-volt **electromagnetic** release type that captures 100% of the exhaust emissions directly from the tail pipe and discharges those emissions to a specific location by means of an exhaust fan. Upon emergency dispatch of the vehicle, the exhaust fan shall automatically start prior to the engine being energized. The exhaust fan shall remain in the "on" position for as long as any engine is running. Upon vehicle exit, the hose assembly remains connected to the tail pipe and automatically disconnects at a specified distance outside the door by de-energizing the electromagnet. The nozzle and hose assembly shall smoothly separate from the vehicle and safely retract to the stored position ready to connect to the vehicle upon reentry. Upon disconnection, the hose assembly shall not be permitted to swing wide or touch the floor, possibly endangering personnel or apparatus. The hose shall remain at the door, ready for reconnection. Once the apparatus has left the building, the fan will automatically shut down after a preset time interval. Upon return, the fan is automatically activated prior to vehicle entry and the nozzle is connected to the tail pipe in a standing position**. Bending over to connect the exhaust system and expose the operator to harmful exhaust fumes is not**

permitted. No positive locking device or moving parts shall be permitted to be connected to the tail pipe. After the vehicle has been turned off, the fan can continues to operate for a preset time interval, normally two minutes.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Nederman.

2.2 SUCTION RAIL ASSEMBLY

.1 The Suction Rail shall be a polished aluminum extrusion that is formed in a configuration such that the extrusion serves not only as a suction duct, but also as the guide rail that the extraction trolley travels in. The wall thickness of the aluminum extrusion shall be no less than 2.381 mm (0.09375”). The weight of the aluminum extrusion is 6.8 kg/m (4.6 lbs. per lineal foot). The area of the aluminum extrusion, in a cross-sectional view, shall have the minimum equivalent area of 189 cm^2 (0.2035 sq. ft.) with an overall length as specified and indicated on the drawings. Each open end of the suction rail shall be covered with an end cap that can also be used as a round duct outlet for 15 cm (6”) diameter exhaust duct. As an alternate outlet, one or more rectangular-to-round transitions can be mounted on the topside of the suction rail after the cutout has been made per the manufacturer’s specified size. A pair of EPDM rubber seals is installed at the bottom of the extrusion opening. The rubber seals have a Teflon strip on the inside surface which enables the trolley to travel smoothly and unhindered. The rubber seals close tightly during fan operation for an airtight seal, but open evenly around the trolley during trolley travel. The suction rail shall be supplied with internal rubber bumpers installed at both ends that serve as secondary stops to the trolley. The suction rail shall be supplied with suspension attachments that are specifically designed for fastening to the configuration of the suction rail. Spacing of the suspension attachments shall not exceed 16 feet center-to-center.

2.3 EXTRACTION TROLLEY ASSEMBLY

.1 The Extraction Trolley Assembly serves as the component in the Rail System that travels in the suction rail, carries and supports the vertical hose assembly, balancer, current collectors, shock absorber and trolley stop mechanism. The Extraction Trolley body shall be made of light weight composite with a low friction surface on each side to enable the trolley to travel smooth through the rubber seal. Also, on a formed bracket mounted to the composite body, shall be a Disconnection box, acting as a circuit breaker for the Electro Magnet. The rail design must be capable of handling up to 4 vehicles parked in tandem.

2.4 BALANCER

.1 Integrated to the Extraction Trolley Assembly is a Balancer. The adjustable tension Balancer shall retract the hose and nozzle away from the vehicle as it leaves the building and safely suspend the assembly off the floor in the storage position when not in use. The Balancer shall have a spring characteristics that ensure that the cord is wound onto the drum at a safe and constant speed.

2.5 VERTICAL HOSE

.1 The Upper Vertical Suction Hose shall be 16 cm (6.2") in diameter, and of suitable flexibility to have a compression ratio of minimum 8:1. The hose material shall be Trevira fabric covered with HYPALON (CSM, Chloro-sulfonated polyethylene). The hose shall be fire resistant according to DIN 4102 B1. The lower hose shall be designed to withstand a 260° C (500° F) engine temperature in conjunction with induced ambient air for cooling. The hose shall be capable of withstanding temperatures of 171° C (340° F) continuously, up to 188° C (370° F) on an intermittent usage basis. (NOTE: If a ‘closed type sealed system’ is being used, the temperature ratings must be 360° C [680° F] and 393° C [740° F] respectively.) The helix shall be external and made of aluminum. The helix shall have high flexibility and the fabric able to withstand oil, chemical, ozone and weather resistance.

2.6 NOZZLE

.1 The Nozzle shall be a minimum of 20cm (8”) diameter and designed to capture 100% of the vehicle exhaust fumes generated at the vehicle tail pipe and is held in place by spring tension in conjunction with the electromagnet connection. The nozzle permits an ambient air mix in the air stream to immediately reduce exhaust emission temperatures up to 50% at the point of capture. The reduced air stream temperatures prolong component life by

not permitting thermal breakdown of materials. The Nozzle shall be designed so as not to cause or create back pressure on any vehicle engine, nor draw raw diesel- or gasoline fumes into the exhaust hose while connected to a non-operating vehicle, nor create the possibility of spinning a non-lubricated turbo which could result in bearing failure.

.2 In a 'closed type sealed system', a pressurized container is created presenting an explosive potential when drawing raw fumes from a non-operating vehicle and all system electrical components must be of explosion proof design. **No closed system will be considered.** These conditions are non-existent with an ambient air mix nozzle design.

.3 The operator never has to touch the Nozzle for connection, but can position the Nozzle over the tail pipe while the operator grips the hose handle and simultaneously connects the electromagnet to the anchor plate. Tension will be automatically applied to the Nozzle created by an internal leaf spring assembly, which holds the Nozzle firmly in place over the tail pipe. The positioning of the electromagnet on the vehicle, combined with the tension created at the Nozzle, shall not allow the Nozzle to come away from the tail pipe until the electromagnet is either automatically or manually de-energized. The Nozzle shall be constructed of both metal and rubber, with no internal movable parts related to the connection of the Nozzle to the tail pipe. The Nozzle Hose shall be a minimum of 16 cm (6.2") in diameter. The hose material shall be lightweight coated fiberglass with a smooth bore. The galvanized steel helix shall be completely rubber covered. The inlet diameter at the Nozzle is oversized to allow maximum airflow capacity for large engines and/or pump tests. The inlet boot of the Nozzle is to be made of EPDM rubber, and bonded to a sturdy 24 gauge steel conical reducer. The design of the nozzle shall allow for maximum flexibility to accept a variety of tail pipe configurations, which typically terminate at 90° to the side of the vehicle. **Tail pipe adapters are not permitted nor required. No positive locking devices or a concept of a positive locking device, pneumatics, internal or external air hoses, wires, airbags, valves or precautionary devices for pneumatic bursting pressure, magnetic (earth magnet type) shall be permitted or allowed**.

2.7 ELECTROMAGNETIC ASSEMBLY

.1 **An electromagnet shall be used as the means of keeping the nozzle and hose assembly attached to the vehicle**, whether at rest or as it moves to the point of exit. The electromagnet shall be 24 volts, DC with power supplied via an insulated conductor encapsulated within the helix of the upper hose. The electromagnet assembly shall consist of a nitro carburized electromagnet disc, a manual override switch, and an anchor plate. The electromagnet disc assembly shall be slightly recessed to serve as a guide for ease of connection to the anchor plate mounted on the vehicle and serve as the energized contact point. The formed collar shall be of a smooth and rounded configuration to prevent hooking or catching on external devices of the vehicle.

.2 A manual override switch shall be easily accessible to disconnect the hose assembly while accessing storage compartments or performing vehicle maintenance. The manual override switch shall be conveniently mounted facing the operator. The purpose of the switch shall be to manually de-energize the electromagnet, allowing the hose and nozzle assembly to come away unrestrained from the vehicle when in the parked position within the building. The 24-volt UL switch shall be surrounded and mounted in a closed cell water resistant neoprene jacket.

.3 The Anchor Plate shall be mounted on the vehicle to allow the operator, in an upright position, to connect the electromagnet. The Anchor Plate shall have an outer circular isolated holder made of hard resilient plastic. Recessed in the center of the holder shall be a finished, Nedox treated steel disc to receive the electromagnet. The Anchor Plate shall be positioned on the vehicle in relation to the vertical and horizontal centerlines of the tail pipe outlet.

2.8 DISCONNECTION SWITCH

.1 Affixed to the Rail near the exit door, shall be a permanent magnet, which in conjunction with the disconnection box causes a 24-volt electromagnet to disconnect the hose assembly from the vehicle. The separation of the entire hose assembly from the vehicle is a one step process whereby no stress or strain is transferred from the vehicle to the exhaust hose or overhead brackets. Numerous mechanical functions to achieve nozzle separation such as valve activation, pneumatic deflation, and pulling forces to remove the nozzle from the tail pipe are not permitted. The disconnection switch shall be adjustable to create a nozzle release point at a specified distance as the vehicle exits the building. If a proper disconnect does not occur, the electromagnet has a built-in safety disconnection feature, which releases it with a 50-pound shear force. Then the hose and nozzle assembly remains intact. With

other systems utilizing a mechanical or pneumatic direct connection to the tail pipe, a breakaway system is required to prevent the entire hose assembly from leaving the building with the vehicle.

2.9 END STOP

.1 The Rail shall be equipped with an End Stop, one for each Trolley, which is designed to stop the travel of the entire hose, nozzle, and balancer assembly. The stopping action itself must be spring cushioned to prevent the assembly from coming to an abrupt and immediate halt at an exit speed of up to 24 km/h (15 mph). The End Stop consists of a coiled spring hydraulic oil damper, which is located in the front end of the each Suction unit.

2.10 FAN AUTO-START

.1 The Fan Auto-Start serves to act as a remote control for fan start up to ensure the exhaust system is always running whenever an emergency vehicle is in operation. Upon dispatch, the exhaust fan shall automatically start and be running at full rpm prior to engine start up via a radio frequency transmitter mounted within the vehicle. The fan stays on as long as any vehicle is in operation. Upon vehicle exit or shut down, a variable timer then activates and the fan automatically turns off after a variable timed cycle. Upon vehicle return, the transmitter shall automatically activate the exhaust fan prior to the vehicle entering the building. The fan remains in operation until all vehicles are turned off and the timer then activates. The Control unit shall be FCC-approved and shall not interfere with radio communications garage doors or on board computers.

2.11 CENTRIFUGAL FANS

.1 The fan shall be a direct drive centrifugal type, high pressure, single width, single inlet as required or indicated. Impeller wheels shall be of a modified radial tip design, with top forward curve and airfoil thickness configuration characteristics. Impeller wheels shall be spark resistant and made of aluminum to prevent static electricity build up. The impeller shall be dynamically and static balanced, and of the non-overloading type to provide maximum efficiency while achieving quiet, vibrations free operation. The fan housing shall be manufactured from cast aluminum. The fan and motor assembly shall be mounted on a galvanized steel frame, which shall protect the motor, while also serving as a mounting platform for field installation.

.2 For fans 5 HP and larger, centrifugal fans shall be fully enclosed, single-width, single-inlet steel construction as required or indicated. Impeller wheels shall have backward inclined or backward curved blades of the non-overloading type. The bearings shall be self-aligned ball bearing type permanently sealed and lubricated. Fan shafts shall be steel and rotate in a non-sparking aluminum rubbing ring. Fans shall be accurately finished, and shall be provided with key and key seats for impeller hubs and fan pulleys. The fans shall be furnished with factory finish protective weather coating and a drain kit. The motor shall be totally enclosed fan cooled (TEFC). Motor starters shall be magnetic with general-purpose enclosures. The fan shall be structurally supported and provided with vibration isolators as specified to ensure quiet and smooth operation. The exhaust discharge outlet shall be in compliance with ACGIH recommendations and EPA requirements. Air intakes, windows, cascade systems, prevailing currents, communications equipment and building aesthetics will be considered in the final location of the fan. Exhaust filtration systems will be provided upon request and silencers will be provided when needed. All fans are tested in accordance with AMCA Standards in an AMCA approved test facility.

2.12 AIR FLOW PERFORMANCE

.1 Fan capacity shall be sized as such as to deliver a **650 cfm** (or as otherwise specified) at each hose drop to the vehicle being served. The exhaust system shall pull exhaust into the nozzle also inducing ambient air. The system shall be designed entirely for a negative pressure vacuum method of exhaust extraction. At no point in exhaust system will ducting be under positive pressure. Exhaust system hose drops shall be sized to maintain equal or larger cross sectional diameters than vehicle tailpipe. Exhaust systems, which do not size hose drops in accord with the vehicle engine capacity, as well as vehicle tailpipe diameter, shall not be accepted. The purpose of this portion of the specification is to insure that the exhaust system is designed to cool down exhaust as they are conveyed to the outside of fire station. This type of exhaust extraction keeps exhaust temperatures well below their designed temperature tolerances. This also prevents thermal break down of hose material thus adding years to system life. Exhaust systems that size exhaust drops without dilution ventilation and also down size the exhaust connection hose, unnecessarily put the vehicle engine warranty at risk. The delivered volume shall take into account all lengths

of ductwork, elbows, and branches, shut off, wyes, etc., which accumulate the static pressure at the fan inlet. Manufacturer provided fans shall be performance guaranteed.

2.13 DUCTWORK SYSTEM

.1 Ducts, unless otherwise specified or approved, shall be round and conform to the dimensions as shown on the drawings. Ducts shall be straight and smooth on the inside with airtight joints. Wherever ducts are used with crimped ends, the joint shall have crimp and bead arrangement. The bead shall provide a rigid stop for the mating open end to seat. Ducts shall be constructed of galvanized steel and sealed in accordance with standard SMACNA methods, for the system designed negative pressure in inches w.g. All duct joints to sealed and air tight.

.2 Ductwork Type and Materials: UMC Class 2 or SMACNA Class II product conveying duct, meet or exceed criteria for construction and performance as outlined in Round Industrial Duct Construction Standards, SMACNA. Materials of construction unless otherwise specified for all ductwork and fittings shall be a minimum G-90 galvanized sheet metal (ASTM A653/A653M). Only when specified, Type 304 stainless steel (ASTM A240/A240M) shall be provided.

.3 Ductwork Sizing and Gauges: Round pipe construction, with the range of available sizes not to exceed 10 inches (254 mm) in diameter. Duct gauge shall depend on diameter and a minimum operating pressure of 8 inches water gauge (1990 Pa). Acceptable Gauge and Reinforcement Requirements: Inner duct diameter 4 inches (101.6 mm) through 11 inches (279.4 mm) diameter shall be 22 gauge standard pipe (International Mechanical Code).

.4 Ductwork Fittings: Round and have a wall thickness 2 gauges (one even gauge number) heavier than the lightest allowable gauge of the downstream section of duct to which they are connected (International Mechanical Code). Air Duct Branch Entrances: Factory fabricated fittings or factory fabricated duct /tap assemblies. Fittings: Constructed so that air streams converge at angles no greater than 45 degree (International Mechanical Code). All Seams: Continuous stitch welded and if necessary internally sealed to ensure air tightness. Turning elbows shall be stitch-welded and used for all diameters and pressures. They shall be fabricated of 24 gauge galvanized steel and constructed as two piece with continuous welded seam construction fittings similar to those provided by Lindab Inc. Tapered Body Fittings: Used wherever particular fallout is anticipated and where air flow is introduced to the transport duct manifold. Reducing fittings shall have a minimum of 2.54 cm (1") graduating increase in diameter per 20 cm (8") in length. Elbows up to 30 cm (12") in diameter shall have a centerline radius of not less than 1.5 times the diameter. Elbows beyond 30 cm (12") in diameter shall have a centerline radius of not less than 2.5 times the diameter. Branches shall enter the mains at a specified angle of not less than 30° with the centerline of the main duct in the direction of airflow, unless otherwise indicated or approved. Flexible connections to the main or branch duct shall be braced with approved metal straps or members.

.5 Where duct of dissimilar metals are connected, or where sheet metal connections are made to fan inlet and outlet, only an approved fireproof flexible connection shall be used. The connection shall be installed and securely fastened by zinc coated steel clinch type draw bands for round ducts.

.6 Ductwork Design Velocities: Minimum of 3500 FPM (20.3 M/Second) to 4000 FPM (23.2 M/Second) transport velocity. Capture Velocity: 5500 FPM (31.9 M/Second) to 6000 FPM (34.8 M/Second) to extract virtually 100 percent of the exhaust gases.

.7 External Ductwork: Sized for the exact inlet and outlet of the exhaust fan blower. An exhaust rain cap shall be supplied and manufactured in accordance with EPA standard for free draft rain cap requirements. Included as an integral part of this rain cap shall be a back draft damper to provide protection from rain and other inclement weather.

.8 Exhaust Penetrations: The core drilling shall be properly sized to reduce the diameter of the opening to the smallest possible size.

2.14 FRAMED OPENINGS AND DUCT SLEEVES

.1 Duct sleeves shall be provided for all round ducts ≤ 38 cm (15") diameter that pass through floors, walls, ceilings, or roofs. Sleeves in non-load bearing walls shall be fabricated of 20-gauge steel conforming to ASTM A 525. Sleeves in load bearing walls shall be fabricated of standard weight galvanized steel pipe conforming to ASTM A 53. Collars for round ducts ≤ 38 cm (15") " shall be fabricated from 20 gauge galvanized steel. Round ducts > 15" in diameter passing through floors, walls, ceilings, or roofs shall be installed through framed openings. Structural

steel members for framed openings shall conform to ASTM A 36. Framed openings shall provide a 2.54 cm (1") clearance between the duct and the opening. A closure collar of galvanized steel ≥ 10 cm (4") wide shall be provided on each side of the walls or floors where sleeves or framed openings are provided.

2.15 STACKHEAD

.1 The exhaust discharge stack head will be a no loss type as recommended by ACGIH or as otherwise specified. The stack head design will protect against weather elements or introduction of debris.

2.16 DUCT TEST HOLES

.1 Test holes with covers shall be provided where indicated or directed, in the duct and plenum to insert Pitot tubes to take air measurements for balancing the air moving system if required.

3 EXECUTION

3.1 EXHAUST SYSTEM

.1 The exhaust removal system shall be installed as indicated and recommended by the manufacturer. Welding and brazing shall conform to ASME-17. Slip joints shall be sealed. Riser duct shall be supported to the structure as indicated on the drawings. Main duct shall be attached to building structural members.

3.2 BUILDING SURFACE PENETRATIONS

.1 All penetrations shall be sealed. Sleeves or framed openings shall be utilized where duct penetrates building surfaces. The space between the sleeve or framed opening and the duct shall be packed with mineral wool or approved material. Closure collars shall be installed around the duct on both sides of the penetrated surface. Collars shall fit tight against the building surfaces and snug around the duct.

3.3 GUIDE TRACK

.1 Installation height of Guide Track shall be between 3 m (10 ft.) to 4.6 m (16 ft.) range or as otherwise indicated on the drawings. The Guide Track shall be installed approximately 36 cm (14”) from the side of the vehicle and ≥ 30 cm (12”) away from the side edge of the exit door. The Guide Track for the exhaust system shall include corrosion resistant brackets for ease of mounting to structural channel, trusses, or angle iron. Brackets shall be a minimum of 0.318 cm (0.125") thickness. Mounting bolts to be no less than 0.953 cm (0.375") diameter (structural grade 8) for connection to steel frame. Bolts required for masonry installation shall be 0.5" x 3.5" expansion bolts, or 0.375" x 4" sleeve anchors for wall mount masonry connection.

.2 Recommendation: Unistrut 1 5/8” or Angle Iron 2”x 2”x 3/16”.

3.4 TESTS

.1 Each exhaust system and inlet shall be balanced to produce the indicated air quantities within 10 percent at the conditions shown. Any fans with bearings shall be lubricated, and the speed, direction and rotation of each fan shall be checked and verified as running correctly. The running current of each motor shall be checked and verified as correct. Upon completion and prior acceptance of the installation, the exhaust system shall be tested at the operating conditions to demonstrate satisfactory functional and operating efficiency. The Contractor shall provide all instruments, facilities, and labor required to properly conduct the tests.

3.5 EXAMINATION

.1 Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.6 PREPARATION

.1 Provide surface/substrate preparation as required by the manufacturer's printed installation instructions. Do not proceed with installation is in proper condition to receive vehicle exhaust system installation.

3.7 INSTALLATION

.1 Install vehicle exhaust system in accord with manufacturer's written instructions, original design and referenced standards.

3.8 ADJUSTING

.1 Adjust vehicle exhaust system for proper operation. Replace any parts that prevent the system from operating properly.

3.9 CLEANING

.1 Remove all debris caused by installation of the vehicle exhaust system. Clean all exposed surfaces to as fabricated condition and appearance.

3.10 PROTECTION

.1 Provide protection of the completed installation until completion of the project. Repair any damage at no additional cost to Owner.

3.11 TRAINING

.1 Provide training to fire department personnel in the daily use and maintenance of the vehicle exhaust removal system that has been installed and specified herein. The fire department shall be notified at least 7 days prior to the date scheduled for the training course. Training shall be for all personnel involved with the operation of the exhaust removal system to include all shifts required to man the particular facility. The Training session shall be performed in person by a recognized representative of the manufacturer of the exhaust removal system, in addition a training video shall be provided to the fire department.

.1 Provide training to all shifts during their normal shift period.

3.12 WARRANTY

.1 Provide a written warranty for a period of 1 year from date of shipment for all components.

END OF SECTION

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for each hood and accessories. Include following:

.1 certified power and control wiring schematics;

.2 product data for all accessories;

.3 drawings indicating methods of assembly and installation details.

.2 Submit with delivery of each hood a copy of the factory inspection report, and include a copy of the report with O & M Manual project close-out data.

.3 Submit site inspection and start-up reports from manufacturer's representative as specified in Part 3 of this section.

.4 Submit documentation from a third party testing laboratory to certify hood to be supplied has been tested and is listed as being in accordance with requirements of NSF/ANSI No. 2.

.5 Hand to Owner, at Substantial Performance of the Work, an identified filter removal tool.

1.2 QUALITY ASSURANCE

.1 Kitchen cooking equipment exhaust hood is to be constructed and certified in accordance with requirements of governing Provincial/Municipal Regulations, and following standards:

.1 UL 300, Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment;

.2 UL 710, Exhaust Hoods for Commercial Cooking Equipment;

.3 UL 1046, Grease Filters for Exhaust Ducts;

.4 NSF/ANSI No. 2, Food Equipment, including listing and approval by a third part testing laboratory;

.5 NFPA 17/17A, Standard for Dry/Wet Chemical Fire Extinguishing Systems;

.6 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 Each hood is to be installed by personnel experienced in installation of food service equipment, using licensed journeyman plumbers and electricians to connect electrical and plumbing services to hood.

.3 Hood manufacturer/supplier is to have an exhaust hood parts and 24/7 service facility within 100 km of site.

.4 Acceptable manufacturers must meet all requirements of this section and drawing details/requirements.

2 Products

2.1 KITCHEN COOKING EQUIPMENT EXHAUST HOOD

.1 CSA certified and labelled, completely enclosed, water-tight Type I grease and smoke extractor exhaust hood with manufacturer, model number, size, and configuration as indicated on drawings, constructed of minimum #20 gauge type 304 stainless steel with a #4 brushed satin finish on all exposed surfaces. Hood designed to permit thorough cleaning of entire hood and to automatically start exhaust fan, and constructed using continuous welded standing seam method with all exposed external welds ground and polished to the specified hood finish. Hood is to be complete with:

.1 hot-dipped galvanized steel framework;

.2 grease extractor type, high efficiency cartridge style baffle filters of adequate number and size to ensure optimum performance, arranged to be easily accessible and removable for cleaning (with a filter removal tool supplied loose) so all exhaust air will pass through filters, installed at an angle not less than 45° from horizontal with housing terminating in a pitched, full length grease trough which is to drain into a removable minimum 3.78 L (1 gal) capacity container;

.3 vapour-proof, recessed fluorescent lighting fixtures with energy efficient ballasts and T-8 WWRS lamps for a minimum of 540 lux (50 f.c.) illumination at cooking surface, pre-wired in accordance with Code requirements to a junction box located at top of the hood;

.4 self-closing, accessible, stainless steel ULC listed and labelled fire damper with fusible link(s) in the duct connection collar, and a pressurized wet chemical fire detection and suppression system with hood fusible link(s), suppression chemical cylinder assembly with wall mounting bracket, a manual pull station, and a surface wall mounting control panel with #4 finish stainless steel hinged enclosure and all required controls and contacts for interconnection to exhaust fan and source of heat supply to cooking equipment, fire alarm system, and, if applicable, building automation system;

.5 factory secured seismic restraint connection hardware.

.6 A double wall insulated front to eliminate condensation and increase rigidity. The insulation shall have a flexural modulus of 475 EI, meet UL 181 requirements and be in accordance with NFPA 90A and 90B.

.7 An integral front baffle to direct grease laden vapors toward the exhaust filter bank.

.8 A built-in wiring chase provided for outlets and electrical controls on the hood face and shall not penetrate the capture area or require an external chaseway.

.9 Removable grease cup for easy cleaning.

3 Execution

3.1 INSTALLATION OF KITCHEN EXHAUST HOOD FOR COOKING EQUIPMENT

.1 Provide an exhaust hood over kitchen cooking equipment.

.2 Install hood level and plumb with access clearances required for operation, maintenance, and cleaning, and in accordance with manufacturer's instructions. Coordinate installation with building structural support facilities.

.3 Install components supplied loose with hood. Perform required fire suppression system and domestic water and drain piping in accordance with requirements of Contract Documents.

.4 Perform required control wiring in conduit in accordance with certified control wiring schematics and requirements of the electrical work wiring requirements. Carefully coordinate all control wiring such that following sequences occur:

.1 with control panel selector switch turned to "RUN", exhaust fan is energized and return air damper is closed;

.2 with control panel selector switch turned to "WASH", exhaust and make-up air fans are de-energized, wash cycle begins after a 60 second delay, and ends after a pre-set time (3 minutes);

.3 when a fire condition occurs with fans not operating, exhaust fan continues to operate, make-up air fan is de-energized, wash down cycle is disabled, and dry contacts of the fire relay re-close;

.4 when a fire condition occurs with fans operating, exhaust fan automatically starts, make-up air fan remains de-energized, wash down cycle stops or is disabled, and dry contacts of the fire relay re-close.

.5 Brace and secure each unit in accordance with requirements specified in Section 20 05 00 - Seismic Controls for Mechanical Systems.

.6 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements. Hood manufacturer/supplier is to visit site at 25%, 50%, and 100% installation intervals and after each visit, is to issue an installation certification report.

.7 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements. Prior to start-up, under supervision of hood manufacturer's technical representative and with all required jurisdictional authorities present, perform a complete test to demonstrate proper operation of all hood functions and sequences.

3.2 DEMONSTRATION AND TRAINING

.1 Include for two, 6 hour on-site operation demonstration and training sessions for two groups of six 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.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit product data sheets for flue gas vents/air intakes and accessories.

.2 Supply a reviewed shop drawing to appropriate trade to indicate vent size and flashing materials supplied, and accurately locate building openings.

2 Products

2.1 CONDENSING APPLIANCE TYPE BH FLUE GAS VENTS (AND COMBUSTION AIR INTAKES)

.1 Equal to Ipex "System 636" PVC (for vent gas to 65°C [130°F]) or CPVC (for vent gas to 90°C [195°F]) solvent weld vent pipe and fittings, in accordance with CAN/CSA B149.1, certified as type BH vents to ULC S636, Standard for Type BH Gas Venting Systems, suitable for negative or positive venting and complete with an orange warning label to verify compliance with ULC S636, and a moulded cap with screen for vertical termination, or low profile wall termination kit, as applicable.

2.2 DOUBLE WALL STAINLESS STEEL VENT FOR CONDENSING EQUIPMENT

.1 Positive pressure double wall stainless steel flue gas vent with a type 304 outer casing, an AL29-4C inner flue, and a 25 mm (1") annular air space, ULC S636 listed and labelled, complete with prefabricated mated fittings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

3 Execution

3.1 INSTALLATION OF FLUE GAS VENTS

.1 Provide ULC listed and labelled flue gas vents for equipment. Confirm flue gas vent diameters prior to ordering.

.2 Support spacing is to be in accordance with flue gas vent manufacturer’s instructions. Installation is to be in accordance with gas fired appliance manufacturer’s instructions and requirements of CAN/CSA B149.1.

.3 Route piping using shortest route possible to termination point while avoiding interference with other work. Slope vent piping for positive drainage.

.4 Secure horizontal sections in place by means of support hardware supplied with vents and conforming to flue diameter, and hanger rods attached to structure. Support spacing is to be in accordance with vent manufacturer’s instructions.

.5 Support vertical flue sections inside building at roof level and wherever else required by means of purpose made vertical support accessories supplied by manufacturer.

.6 Hand flashing collars to roofing trade at site on roof for installation and flashing into roof construction. Install counter-flashing pieces over collars.

.7 Equip termination of each chimney with a rain cap. Confirm height requirement for chimney above roof prior to installation, and ensure proper distance from fresh air intakes is maintained.

.8 Anchor and restrain vents in accordance with requirements of Section 20 05 48.16 - Seismic Controls for Mechanical Systems.

.9 Provide required accessories, including insulated thimbles at building wall penetrations, barometric damper(s), cleanout(s), fire stops, and expansion joints where shown and/or required.

.10 Locate and install barometric dampers in accordance with manufacturer’s instructions and field adjust to suit operating conditions.

End of Section

1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 51 23 – Gas Vents.

1.2 SUBMITTALS

.1 Submit shop drawings/product data sheets for radiant heaters, including accessories, control, and power and control wiring schematics.

.2 Submit with delivery of heaters, copies of the factory inspection report, and include a copy of each report with O & M Manual project close-out data.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

.4 Submit signed copies of radiant heater manufacturer's extended warranties as follows:

.1 heater controls: 3 years;

.2 combustion chamber and radiant tubes: 7 years.

.5 Submit a signed copy of unit heater manufacturer's 15 year extended warranty for stainless steel heat exchanger of each unit heater.

.6 Install one unit heater (mechanically and electrically) in a location selected by Consultant. Operate heater at full fire to demonstrate specified air throw. Supply all required measurement instruments. If air throw is not as specified, modify or change unit heater discharge nozzle to obtain specified results. Do not install remainder of heaters until mock-up has been accepted.

1.3 QUALITY ASSURANCE

.1 Heaters and installation of heaters are to be in accordance with requirements of following:

.1 all applicable Provincial Codes and Standards;

.2 CAN/CSA-B149.1, Natural Gas and Propane Installation Codes.

.2 Heater installation tradesmen are to be journeyman tradesmen licensed to install gas fired equipment.

2 Products

2.1 GAS FIRED UNIT HEATERS

.1 CSA or cETL certified condensing horizontal air flow unit heaters, each factory assembled, pre-rewired, and test fired, each in accordance with drawing schedule, and with characteristics as follows:

.1 noise: not to exceed 75 dBA at 1 m (3');

.2 efficiency: minimum steady state thermal efficiency of 93% in accordance with ASHRAE 90.1;

.3 electrical supply: 120 volts, 1-phase, 60 Hz;

.4 gas supply: between 1.7 and 3.5 kPa (0.25 and 0.50 psi);

.5 venting: horizontal or vertical.

.2 Internally insulated cabinet constructed of heavy-gauge galvanized steel, finished with baked powder epoxy enamel, and complete with hinged access door, adjustable louvers, a wiring junction box mounted inside or on exterior of cabinet, mounting spot nuts for hanger rods secured to top of cabinet, or an accessory mounting bracket kit.

.3 Tubular, curved design 409 stainless steel heat exchanger, secured to a vest panel equipped with flue box and a motorized combustion air inducer to purge heat exchanger and positively vent combustion products, and aluminized steel inshot burners, each removable from assembly or all removable as a single component, and

complete with a venturi to mix gas and air for proper combustion, and a burner view port. Secondary heat exchanger made of AL29-4® stainless steel and complete with a 10-year warranty.

.4 Direct driven propeller type fan(s), depending on unit size, with permanently lubricated open drip-proof motor(s) conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, and a wire cage guard.

.5 Factory installed and pre-wired controls and safeties complete with:

.1 24 volt redundant combination gas valve with 100% safety shut-off, manual main shut-off valve, pressure regulator, and automatic solenoid valve;

.2 solid-state, electronic, direct spark ignition and a separate electronic flame sensor to initiate 3 attempts to re-ignite after loss of flame, then locks out unit operation;

.3 pressure switch to prove adequate flow through venting;

.4 high temperature limit controls with a fixed temperature setting to protect from abnormal operating temperatures;

.5 solid-state, integrated, combination ignition and fan control board with fan timer control, diagnostic LED for trouble shooting, and continuous fan operation control;

.6 120/24 volt control transformer;

.7 terminal strip for 24 volt control connections;

.8 all required hardware to interface unit heater control with building automation system in accordance with drawing control sequence and points list.

.9 Energy Saver Controls – as the temperature increases, gas to be disabled and stratified ceiling air circulated to heat the space until ceiling air temperature decreases below setpoint.

.6 Contractor Convenience Package featuring a condensate pump convenience outlet, unit on/off switch, heater function status indicator lights, and external terminals for thermostat wiring

.7 Heavy-gauge galvanized steel discharge nozzles selected by heater manufacturer to achieve scheduled air flow, finished to match cabinets.

.8 Seismic restraint anchors factory secured to heaters.

.9 Acceptable manufacturers are:

.1 Modine

.2 Beacon-Morris;

.3 Thomas & Betts Corp. "Reznor";

.4 Sterling HVAC Products.

3 Execution

3.1 INSTALLATION OF GAS FIRED UNIT HEATERS

.1 Provide gas fired unit heaters.

.2 Secure unit heaters in place at proper height by means of hanger rods attached to structure. Ensure heaters are level and plumb. Provide any supplemental structural steel necessary for installation where shown. Ensure unit discharge is not obstructed.

.3 Brace and restrain each unit heater in accordance with requirements of Section 20 05 48.16 - Seismic Controls for Mechanical Systems.

.4 Ensure air throw from each heater conforms to air throw of approved mock-up.

.5 Connect with valved gas piping with drip leg. Use a length of flexible gas piping with 360° loop for final connection.

.6 Provide a maximum of 1.5 m (5') of single wall stainless steel horizontal vent between unit heater and flue. Provide flues in accordance with requirements of Section 23 51 23 - Gas Vents.

.7 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.8 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

3.2 DEMONSTRATION AND TRAINING

.1 Include for a 1/2 day 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 abnormal events.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Heat Recovery Ventilators

1.2 SUBMITTALS

.1 Submit shop drawings/product data sheets for heat recovery ventilators, including accessories, and all required power and control wiring schematics.

.2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O & M Manual project close-out data.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

.4 Supply a spare filter set for each ventilator and store at site where directed prior to Substantial Performance of the Work.

.5 Submit a signed extended warranty direct from manufacturer to Owner covering the energy recovery wheel from material and workmanship defects for an additional 4 years after Contract warranty expires.

.6 Supply reviewed copies of ventilator/curb assembly shop drawings or product data to trade who will cut roof openings for ventilators, and ensure openings are properly located.

1.3 QUALITY ASSURANCE

.1 Heat recovery ventilator manufacturers are to be current members of Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:

.1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;

.2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;

.3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;

.4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;

.5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans;

.6 AHRI Standard 1060, Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment;

.7 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers;

.8 UL 1812, Ducted Heat Recovery Ventilators;

.9 CSA or ETL certification for all electrical components.

.2 Acceptable manufacturers are:

.1 Cook;

.2 Greenheck Fan Corp.;

.3 Venmar CES Inc.;

.4 Summeraire Manufacturing;

.5 Carrier Corp;

.6 Daikin;

.7 Aldes.

2 Products

2.1 DEDICATED OUTSIDE AIR SYSTEMS

.1 Factory assembled, internally wired heat recovery ventilators in accordance with drawing schedule, and with AHRI certified energy recovery ratings.

.2 Interior Unit Casings and Frame: Internal frame type casing constructed of heavy-gauge G90 galvanized sheet steel with interior surfaces lined with 25 mm (1") thick, 24 kg/m³ (1-½ lb./ft.³) density coated glass fibre duct lining material meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies, and installed with all exposed edges tucked under flanges. Additional features and requirements as follows:

.1 casings complete with factory sealed metal-to-metal joints, a solid integral base with up-turned lips around bottom openings, separate openings and knock-outs for power and control wiring conduit connections, top panels, where joints are required, are to be equipped with a standing seam, and all metal exposed to weather is to be factory cleaned, primed, and finished with baked enamel;

.2 removable gasketed panels or hinged gasketed access doors provided for access to all interior components;

.3 stainless steel drain pan pitched for positive drainage and equipped with captive condensate drain pipe connection.

.3 Exterior Unit Casings and Frame: Internal frame type double wall weather-proof casing constructed of heavy-gauge G90 galvanized sheet steel, minimum #18 gauge for exterior panels, minimum #24 gauge with interior panels, with 25 mm (1") thick, 24 kg/m³ (1-½ lb./ft.³) density coated glass fibre insulation material meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies and secured in place between panels such that it will not sag. Additional features and requirements as follows:

.1 weather-tight casings, complete with factory sealed metal-to-metal joints, a solid integral base with up-turned lips around bottom openings, and separate openings and knock-outs for power and control wiring conduit connections;

.2 removable gasketed panels or hinged gasketed access doors provided for access to all interior components;

.3 stainless steel drain pan pitched for positive drainage and equipped with captive condensate drain pipe connection;

.4 downturned design air intake and exhaust hoods constructed and factory finished as for casings, each with an "A" water penetration classification rating up to 200 mm/hr (8"/hr) rainfall at 22 m/s (50 mph) when tested in accordance with AMCA Standard L-500, and washable aluminium mesh pre-filters;

.5 minimum 200 mm (8") high, full perimeter, galvanized steel insulated roof curb supplied loose with each unit for field assembly, consisting of die-formed sections with gasket material for installation between curb and unit base.

.4 Enthalpy type energy recovery wheel for both sensible and latent heat recovery, designed to ensure laminar air flow, with energy transfer ratings in accordance with ASHRAE 84 and AHRI certified to AHRI 1060, designed to transfer moisture entirely in vapour phase, consisting of removable segments for larger wheels, and complete with:

.1 silica gel desiccant permanently bonded to lightweight polymer media mounted in a stainless steel rotor;

.2 bearings selected for a minimum L-10 life in excess of 400,000 hours;

.3 high-strength urethane drive belt factory installed in a pre-stretched state, and a motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical;

.4 frost control protection with an electric pre-heater.

.5 Disposable glass fibre media filters, ULC listed Class 2, side removable, 50 mm (2") thick, pleated, MERV 8 rating, factory or field installed in a die-formed galvanized steel filter rack at air intake opening.

.6 Centrifugal, draw-through within reference to the energy recovery wheel, double width and inlet exhaust and supply fans with forward curved blades, belt driven or direct driven as indicated, statically and dynamically balanced, mounted to unit base with neoprene vibration isolation, and equipped with:

.1 ground and polished steel fan shafts mounted in permanently lubricated sealed ball bearing pillow blocks selected for a minimum L-10 life in excess of 200,00 hours at maximum operating speed;

.2 motors and where indicated, belt drives conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical.

.7 Each ventilator is to be equipped with a sealed and factory pre-wired control box containing terminal blocks for power and control wiring connections, integral door interlocking disconnect switch, an overload protected contactor for each motor, fuses, and 24 VAC secondary control transformer.

.8 Control system in accordance with drawing control schematic/sequence, and to include if indicated, all required hardware and circuitry for connection into building automation system using protocol as specified with the system.

.9 Factory supplied, mounted, and wired variable frequency drives conforming to requirements of Section 20 05 13.13 - Variable Frequency Drives for Mechanical Equipment.

.10 Electric Preheat coils in accordance with drawing schedule, each certified in accordance with CSA C22.2 No. 155, Electric Duct Heaters and CAN/CSA C22.2 No. 236, Heating and Cooling Equipment, and each complete with frame members, terminal boxes and covers and associated sheet metal work constructed of heavy-gauge die-formed steel with an integral corrosion-resistant coating and fabricated into coil shape by spot welding, a corrosion protected sheathed heating element, an automatic reset and an auxiliary manual reset snap-action high temperature limit control to protect coils from overheating from any cause, and a pre-wired control panel for electrical power and control connections.

.1 Each control panel is to be complete with:

.1 disconnect switch;

.2 magnetic contactor(s);

.3 terminal blocks for power and control wiring connections;

.4 pre-wired differential pressure switch to shut-down coil upon sensing a "no-airflow" condition;

.5 fused control transformer;

.6 electronic step controller to suit the number of heating stages;

.11 Factory secured seismic restraint connection hardware.

3 Execution

3.1 INSTALLATION

.1 Provide heat recovery ventilators.

.2 For suspended units, provide galvanized steel mounting brackets with vibration isolators and suspend each unit, level, and plumb, by means of hanger rods. Provide supplementary support steel as required.

.3 Secure each indoor floor mounted ventilator in place, level and plumb, on neoprene-steel-neoprene vibration isolation pads on a concrete housekeeping pad.

.4 Supply an assembled roof curb for each outdoor roof mounted ventilator and hand to roof trade at site on roof. Carefully locate and size roof openings. Provide gasket material supplied with curb on perimeter of curb and secure ventilator in place.

.5 Brace and secure each unit in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Equipment.

.6 Coordinate power wiring connection and provision of a disconnect switch for each ventilator in accordance with electrical work Specification where power wiring is specified.

.7 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.8 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

3.2 DEMONSTRATION AND TRAINING

.1 Include for a ½ day on-site heat recovery ventilator operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full heat recovery ventilator internal inspection, construction details, operation, maintenance, abnormal events, and setting up controls.

End of Section

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for all make-up air units. Include following:

.1 certified fan performance curves;

.2 certified sound power data;

.3 hardware for section-to-section site connections;

.4 dimensioned layouts, including dimensioned curb layouts as applicable;

.5 product data for fan motors.

.2 Submit with delivery of each furnace a copy of the factory inspection and fire test report as specified in Part 2 of this section, and include a copy of each report with O & M Manual project close-out data.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

.4 Submit spare air filters as specified in Part 2 of this section.

1.2 QUALITY ASSURANCE

.1 Make-up air units and installation are to be in accordance with requirements of following:

.1 all applicable Provincial Codes and Standards;

.2 CAN/CSA B149, Natural Gas and Propane Installation Codes;

.3 CSA or cETL listed and labelled electrical components.

.2 Make-up air unit installation tradesmen are to be journeyman and licensed gas fitters.

.3 Acceptable manufacturers are:

.1 CaptiveAire;

.2 En Mar Systems Ltd.;

.3 Greenheck Fan Corp.;

.4 Trane Canada Corp.;

.5 Mestek Inc. Sterling;

.6 Engineered Air;

.7 Thomas & Betts Reznor.

2 Products

2.1 GAS FIRED MAKE-UP AIR UNITS

.1 Description: An Indirect-fired gas heating and ventilating unit(s), as indicated on the drawings shall be furnished. Orientation shall be Horizontal (Down) (Side) (Up) discharge. Unit(s) shall be factory assembled, tested and shipped as a complete packaged assembly, for indoor or outdoor mounting, consisting of the following:

.1 gas furnace;

.2 centrifugal blower (forward-curved double width/double inlet or backwards inclined);

.3 motor starter with thermal overload protection;

.4 motor and drive assembly;

.5 fuel burning and safety equipment;

.6 temperature control system, and

.7 gas piping.

.8 Pre-piped and charged condenser(s)

.2 Down discharge, air-tight, weather-proof make-up air units, approved for operation in ambient temperatures of -50°C (-60°F), in accordance with drawing schedule and details, factory inspected and fire tested with an inspection and fire test report prepared and submitted, and following additional performance features:

.1 units are to be suitable for operation at any supply gas pressure between 1.7 kPa and 3.5 kPa (0.25 psi and 0.51 psi);

.2 unless otherwise specified, sound emitted through casings or intakes of roof mounted units at maximum air flow rate is not to exceed 78.4 dBA at 1 m (4'), and for interior spaces, sound emitted through supply and return air openings is not to exceed 82 dBA at 1.5 m (5').

.3 Housing

.1 Unit housing shall be constructed of 20 Gauge G-90 galvanized steel. The wall panels and roof panels shall be fabricated by forming double-standing, self-locking seams that require no additional support. The floor and wall panels shall be caulked air tight with a silicone caulk. All casing panels shall be attached with sheet-metal screws or rivets, which can be removed to field service large components. The unit base shall be suitable for curb or flat mount. The base shall be constructed of galvanized steel for improved rigidity. Base shall be structurally reinforced to accommodate the blower assembly and burner. Housing construction should be suitable for outdoor or indoor installation.

.2 All doors and at least one side of every sheet metal surface of the unit separating two air-masses of different air temperatures shall be faced with properly secured 1" aluminum-faced insulation for condensation prevention. The discharge of the unit (Down/Side/Up) shall be internal to the heating module containing the furnaces.

.3 All electrical controls on the control board shall be mounted in an isolated, fully enclosed and insulated vestibule, completely separated from any combustion air, but accessible for servicing needs.

.4 All furnace exhaust flues shall be of double-wall construction. All furnace exhaust flue connections and roof-penetration seams shall be sealed with High-Temp Fire-Barrier 2000+ type silicone caulking.

.5 All unit housings, sizes 1-3, shall be equipped with Internal Air Distribution Screens on the upstream side of each furnace heat-exchanger.

.6 All gas valves and electrical safety-limits shall be mounted within the burner vestibule; wiring to these components shall be properly secured and away from all high temperature metal surfaces. The burner vestibule shall be an integral part of the unit and not extend outside the exterior casing of the unit and not exposed to the main air stream.

.7 If an outdoor unit, high wind rain caps shall be installed at the termination of the furnace discharge flues.

.8 The vestibule full-size door shall provide easy access to controls and gas-train components. Blower door shall provide easy access to blower, motor and drives. Access doors shall be provided on both front and back side of unit providing full access to every part of the unit.

.9 The unit shall have double-wall construction consisting of at least two layers of 20 gauge G-90 galvanized steel.

.4 Blower

.1 Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with set screws and keys. The blower assembly shall be isolated from the fan structure with vibration isolators.

.2 Blower capacity shall be per schedule.

.3 Blower(s) shall be forward-curved, centrifugal, Class I or II (depending on requirements of the application), double width, double inlet, constructed G-90 galvanized steel. Unit shall have a heavy-duty, solid-steel shaft.

.4 Direct drive blower assembly shall consist of a centrifugal backward inclined, non-overloading wheel secured directly to a heavy duty, ball bearing type motor via two set screws. The motor and wheel assembly shall be mounted to a heavy gauge galvanized steel frame. The motor shall be controlled by a variable frequency drive, allowing for variable airflow without the need of belts and pulleys.

.5 Motors shall be heavy duty ball bearing type and furnished at the specified voltage, phase and enclosure. Motor mounting plate shall be constructed of heavy gauge galvanized steel and shall be designed to provide easy adjustment of belt tension.

.6 Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested specifically for use in air handling applications.

.5 COOLING EQUIPMENT

.1 All cooling equipment should conform to local code requirements. All gas manifold components shall be piped and wired at the factory.

.2 Components Include:

.1 14 SEER minimum condenser
.2 Thermal Expansion Valve
.3 Filter/Dryer
.4 Hard Start Kit for Condenser
.5 Insulated Suction Lines
.6 Multiple Stages where required
.7 Pre Charged System
.8 R-410A Refrigerant

.6 GAS EQUIPMENT

.1 All gas equipment shall conform to local-Code requirements

.2 Components:

.1 modulating-gas valve
.2 on/off redundant gas valve
.3 burner
.4 main-gas shut-off valve
.5 main-gas regulator
.6 two solenoid valves

.3 All gas manifold components shall be piped and wired at the factory

.7 SAFETY CONTROLS

.1 motor starter with adjustable overloads

.2 main air-flow safety switch

.3 electronic flame-safety relay

.4 high-temperature limit switch

.5 non-fused disconnect

.6 flame roll-out switch

.7 main-gas regulator

.8 two solenoid valves

.9 modulating-gas valve

.10 burner

.11 combustion air-proving switch

.12 High gas-pressure switches to open circuit to electronic flame-safety relay, if gas pressure is too high.

.13 Low gas-pressure switch to open circuit to electronic flame safety relay, if gas pressure is too low.

.14 Adjustable low temperature blower-safety control with bypass timer to shut down unit, if discharge temperature drops below setting.

.8 ACCESSORIES

.1 Inlet Dampers: Manufacturer shall provide and install on unit, when possible, a two-position, motor-operated damper with internal end switch to energize the blower-starter circuit, when damper is 80% open. Blades shall be a maximum of 6" wide 16 Gauge G-90 galvanized steel shall be made to guarantee the absence of noticeable vibration at design air velocities. Damper blades to be mounted on friction-free synthetic bearings. Damper edges shall have PVC coated polyester fabric mechanically locked into blade edge. Jamb seals to be flexible metal, compression type.

.2 Filters: The filters shall be (2") thick, aluminum mesh, coated with super-filter adhesive. Aluminum-mesh filters shall have aluminum frames with media to be layers of slit and expanded aluminum, varying in pattern to obtain maximum depth loading. Washable 2" filters shall be enclosed in two-piece, die-cut frame with diagonal supports. Frame shall be constructed of heavy-duty beverage board. Filter media is supported on the air leaving side by a metal grid.

.3 Filter Section: shall be (insulated) constructed of G-90 galvanized steel with filters supported by internal slides and with removable access panels. Filters shall be provided in a v-bank arrangement.

.4 Fresh-Air Inlet Hood: Shall be constructed of G-90 galvanized steel with birdscreen.

.5 Fresh-Air Inlet Hood/Filter Combination: Shall be constructed of G-90 galvanized steel with birdscreen and (2") cleanable filters supported by internal slides mounted in the inlet face of the hood.

.6 Discharge Diffusers: Shall be constructed of G-90 galvanized steel with horizontal and vertical blades capable of four-way diffusion.

.7 Curb: 20" curb shall be constructed of 18 ga G-90 galvanized steel as a completed welded assembly.

.8 Cooling Coil Section: Cooling coil section shall be bolted directly to discharge of blower section. Coil section to be designed to fit onto common curb with main unit. Base of coil section to be constructed same as main unit with double pitch stainless steel drain pan for coil. Casing and roof to be 20 ga. G-90 galvanized construction. Inside of section to be fully insulated with foil back insulation. DX or chilled water coil to meet scheduled requirements.

.9 TEMPERATURE CONTROL SYSTEMS

.1 BAS (Building Automation System) Control: For building exhaust-air replacement with modulated temperature control based off of BAS supplied 0-10 Vdc or 4-20mA input signal. Auxiliary contacts and relays provided for contractor in the field.

.10 VAV

.1 VAV (Static Pressure Control): A factory-supplied field wired ECM is provided which varies the speed of the blower wheel. The WCM is controlled by a field wired Static Pressure Controller which measures building pressure and closes and opens contacts on the WCM to accelerate of decelerate the blower speed to maintain the building pressure set on the Static Pressure Controller. Factory supplied automatic dampers maintain the burner profile pressure drop as the blower speed is varied.

.2 Operating lights mounted in a remote-control panel to indicate: power, burner ON and blower ON.

.11 WIRING AND ELECTRICAL

.1 The control circuit voltage shall be 24 volts.

.2 A control transformer shall be provided.

.3 Unit shall have standing 120 Vac power.

.4 The control wiring shall be carried in wire channel or conduit.

.5 Wiring in control enclosures shall be in accordance with the National Electrical Code and the local code, as it may affect the installation.

.6 Motor starter shall be provided.

.7 Starter shall be line voltage, definite purpose type.

.8 Unit(s) shall be complete with all items such as relays, starters, switches, safety controls, conduit and wire as previously mentioned, and as required for proper operation.

.9 All factory-mounted controls shall be factory prewired to the unit control panel.

.10 Each condenser shall have a separate circuit enabling the supply fan motor to accept signals from a VFD without interfering with condenser operation.

.11 Single point electrical connection shall be supplied.

.12 Additional Components

.1 Blower-on delay timer to pre-heat the heat-exchanger prior to energizing the main blower.

.2 Convenience outlet shall be provided on the control board with 120 Vac service.

.3 Freeze-stat shall be provided with adjustable dials for time and temperature settings to shut down the main blower in case of burner failure.

.4 Fire stat with adjustable set-point temperature.

.5 Dirty filter airflow switch with LED indicator light on remote panel.

.6 Cabinet heater strip with thermostat.

.7 ECM Drive for main blower motor.

.8 Roof mounting curb factory supplied loose and ready for site assembly and insulation, 405 mm (16") high, complete with wood nailer and site assembly hardware.

.9 Factory secured seismic restraint connection hardware.

3 Execution

3.1 INSTALLATION OF MAKE-UP AIR UNIT

.1 Provide a gas fired make-up air unit on roof.

.2 Unless otherwise specified or required, provide required rigging and hoisting/moving equipment required to move units to required location. Perform rigging/hoisting/moving in accordance with unit manufacturer’s directions and details.

.3 Supply a curb for each unit, assemble curb, and hand curb to roofing trade on roof for installation and flashing into roof construction. Provide continuous gasketing around perimeter of curb between curb and unit mounting frame. Insulate curb with rigid weather-proof board type insulation in accordance with curb manufacturer's details.

.4 Install components shipped loose with units. Install a discharge air temperature sensor in supply ductwork approximately 2 m (6-½') downstream of unit and in accordance with manufacturer's recommendations.

.5 Brace and secure unit in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Systems.

.6 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

.7 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.2 DEMONSTRATION AND TRAINING

.1 Include for a 1/2 day 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 abnormal events.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets, complete with control components, and piping and wiring schematics.

.2 Prepare and submit a schematic layout of refrigerant piping showing all piping components required for satisfactory operation and maintenance of the system(s), including but not limited to pipe sizes, charging valve, isolating valves, sight glasses, strainers, driers, traps, etc. Schematic diagram must be reviewed with and approved by air conditioning equipment supplier prior to submittal to Consultant.

1.2 CLOSEOUT SUBMITTALS

.1 Submit a start-up and certification letter from equipment supplier as specified in Part 3 of this Section.

1.3 QUALITY ASSURANCE

.1 Split system air conditioning equipment and installation of equipment are to be in accordance with requirements of following:

.1 All applicable provincial codes and standards;

.2 ANSI/AHRI Standard 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

.2 Split system air conditioning system installation tradesmen are to be journeyman refrigeration mechanics.

.3 Acceptable manufacturers are:

.1 Daikin Industries Ltd.;

.2 Mitsubishi Electric Sales Canada Inc.;

.3 Panasonic Canada Inc.

.4 LG.

2 Products

2.1 GENERAL

.1 VRF system shall automatically vary the target evaporating and condensing temperatures based on building load and weather conditions to increase part load efficiency (Variable Refrigerant Temperature). The condensing unit shall also feature customizable operating modes which allows for the manual setting of target evaporating and condensing temperatures.

.2 System shall permit simultaneous heating and cooling of each indoor unit. Multiple indoor units connected to a single branch selector port shall operate in the same mode (heating or cooling), similar to a two pipe heat pump system. Refer to article “central controls” in this section for any central controller and/or mode switchover sequence that may be required.

2.2 FAN COILS

.1 Fan coils shall monitor and maintain the unit superheat (cooling mode) or subcooling (heating mode) using a computerized PID control. Internal unit components shall be factory wired and piped, and complete with electronic proportional expansion valve, flare connections, condensate drain pan, self-diagnostics, and auto-restart function.

.2 FXAQ – Wall Mounted Unit

.1 Equal to Daikin indoor unit FXAQ, shall be a wall mounted fan coil unit for installation onto a wall within a conditioned space. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment.

.2 The indoor unit's sound pressure shall range from 31 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and 3.3 feet away from the unit.

.3 The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing.

.4 The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.

.5 The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

.6 The fan type shall be direct-drive cross-flow with statically and dynamically balanced impeller with high and low fan speeds available.

.7 Units shall be provided with a loose field installed condensate pump.

.3 FXSQ – 10" Concealed Ceiling Ducted Unit

.1 Equal to Daikin indoor unit FXSQ, shall be a built-in ceiling concealed fan coil unit with variable speed direct drive DC type fan and auto CFM adjustment at commissioning. Casing shall be constructed of galvanized steel. Configuration shall be horizontal discharge air with horizontal return air, with a maximum height of 9-5/8'' and be designed to fit in tight ceiling plenums.

.2 The indoor unit's sound pressure shall range from 28 dB(A) to 36 dB(A) at low speed measured 5 feet below the ducted unit.

.3 The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump shall provide up to 25" of lift from the center of the drain outlet and have a built-in safety shutoff and alarm.

.4 The fan shall have a variable speed direct drive DC motor with statically and dynamically balanced impeller with 3 user-selectable fan speeds. The automatic fan speed mode shall allow the fan to vary between 5 speeds based on space load. The unit shall have logic for automatically adjusting external static pressure settings of the fan motor (selectable during commissioning).

.5 The unit shall ship from the factory in a rear return configuration and shall be field convertible to a bottom return configuration.

2.3 CONDENSING UNIT

.1 The condensing unit shall be factory assembled in North America and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin inverter scroll compressors, motors, fans, heat exchanger, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver (heat recovery only) and suction accumulator.

.2 The system will automatically restart operation after a power failure and will not cause any settings to be lost.

.3 The unit shall incorporate an auto-charging feature to ensure proper refrigerant charge.

.4 The following safety devices shall be included on the condensing unit: high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter, and anti-recycling timers.

.5 The inverter scroll compressors shall be high efficiency reluctance DC (digitally commutating), hermetically sealed, variable speed type. Temperatures and pressures shall be read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value. Non inverter-driven compressors shall not be accepted.

.6 Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. Upon complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

.7 The compressors' motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.

.8 Inverter board shall be refrigerant-cooled to prevent inefficient and unstable operation that can result from air-cooled inverter boards due to varying ambient conditions.

.9 The compressor shall be internally isolated to avoid the transmission of vibration.

.10 In the case of multiple condenser modules, operation hours of the compressors shall be balanced by means of the Duty Cycling Function

.11 The fan motor shall have inherent protection and permanently lubricated bearings. The motor shall be provided with a fan guard to prevent contact with moving parts. The condensing unit shall consist of one or more propeller type, direct-drive 350 W or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter. Motors shall be capable of delivering design air at high external static pressures up to 0.32 in WG (factory set as standard at 0.12 in. WG) to accommodate field applied condensing unit discharge ductwork.

.12 Night setback control for low noise operation shall automatically limit the maximum speed of the fan motor.

.13 The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tubes with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.

.14 The fins are to be covered with an anti-corrosion hydrophilic blue coating as standard with a salt spray test rating of 1000hr (ASTM B117 & Blister Rating:10), Acetic acid salt spray test of 500hr (ASTM G85 & Blister Rating:10).

.15 The outdoor unit shall be capable of heating operation down to -13°F ambient temperature. Tested factory data on heating capacity and efficiency shall be available. Continuous heating shall be provided during defrost mode for multi-module systems.

.16 The outdoor unit shall be capable of cooling operation down to +23°F without any additional low ambient controls.

.17 The outdoor coil shall have a three-circuit heat exchanger design. The lower part of the coil shall be used for inverter cooling, enhancing defrost during heating operation.

.18 The system shall have a factory standard technical cooling option to allow simultaneous heating and cooling down to -4°F. Manufacturers that cannot guarantee simultaneous heating and cooling down to -4°F, even when the system is cooling-dominant, shall provide separate systems for zones requiring year-round cooling.

2.4 FLEX BRANCH SELECTOR BOX

.1 Selector box cabinets shall have a galvanized steel plate casing and shall house multiple electronic expansion valves and a sub-cooling loop. The unit shall contain sound absorption thermal insulating material made of flame and heat resistant foamed polyethylene.

.2 Branch selector boxes shall not require drain pan and drain connections. Manufacturers with branch selector boxes requiring secondary drain pans and drain connections shall coordinate with the installing contractor at no extra cost to the owner.

.3 Manufacturers with branch selector box sizes, arrangements, or locations that differ from what is specified shall make the necessary arrangements to ensure their alternative branch selector boxes both fit in the space and that CSA B52 compliance is still met (CSA compliance shall include the life-safety maximum refrigerant charge allowance).

.4 Manufacturers shall provide sound data for all branch selector boxes. If sound data is unavailable or exceeds the scheduled values, or if branch boxes make use of solenoid valves instead of electronic expansion valves, necessary precautions shall be taken. Precautions shall include the supply and install of sound blankets, or the relocation of

branch boxes away from the occupied spaces, or extra insulation to the ceilings and walls around the branch selector boxes, all at no extra cost to the owner.

Model	Operating Sound	Max Sound
	dB(A)	dB(A)
BSF4Q54TVJ	38	45
BSF8Q54TVJ	39	47

2.5 LOCAL CONTROLS

.1 Fan coil units shall be supplied with individual zone controllers, similar to Daikin model BRC1E73

.2 Zone controllers shall be hard wired by installing contractor.

.3 Controllers shall be able to function as follows:

.1 The controller shall have single and dual setpoints for occupied periods, and independent setback setpoints for unoccupied periods.

.2 The controller shall have the ability to digitally prohibit individual buttons and functions, including custom mode selection.

.3 The controller shall have a self diagnosis function that constantly monitors the system for malfunctions.

.4 The controller shall be equipped with a thermostat sensor.

.5 Controller shall have built-in 7-day, weekday plus Saturday Sunday (5+1+1), weekday plus weekend (5+2) and everyday (1) scheduler.

2.6 CENTRAL CONTROLS

.1 Provide an advanced multi-zone controller for installation in a common area as shown on the plans, equal to Daikin iTouch Manager. The controller shall have a 10” LCD touch screen display with the following screen views and functionalities:

.2 Central control of set points, schedules, fan speeds, heat/cool mode, and of setback (override) temperature settings during unoccupied periods.

.3 Adjustable temperature limits to restrict local wall mounted thermostat setpoint ranges.

.4 Visible and audible alarm indication of any system malfunctions with error code.

.5 Tiered hierarchy allowing for control of fan coil units independently or as a group.

.6 Remotely disable individual functions of the wall mounted zone controllers.

.7 Web enabled for remote access from PC, tablet or portable device and automatic alert and error emails.

.8 The following two automatic changeover methods shall be available. One shall be selected upon commissioning.

.1 Averaging Method – the central controller shall sum up the difference between room temperatures and set points for all indoor units in the system. Once this delta reaches the primary changeover dead band of ± 2°F (adjustable), the central controller shall change over the system automatically.

.2 Voting Method – The central controller shall evaluate the difference between individual room temperatures and set points, and only include a fan coil in the algorithm if the difference has passed the primary dead band for more than the guard timer, or past the secondary dead band. Heating priority option shall be available.

.9 For both automatic changeover options, a weight (0-3) can be added to each indoor unit. The automatic changeover algorithm shall use this weighting to prioritize changeover for the more heavily weighted fan coils.

.10 Upon any changeover, a guard timer shall prevent another changeover for a period of 15, 30, or 60 (default) minutes.

.11 The guard timer shall be ignored by a change of setpoint manually from either the central controller or the remote controller, by schedule, or if the secondary dead band is reached with either of the automatic changeover algorithms. The secondary changeover dead band shall be the sum of the primary changeover dead band (adjustable) ± 1°F (adjustable)

.12 "3D" Floor plan graphic layout

.13 The central controller shall have the capability for site floor plans to be uploaded as a background to create a graphics interface. Background shall be project specific floor plans rendered in "2D" or "3D".

.14 Floor plan layout shall be displayed both on the local central controller, as well as accessible from the web.

.15 Floor plan will include capability to control indoor unit, and auxiliary inputs / outputs, such as designated lighting control, as follows:

.16 Up to 4 status points to be assigned to the control point icon (room name, room temperature, set point, and mode).

.17 Status and control points to display on corresponding location of zone served on floor plan.

.18 Digital input and output icons will display On/Off status.

.19 Analog input icons will display analog value.

.20 Up to 60 floor layout sections shall be possible depending on project scope.

.21 The iTM BACnet Server Gateway Option shall be capable of making the iTouch Manager work as a BACnet gateway using the BACnet/IP protocol. The iTM BACnet Server Gateway Option shall be capable of exposing indoor unit management points as BACnet objects to the BMS.

.22 The iTM BACnet Server Gateway Option shall allow the following functions:

.1 Support Change of Value (COV) notifications.

.2 Provide unique virtual BACnet device identification number (ID) for every indoor unit group address.

.3 The iTM BACnet Server Gateway Option shall be capable of being configured as a foreign device. It shall be capable of communicating across BACnet Broadcast Management Devices (BBMD) in different subnet networks.

.23 In addition to the standard BACnet VRF points, the Building Management System shall monitor and/or control the following BACnet objects for indoor units:

.1 Occupancy Mode: Unoccupied, Occupied, Standby

.2 Cooling and heating setpoints during occupied and unoccupied modes.

.24 The Building Management System may choose to monitor and control the following BACnet objects linked to iTM control logic:

.1 Enable/Disable iTM Schedule operation.

.2 Enable/Disable iTM Auto Changeover Operation.

.3 Set Timed Override Minutes - Monitor and configure timer extension for the indoor unit on iTM (30, 60, 90, 120, 150, 180 minutes)

.4 System forced off - Enable/Disable all emergency stop programs that are registered on the iTM.

.25 The BMS shall have the ability to utilize scheduling functions on the iTouch Manager.

.26 The BMS shall have the ability to utilize automatic changeover function on the iTouch Manager, removing the need to program automatic changeover sequences on the BMS.

.27 VRF manufacturer shall commission the BACnet server. BMS contractor shall provide VRF manufacturer with static IP address and instance number for commissioning. IP connection shall be by BMS contractor.

.28 All programming for monitoring and control of VRF system via the BACnet server shall be by BMS contractor, as per the Sequence of Operation.

2.7 ELECTRICAL

.1 Independent electrical power for fan coils and branch selector boxes shall be 208/230 volts, 1 phase, 60 hertz. The unit shall be capable of operating within the limits of 187 volts to 253 volts.

.2 Unless limited by local electrical codes and standards, multiple fan coils and branch selector boxes can be connected to the same breaker. Field provided individual disconnect switches for each fan coil are required.

.3 Electrical power for condensing units shall be 208/230 volts, 3 phase, 60 hertz. The unit shall be capable of operating within the limits of 187 volts to 253 volts.

.4 The control voltage between the indoor and outdoor unit shall be 16VDC. The control wiring shall be communication type stranded non-shielded 18-2 AWG.

.5 Control wiring shall be installed in a daisy chain configuration between all VRF components as per Manufacturer.

3 Execution

3.1 INSTALLATION

.1 Provide VRF equipment consisting of exterior condensing units and indoor evaporator units as scheduled and/or indicated on the drawings.

.2 Units shall be stored and handled according to the manufacturer's recommendations. Units shall be kept clean and isolated from dust and debris.

.3 Contractor shall inspect all equipment upon delivery and notify shipping company and manufacturer immediately of any damage.

.4 Install condensing units on a flat surface level within 1/8 inch, and elevate a minimum of 18" from ground or roof surface, on vibration isolation pads. Provide intermediate supports as recommended by the equipment manufacturer.

.5 Indoor evaporator units to be installed as located on the drawings. Confirm exact location prior to roughing-in.

.6 Install loose control components and perform required control wiring (except building automation system connections) between condensing unit and evaporator in conduit in accordance with manufacturer's control wiring schematic and wiring standards of electrical work.

.7 Connect condensing unit and indoor evaporator units with refrigerant piping in accordance with piping shop drawing schematic. Refer to Section 23 23 00 – Refrigerant Piping. Provide any required additional refrigerant.

.8 High/low pressure gas line, liquid, and suction lines must be individually insulated between the outdoor and indoor units.

.9 Use refrigeration best practice to allow pipes to expand and contract freely. Review manufacturer installation instructions to ensure expansion joints are properly designed.

.10 Anchor equipment in accordance with requirements specified in Section 20 05 48.16 – Seismic Controls for Mechanical Systems. Provide flexible connections in all piping connections to equipment.

3.2 STARTUP AND ADJUSTING

.1 Pressure test all systems to 550 PSI after system was vacuumed and held to below 500 microns for at least one hour. Review manufacturer installation instructions for proper pressure test procedures.

.2 Design and install all piping as per TSSA and CSA B52 regulations and apply and obtain TSSA certification for all systems.

.3 Refer to Section 20 05 00 – Common Work Results for Mechanical; for equipment/system manufacturer certification and start-up requirements.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for electric heaters, including accessories.

.2 Submit a site start-up report from manufacturer's representative as specified in Part 3 of this Section.

.3 Submit manufacturer's standard colour chart.

2 Products

2.1 GENERAL RE: ELECTRIC HEATERS

.1 Electric heaters are to be certified and labelled in accordance with CSA C22.2 No. 46, Electric Air-Heaters, and are to be complete with automatic reset high limit temperature control, baked epoxy/polyester powder coat white or almond finish as selected, and in accordance with drawing schedule.

.2 Acceptable manufacturers are:

.1 Ouellet Canada Inc.;

.2 Chromalox Inc.;

.3 Stelpro Design Inc.

2.2 MOTORIZED CABINET HEATERS

.1 Surface mounted or recessed cabinet heaters as shown, each complete with:

.1 #18 gauge steel cabinet and removable front panel with integral louvers and grille with rounded corners;

.2 tubular steel heating element with aluminium fins;

.3 steel fan wheel, direct driven by means of a motor conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical, and complete with a fan delay to purge heater of residual heat;

.4 factory installed, tamperproof, adjustable thermostat;

.5 factory supplied enclosure accessories as indicated on drawings and/or heater schedule;

3 Execution

3.1 INSTALLATION OF ELECTRIC HEATERS

.1 Supply electric heaters, complete with all required accessories. Hand heaters, in original packaging, to electrical trade at site in room/area where they are to be installed.

.2 Locate electric heaters for electrical trade so accurate electrical rough-in can be made. Confirm exact locations prior to electrical rough-in.

.3 Ensure heaters are properly installed.

.4 Where remote thermostats are indicated, provide thermostats and required control wiring and accessories. Unless otherwise indicated, locate thermostats 1.4 m (5') above floor, and confirm exact thermostat locations prior to roughing-in.

.5 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

3.2 DEMONSTRATION AND TRAINING

.1 Include for a 4 hour on-site heater operation demonstration and training session. Training is to be a full review of all components including but not limited to construction details, operation, and maintenance.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for products specified in Part 2, including accessories.

.2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O&M Manual project close-out data.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

.4 Submit 3 identified keys for cabinet doors for each humidifier prior to Substantial Performance of the Work.

2 Products

2.1 ELECTRIC/ELECTRONIC STEAM HUMIDIFIER

.1 Dristeem CSA certified, package type, 3-phase, 60 Hz, fully automatic electric/electronic steam humidifier in accordance with drawing schedule, capable of discharging pure steam with no mineral dust carryover, and complete with:

.1 1.3 mm (0.05") thick enamelled steel barriered wall mounting cabinet with hinged and lockable door with interlock switch for the 3-phase power electrical section, an additional door to isolate line voltage components, and a separate plumbing compartment;

.2 disposable plastic water/steam cylinders with mesh electrodes;

.3 solenoid drain and fill valves;

.4 control panel with self-diagnostic microprocessor-based control system with LCD display and keypad, steam capacity adjustment, manual drain activation pushbutton, rest pushbutton, digital operation and fault indication and display, and LED indication for current draw, humidistat demand, steam output, capacity adjustment, draining, normal operation and cylinder full, self-check on start-up, and automatic drain of cylinder at end of season;

.5 duct or plenum mounting steam distributor assembly with a length to suit mounting location, complete with condensate separator and return leg;

.6 required lengths of steam supply and condensate return hose;

.7 wall mounting 24 volt adjustable tamper-proof humidistat with 10% to 90% RH range;

.8 duct mounting differential pressure switch for air flow proving interlock;

.9 condensate pump and condensate tempering assembly;

.10 duct mounting adjustable high limit humidistat.

.2 Acceptable manufacturers are:

.1 Dristeem;

.2 Nortec Division (Climate Canada) Ltd.;

.3 Aprilaire Inc.;

.4 Vapac Humidification;

.5 Armstrong International Ltd.;

.6 Hygromatic (Spirax Sarco);

.7 Carnes Co.;

.8 Northern Industrial Humidifiers "Neptronic";

.9 Condair.

2.2 DEHUMIDIFIER

.1 Dehumidifier equal to Aprilaire Model 1850 ceiling hung, self-contained, dehumidifier, as follows:

.1 corrosion-resistant aluminum coils;

.2 removable duct connections;

.3 return air filter;

.4 11.9 gallons per day removal capacity;

.5 built-in digital control with top and front mounting options;

.6 remote control panel;

.7 smart control to automatically start dehumidification when humidity above target is sensed.

.2 Acceptable manufacturers are:

.1 Aprilaire Inc.;

.2 Honeywell;

.3 Anden.

3 Execution

3.1 INSTALLATION OF ELECTRIC/ELECTRONIC STEAM HUMIDIFIERS

.1 Provide electric/electronic steam humidifiers.

.2 Secure each steam generator assembly in place, level, and plumb, in accordance with manufacturer's instructions.

.3 Install steam distributor manifold assemblies and secure in place. Coordinate installation with sheet metal trade.

.4 Connect steam generators and distribution manifolds with steam and condensate hose kits supplied with humidifiers. Install in accordance with manufacturer's instructions.

.5 Install humidistats and pressure differential air flow proving switches and connect with 24 volt control wiring in conduit to steam generator control panel.

.6 Supply a spare water/steam cylinder for each unit and 3 identified keys for each steam generator cabinet and hand to Consultant at site prior to Substantial Performance of the Work.

.7 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.8 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.9 Include for a 1/2 day 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 abnormal events.

.10 When installation is complete, arrange for the humidifier manufacturer to visit site to supervise start-up, testing and adjusting of each humidifier, including all controls and safeties, and when this work is complete, obtain from manufacturer and submit a letter stating humidifiers have been properly installed, started, adjusted, and are in proper operating condition.

3.2 INSTALLATION OF DEHUMIDIFIERS

.1 Provide dehumidifiers.

.2 Secure in place, level, and plumb, from structure by means of galvanized steel hanger rods with galvanized steel hardware, and vibration isolation spring hangers. Ensure unit drain pan is connected with properly sized, insulated condensate drainage piping terminated over a suitable drain point.

.3 Brace and secure equipment in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Systems.

.4 Install humidistat. Confirm exact locations prior to roughing-in.

.5 Perform required control wiring (except building automation system connection) in conduit in accordance with manufacturer's control wiring schematics and wiring standards of the electrical work.

.6 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.7 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.8 Include for a 1/2 day 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 abnormal events.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for following:

.1 all control system components;

.2 identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;

.3 certified wiring diagrams for all systems.

.2 Submit following samples for review:

.1 control damper section with linkage, operator, and certified flow and leakage data;

.2 wall mounting control system flow diagram as specified in Part 2 of this Section;

.3 each type of thermostat to be used, each identified as to intended use.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

.4 Submit written confirmation from control component manufacturer that site installation personnel are qualified and experienced in installation of components, and have parts and service availability on a 24/7 basis.

1.2 QUALITY ASSURANCE

.1 Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.

.2 Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

2 Products

2.1 CONTROL DAMPERS AND OPERATORS

.1 T. A. Morrison & Co. Inc. "TAMCO" 100 mm (4') deep, flanged, AMCA low leakage certified aluminium dampers. Dampers for modulating and mixing applications are to be parallel blade type. Dampers for open-shut service are to be opposed blade type. Maximum blade length is to be 1 m (4'). Dampers greater than 2 sections wide are to be complete with a jackshaft. Each damper is to be complete with:

.1 extruded 6063T5 aluminum frame and airfoil blades, each with an integral slot to receive a gasket;

.2 extruded TPE frame gaskets and extruded EPDM blade gaskets;

.3 slip-proof aluminium and corrosion resistant plated steel linkage of a metal thickness to prevent warping or bending during damper operation, concealed in frame, equipped with seal-sealing and self-lubricating bearings consisting of a Celcon inner bearing fixed on hexagonal blade pin and rotating in a polycarbonate outer bearing inserted in frame.

.2 For insulated damper(s), Series 9000 as above but with all 4 sides of frame insulated with polystyrene, and blades thermally broken and insulated with expanded polyurethane foam.

.3 Each damper motor is to be shaft mounted, spring return, fail safe in the normally open or normally closed position, sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, to suit sizes of dampers involved, and to provide sufficient force to maintain damper rated leakage characteristics. Each operator is to be complete with a damper position indicator, and external adjustable stops to limit length of stroke in either direction, and is to be mounted on a corrosion resistant adjustable bracket. Operating arms are to have double yoke linkages and double set screws for fastening to damper shaft. Operators for dampers to be connected to building fire alarm system or to freeze protection devices are to be equipped with additional relays

to permit dampers to respond and go to required position in less than 15 seconds upon receipt of a signal. Operator enclosures are to be suitable in all respects for environment in which they are located.

.4 Electric damper operators are to be equal to Belimo EF Series 24 volt or 120 volt AC spring return, direct coupled electric motor operators for either modulating or 2-position control as required. Each operator is to be overload protected and complete with an enclosure to suit the mounting location.

2.2 LOCAL CONTROL PANELS

.1 NEMA 1 (NEMA 2 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

2.3 CONTROL SYSTEM COMPONENTS

.1 Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.

.2 Sensor/transmitter input devices must be suitable in all respects for the application and mounting location. Devices are as follows:

.1 unless otherwise specified, temperature sensors are to be resistance type, either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD with accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications, as follows:

.1 chilled water, room temperature, and duct temperature points, ±1°C (±0.5°F);

.2 all other points, ±0.75°C (±1.3°F).

.2 room temperature sensors constructed for surface or recessed wall box mounting, complete with an adjustable set-point reset slide switch with a ± 1.66°C (±3°F) range, individual heating/cooling set-point slide switches as required, a momentary override request pushbutton for activation of after-hours operation, an analogue thermometer;

.3 outside air sensors designed and constructed for ambient temperatures and to withstand environmental conditions to which they are exposed, complete with a NEMA 3R enclosure, solar shield, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;

.4 insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weather-proof with gasket and cover where outside) through a hole in duct;

.5 factory solid-state relative humidity sensors with an element that resists contamination, weather-proof with a NEMA 3R enclosure for outside air applications, supplied with a type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with a factory calibrated humidity transmitter which is accurate (including lead loss and analog to digital conversion) to 3% between 20% to 80% RH at 25°C (77°F) and equipped with non-interactive span and zero adjustments, and a 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;

.6 carbon dioxide sensors for air quality control purposes having a maximum 20 second response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:

.1 measurement range: 0 to 2000 ppm;

.2 accuracy: ±100 ppm;

.3 repeatability: ±20 ppm;

.4 drift: ±100 ppm per year;

.5 output signal: 0 to 10 VDC proportional over the 0 to 2000 ppm range.

.3 Pressure transmitters 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. Pressure transmitters are to transmit a 0

to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal. Differential pressure transmitters used for 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 balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:

.1 building differential air pressure: equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:

.1 maintain accuracy up to 20 to 1 ratio turndown;

.2 reference accuracy: +0.2% of full span.

.4 Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:

.1 Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:

.1 each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static tops on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as ±20° in approaching air stream;

.2 each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors places at equal distances along its length in accordance with ASHRAE Standards for duct traversing.

.2 Duct Flow Measuring Stations: #14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm (¾") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000') per minute. Additional requirements as follows:

.1 total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16th Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;

.2 static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;

.3 main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;

.4 each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;

.5 each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.

.3 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.

.4 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.

.5 Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 ampere signal which will be converted to a 4 to 20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:

.1 equal to Veris Industries 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 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.

.6 Honeywell Analytics microprocessor-based gas detection system, programmable monitoring and alarm equipment as indicated on drawings, CSA certified, in accordance with ANSI/UL 2017, General-Purpose Signaling Devices and Systems, ANSI/UL 2034, Single and Multiple Station Carbon Monoxide Alarms, and CAN/CSA C22.2 No. 61010, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use-Part 1: General Requirements, and as follows:

.1 Control Panel: Model 301C, 24 volt AC wall mounting NEMA 4 enclosure, capable of communicating with a building automation system to monitor exhaust fan status (primary or secondary), zone concentration and alarms through required protocol, and complete with:

.1 capability of communicating digitally with networked transmitters and relay modules through 3 RS-485 Modbus communication buses, each capable of accepting a combination of up to 32 addressable transmitters, relay modules, or annunciator panels at a maximum distance of 600 m (2000'), with power supply sufficient to power entire gas detection network;

.2 factory programmed software to enable required sequence of operation;

.3 3 internal DPDT relays rated at 5 amperes at 30 VDC, at fully programmable alarm levels and within programmable time delays, and capable of activating multiple relay modules of 8 external relays each at programmable alarm set-points and time delays;

.4 alphanumeric display indicating concentration and type of gas detected as well as location of sensor/transmitter, and 2 alarm levels for each sensing point;

.5 identified LED’s to indicate Power, Alarm Levels A, B and C, and/or Fault;

.6 audible alarm rated at minimum 65 dBA at 1 m (3') that will fully activate at programmable levels;

.7 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;

.8 capability of long term data logging to determine trends;

.9 capability of output communication through BACnet/IP to building automation system to monitor system status and to view logged historical data.

.2 CO and NO2 Sensors: Model E3SM-E3SCO with E3SRMNO2 remote sensor, 24 volt AC/DC wall mounting enclosure, capable of communicating with a building automation system to monitor exhaust fan status (primary or secondary), zone concentration and alarms through required protocol, and complete with:

.1 microprocessor-based, factory calibrated, ambient humidity and temperature compensated CO element capable of producing a RS-485 digital serial loop output signal to control panel;

.2 alphanumeric display indicating exact concentration and type of gas detected, and 2 alarm levels for each sensing point;

.3 identified LED’s to indicate Power (green), and Alarm Levels A and B (amber);

.4 audible alarm rated at minimum 65 dBA at 1 m (3') that will fully activate at programmable levels;

.5 continuous monitoring electro-chemical sensors, one for carbon monoxide, one for nitrogen dioxide.

.3 SO2 Sensor: Sensepoint XCD RTD 3 wire, 4-20mA and RS485 MODBUS output fixed point detector with in-built alarm and fault relays for the protection of personnel and plant from toxic and oxygen hazards. Incorporating a transmitter with local display and optional remote mounted sensor, fully configurable via non-intrusive magnetic switch interface, and complete with:

.1 Sulphur Dioxide sensor.

.4 Acceptable manufacturers are:

.1 Honeywell Analytics/Vulcain Inc.;

.2 Mine Safety Appliance Co. (MSA);

.3 Armstrong Monitoring Co.;

.4 Quatrosense Environmental Ltd. (QEL).

.7 Double contact switches to monitor equipment status and safety conditions, and generate alarms when a failure or abnormal condition occurs. Status and safety switches are to be as follows:

.1 current sensing switches: equal to Veris Industries self-powered dry contact output switches for sensing run status of motor loads, each calibrated to indicate a positive run status only when motor is operating under load, and 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;

.2 air filter status switches: equal to Johnson Controls Inc. or Cleveland Controls automatic reset type differential pressure switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC, a scale range and differential pressure adjustment appropriate for the service, and an installation kit which includes static pressure taps, tubing, fittings, and air filters;

.3 air flow switches: equal to Johnson Controls Inc. or Cleveland Controls pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type with an appropriate scale range and pressure adjustment;

.4 air pressure safety switches: equal to Johnson Controls Inc. or Cleveland Controls manual reset switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC and an appropriate scale range and pressure adjustment;

.5 low temperature limit switches: manual reset type equal to Johnson Controls Inc. Model A70, each complete with DPST snap acting contacts rated for 16 amperes at 120 VAC, a minimum 4.5 m (15') sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm (18") section of element, and where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required.

.8 Electronic signal isolation transducers equal to Advanced Control Technologies for installation whenever an anolog output signal from building automation system is to be connected to an external control system as an input (i.e. equipment control panel), or is to receive as an input signal from a remote system, and to provide ground plane isolation between systems.

.9 Each manual override station is to be complete with contacts rated minimum 1 ampere at 24 VAC and is to provide following:

.1 integral H-O-A switch to override controlled device pilot relay;

.2 status input to building automation system to indicate whenever switch is not in the Auto position;

.3 status LED to illuminate whenever output is On;

.4 override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.

.10 Electronic/pneumatic transducers equal to Johnson Controls Inc. transducers with an output of from 3 to 15 psig, an input of from 4 to 20 mA or 10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.

2.4 SYSTEM WIRING MATERIALS

.1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in appropriate Section(s) of Electrical Work specification.

3 Execution

3.1 DEMOLITION

.1 Perform required control system demolition work.

.2 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

3.2 GENERAL RE: INSTALLATION OF CONTROLS

.1 Provide complete systems of control and instrumentation to control and supervise building equipment and systems in accordance with this Section and drawings.

.2 Control systems are to generally be as indicated on drawing control diagrams and are to have all the elements therein indicated or implied.

.3 Control diagrams show only the principal components controlling the equipment and systems. Supplement each control system with all relays, transformers, sensors, etc., required to enable each system to perform as specified and to permit proper operation and supervision.

.4 Brace and secure control system equipment in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical.

3.3 SUPPLY OF CONTROL AIR DAMPERS AND OPERATORS

.1 Unless otherwise specified, supply required control dampers. Hand dampers to sheet metal trade at site in location where they are required for installation as part of sheet metal work. Ensure each damper is correctly located and mounted.

.2 Unless otherwise specified or scheduled, insulated dampers to be provided for all outdoor air intake and exhaust air applications.

.3 Provide linkage and operators for dampers. Wherever possible locate damper operators so they are accessible from outside duct, plenum, and equipment casings. Bracket mount operators on ducts or plenums clear of insulation where applicable.

.4 Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.

.5 Ensure dampers located in ductwork other than galvanized steel are constructed of type 316 stainless steel.

3.4 INSTALLATION OF THERMOSTATS

.1 Unless otherwise noted, provide required thermostats.

.2 Provide a ventilated clear acrylic cover for each thermostat located in finished areas, and a wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.

.3 Unless otherwise indicated, mount room thermostats 1.5 m (5 ft.) above finished floor level. Confirm exact location of thermostats prior to roughing-in.

.4 Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.

.5 Perform control wiring associated with installation of electric or electric-electronic thermostats.

3.5 INSTALLATION OF CONTROL SYSTEM COMPONENTS

.1 Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.

.2 Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

3.6 INSTALLATION OF GAS DETECTION SYSTEM

.1 Provide gas detection system sensor/transmitter and control panel equipment for areas where indicated and/or specified on drawings.

.2 Confirm exact locations of equipment 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 wiring requirement specified in the electrical work specification and system manufacturer's certified wiring schematics. Provide 24 volt interlock wiring to exhaust fan starters in accordance with drawing control requirements.

3.7 CONTROL WIRING

.1 Perform required control wiring work for control systems except:

.1 power wiring connections to equipment and panels, except as noted below;

.2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;

.3 starter interlock wiring.

.2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2') connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.

.3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.

.4 Wiring work is to be in accordance with certified wiring schematics and instructions, and wiring standards specified in appropriate Sections of Electrical Work Specification.

3.8 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

.1 Refer to identification requirements specified in Section 20 05 00 – Common Work Results for Mechanical.

.2 Identify equipment as follows:

.1 enclosures and components: engraved laminated nameplates with wording listed and approved prior to manufacture of nameplates;

.2 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings.

3.9 TESTING, ADJUSTING, CERTIFICATION, START-UP, AND TRAINING

.1 When control work is complete, check installation of components and wiring connections, make any required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting and balancing work.

.2 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.3 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.4 Include for 2 full, 8 hour days on-site operation demonstration and training sessions. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

.5 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

End OF Section

1 General

1.1 ABBREVIATIONS AND DEFINITIONS

.1 Abbreviations used in this Specification are as follows:

.1 BAS building automation system;

.2 DDC direct digital controls;

.3 LAN local area network;

.4 PC personal computer.

1.2 SUBMITTALS

.1 Submit shop drawings/product data sheets for BAS components. As a minimum, submit the following:

.1 BAS network architecture, including modes and interconnections;

.2 systems schematics, sequences, and flow diagrams;

.3 points schedule for each point in BAS, including point type, object name, expanded ID, display units, controller type, and address;

.4 samples of graphic display screen types and associated menus;

.5 detailed Bill of Materials for each system or application, identifying quantities, part numbers, descriptions, and optional features;

.6 control damper schedule including a separate line for each damper and a column for each of damper attributes including code number, fail position, damper type, damper operator, duct size, damper size, mounting and actuator type;

.7 control valve schedules including a separate line for each valve and a column for valves as for control dampers;

.8 room schedule including a separate line for each HVAC terminal unit indicating type, location and address;

.9 details of BAS interfaces and connections to other systems;

.10 product data sheets or marked catalogue pages including part number, photograph and description for BAS hardware and software.

.2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.3 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM

.1 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 complete, functional DDC control system. BAS is to be accessible through standard personal computers within building through a wireless application protocol device, or remotely through Internet by means of a standard web browser.

.2 BAS is to be field expandable, with a distributed 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 execution of control strategies at other operational devices. BAS is to maintain all settings and overrides through a system re-boot, and is to incorporate, as a minimum, following integrated features, functions and services:

.1 graphic user interface for accessing and viewing BAS information, commanding points, changing setpoints, responding to alarms, programming time-of-day schedules;

.2 operator information, alarm management, and control features;

.3 enterprise-level information and control access;

.4 information management including monitoring, transmission, archiving, retrieval, and reporting functions;

.5 diagnostic monitoring and reporting of BAS functions;

.6 off-site monitoring and management access;

.7 energy management;

.8 standard applications for terminal HVAC systems.

.3 BAS to be installed/hosted on City of Brampton virtual server to be allocated to the vendor.

.1 Virtual Server is owned by the City of Brampton and will house all software pertaining to the BAS.

.2 City of Brampton's Digital Innovation Team will provide access to the BAS vendor to the server to install, interface and configure the new BAS.

.3 Server supplied by vendor for BAS operations is not acceptable. BAS Vendor is responsible to interface the new BAS to the available server.

.4 All trends, graphs and database to reside on the Virtual Server.

.4 BAS is to include, but not be limited to, following:

.1 remote network access to the BAS installed in the City of Brampton virtual server;

.2 portable operator's terminal;

.3 network of standalone network automation engine(s);

.4 network of field equipment controllers;

.5 input/output modules;

.6 local display devices;

.7 distributed user interfaces;

.8 network processing, data storage and communication equipment;

.9 all other components required for a complete and operating BAS.

1.4 QUALITY ASSURANCE

.1 BAS hardware and software is to be installed by experienced personnel employed and trained by manufacturer/supplier of field equipment controllers. System wiring is to be installed by journeyman electricians or under direct on-site supervision of journeyman electricians.

2 Products

2.1 GENERAL RE: BUILDING AUTOMATION SYSTEM

.1 Control systems are to follow the City of Brampton BAS Guidelines as specified in Section 25 05 02.01 CoB Energy Management Guide & Compendium Article 2.4 Building Automation Systems and Appendix – BAS Design and Implementation Principles. Where conflicts arise between this specification section and the City of Brampton BAS Guidelines, the City of Brampton BAS Guidelines shall govern.

.2 Control system components (field devices) other than those specified in this Section are generally specified in Section 25 05 01 - Automatic Control Systems. Component's factory installed with equipment or supplied with equipment are specified in mechanical work Sections with equipment.

.3 BAS specified in this Section is an expandable DDC building automation system in accordance with drawing control diagrams and sequences, and points lists. Acceptable manufacturers are:

.1 Johnson Controls Canada LP;

.2 ESC Automation Inc.;

.3 Siemens Canada.

2.2 BAS ARCHITECTURE

.1 The network is to follow a 2-tier structure

.1 BCs and AWS to be on Tier1. These are to be IP-Based controllers and connected directly to CoB's base network infrastructure.

.2 AACs, ASCs, and other field controllers to be on Tier 2. These are non-IP controllers and to be connected through MS/TP infrastructure originating from the BCs

.2 BAS is to be based industry standard Ethernet TCP/IP communications protocol. Where used, LAN controller cards are to be standard "off-the-shelf" products available through normal PC vendor channels. BAS is to be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication. BAS is to be compatible with other enterprise-wide networks, and where indicated, BAS is to be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

.3 Network automation engines are to provide supervisory control over control network and are to support BACnet/IP and BACnet Standard MS/TP bus communication protocol (ASHRAE SSPC-135, Clause 9). 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 control network.

.4 BAS is to include appropriate hardware and software to allow BACnet bi-directional data communications between BAS and building equipment/system control panels. BAS is to receive, react to, and return information from connected equipment and systems. Data required by application is to be mapped into automation engine's data base and is to be transparent to operator. Point inputs and outputs from building equipment/system control panels is to have real-time interoperability 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.

2.3 DISTRIBUTED WEB BASED USER INTERFACE

.1 Features and functions of dedicated web-based user interface described above are to be available on any computer connected directly or via a wide area or virtual private network to BAS network, which conforms to the following specifications:

.1 software is to run on Microsoft Internet Explorer (8.0 or higher) browser;

.2 minimum hardware requirements are:

.1 2 GB RAM;

.2 2.0 GHz clock speed Pentium 4 microprocessor;

.3 120.0 GB hard drive;

.4 keyboard with 83 keys minimum;

.5 SVGA 1024 x 768 resolution display with 64K colours and 16-bit colour depth;

.6 mouse or other pointing feature.

2.4 REMOTE ACCESS VIA SMART PHONE AND/OR TABLET DEVICES

.1 Available with an operator interface designed for use on various modern smart phone devices with network connectivity with the follow features:

.1 Mobile user interface operating over standard TCP network connection, performing well down to standard mobile 3G speeds, and optimized to ensure very high performance across different network topologies.

.2 Solution written with HTML5 web standards and browser agnostic, not deploying or using ActiveX controls, nor requiring installation of Java Runtime engine.

.3 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.

.4 Without alternation, mobile user interface operable within any standard internet browser from a normal personal computer.

.2 Along with optimized smart phone user interface, a dedicated tablet access user interface, optionally providing full operator workstation functionality, on a tablet style device. Tablet interface is to support standard operator workstation features including full operator scope of responsibility, and operable using commercial off-the-shelf technology.

2.5 USER INTERFACE APPLICATION COMPONENTS

.1 Integrated browser based client application is to be used as user operator interface program. System is to employ an event-driven rather than a device polling methodology to dynamically capture and present new data to user. Additional features are as follows:

.1 inputs, outputs, set-points, and other parameters as defined in Part 3 of this Section, shown on drawings, or required as part of system software are to be displayed for operator viewing and modification from operator interface software;

.2 user interface software is to provide help menus and instructions for each operation and/or application;

.3 system is to support customization of user interface configuration and a home page for each operator;

.4 system is to support user preferences in alarm, trend, display, and applications screen presentations;

.5 controller software operating parameters are to be displayed for operator to view/modify from user interface, and these parameters are to include set-points, alarm limits, time delays, PID tuning constants, run times, point statistics, schedules, etc.;

.6 operator interface is to incorporate comprehensive support for functions including but not limited to 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 system is to support a list of application programs configured by users that are called up by the Tools Menu, hyperlinks within graphic displays, and key sequences;

.8 operation of control system is to be independent of user interface, which is to be used for operator communication only.

.2 System is to have a minimum of 5 levels of nesting, and the capability of displaying multiple navigation trees to aid 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. Navigation

trees are to be "dockable" to other displays such as graphics, meaning trees will appear as part of display but can be detached and then minimized to Windows task bar or closed altogether, however, a simple keystroke will reattach navigation to primary display of user interface.

.3 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. 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 4 categories of alarm sounds customizable through user defined wav files. Alarm management segment of user interface is to provide, as a minimum, following alarm functions:

.1 log, date, and time of alarm occurrence;

.2 generate a "pop-up" window or populate a dedicate section of screen 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 PC hard drive for alarms by recording user acknowledgement, deletion or disabling of an alarm, name of the user, alarm, action taken, and time/date of alarm;

.5 facilitate ability to direct alarms to an email address or alphanumeric pager, in addition to pop-up window described above;

.6 any attribute of any object in system may be designated to report an alarm.

.4 Reports and summaries are to be generated and directed to 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. System is to permit creation of custom reports and queries via a standard web services XML (Extensible Mark-up Language) interface and commercial of-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports. As a minimum, BAS is to provide following reports and summaries:

.1 all points in 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.

.5 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 5 years in advance, user selected with the pointing device or keyboard. Changes to schedules made from user interface are to directly modify network automation engine schedule database. Selection of a single menu item or tool bar button is to print any displayed schedule. As a minimum, following functions are to be provided:

.1 weekly schedules;

.2 exception schedules;

.3 monthly calendars;

.4 global schedules.

.6 BAS Is to be complete with multiple-level password access protection to permit 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 minimum), a password (12 characters minimum), and access levels;

.2 each user may change his or her password at any time;

.3 when editing or entering passwords, system is not to echo actual characters for display on monitor;

.4 minimum of 500 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 access level assigned to password of each user;

.6 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 operation or configuration of control system is to be recorded, including acknowledgement and deletion of alarms;

.7 minimum of 5 levels of access is to be supported individually or in any combination of 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.

.7 User interface is to be equipped with screen management capabilities that allows user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network of user defined navigation trees.

.8 Graphics application program is to be an integral part of user interface and is to include a create/edit function and a runtime function, and system architecture is to support a number of graphic documents (graphic definition files) limited only by memory and computing resources to be generated and executed. Graphics are to be capable of displaying and providing animation based on real-time data that is acquired, derived, or entered. Additional features include following:

.1 maximum of 16 graphic applications are to be able to be executed at any one time on a user interface or workstation with 4 visible to user, and each graphic application is to capable of 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 unique background is to be assigned on a per graphic basis;

.5 colour of animations and values on displays is to indicate status of object attribute.

.2 it is to be possible to change values (set-points) and states in system controlled equipment by using drop-down windows accessible via pointing device;

.3 graphic editing tool is to be provided to permit creation and editing of graphic files, and graphic editor is to be capable of performing/defining animations, defining runtime binding, and:

.1 in general, facilitate 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 many graphic displays representing part of building and various building components are exact duplicates, with exception that various variables are bound to different field values, consequently, it is to be possible to bind value of a graphic display to aliases, as opposed to physical field tags.

.9 Trend and change of value data is to be stored within the automation engines or 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 trend buffers are full. Exports are to be as requested by user or on a time scheduled basis. System is to be equipped with a configurable data storage sub-system for collection of historical data which can be stored in either Microsoft Access or SQL database format. Each automation engine is to store, trend, and point history data for 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 each automation engine or server is to 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.

.10 Trend viewing utility with access to data points and capability of defining trend study displays to include multiple trends is to be provided, and is to include:

.1 capability of retrieving any historical database point for use in displays and reports by specifying 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 operator at any time without reconfiguration of processing or collection of data;

.4 display magnitude is to be automatically scaled to show full graphic resolution of 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 display is to support user's ability to change colours, sample sizes, and types of markers.

.11 BAS is to be equipped with a database manager that separates database monitoring and management functions by supporting 2 separate windows. Database secure access is to be accomplished using standard SQL authentication including ability to access data for use outside of BAS application. Additional features are as follows:

.1 database management function is to include summarized information on trend, alarm, event, and audit for backup, purge, and restore database management functions;

.2 database manager is to support 4 tabs as follows:

.1 statistics, which is to display database server information and trend, alarm (event), and audit information on BAS database;

.2 maintenance, which is to be an easy method of purging records from BAS server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting database, and allowing for retention of a selected number of day's data;

.3 backup, which is to provide 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 user to log into an Expert Mode in order to view Restore screen.

.3 status bar is to appear at bottom of BAS database manager tabs and is to indicate information on 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 BAS Deice Manager;

.10 Action Successful.

.4 database manager monitoring functions are to be accessed through Monitoring Settings window and are to continuously read database information once user has logged in;

.5 system is to advise user via task bar icons and email messages when a database value has exceeded a warning or alarm limit;

.6 Monitoring Settings window is to have following sections:

.1 General: allow user to set and review scan intervals and start times;

.2 Email: allow user to create and review email and telephone text messages to be delivered when a warning or alarm is generated;

.3 Warning: allow user to define warning limit parameters, set reminder frequency, and link email message;

.4 Alarm: allow user to define alarm limit parameters, set reminder frequency, and link email message;

.5 Database Login: protect system from unauthorized database manipulation by creating a read access and write access for each trend, alarm (event), and audit databases as well as an Expert Mode required to restore a database.

.7 Monitoring Settings taskbars to display following informational icons:

.1 Normal: indicates by colour and size that databases are within their limits;

.2 Warning: 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 BAS is to indicate via taskbar icons and email messages when a database value has exceeded a warning or alarm limit;

.12 BAS is to be equipped with a demand limiting and load rolling program for purpose of limiting peak energy usage and reducing overall energy consumption. Program is to support both Sliding Window and Fixed Window methods of predicting demand. Additional features are as follows:

.1 system is to support 3 levels of sensitivity in Sliding Window demand calculations for fine tuning the system, as follows:

.1 Low Setting: sheds loads later and over shortest period of time and maximizes period of time equipment is on;

.2 Medium Setting: sheds loads earlier over a period of time greater than Low Setting, and increases time equipment is on and decreases probability of exceeding "Tariff Target";

.3 High Setting: sheds loads earlier and over a longer period of time than Medium Setting to minimize probability of exceeding "Tariff Target".

.2 system is to have both a Shed Mode and a Monitor Only Mode of operation, as follows:

.1 when Shed Mode is engaged, system is to actively control demand;

.2 when Monitor Mode is engaged, system is to simulate shedding action but will not take any action.

.3 Demand Limiting Program is to monitor energy consumption rate and compare it to a user defined "Tariff Target", and maintain consumption below target by selectively shedding loads based on a user defined strategy;

.4 Demand Limiting Program is to be capable of supporting a minimum of 10 separate load priorities, with each load user assigned, and a minimum of 12 separate "Tariff Targets" defining maximum allowed average power usage during current interval;

.5 system is to support a maximum shed time for each load as determined by user, and system is to restore load before maximum shed time has expired;

.6 system is to support a minimum shed time for each load as determined by user, and system is not to restore load before minimum shed time has expired;

.7 system is to support a minimum release time for each load as determined by user, and system is not to shed load until it has been off for minimum release time;

.8 system is to support three user defined options if meter does not function properly, as follows:

.1 shedding – currently shed loads will be released as their maximum shed time expires;

.2 maintain current shed rate – system will use demand limiting shed rate that was present when meter began to function improperly;

.3 use unreliable meter shed rate – system is to control to a user defined unreliable shed rate target.

.9 Load Rolling Program is to sum the loads currently shed and compare sum to a user defined load rolling target, and system is to maintain consumption below target by selectively shedding loads based on a user defined load priority;

.10 Load Rolling Program is to be capable of supporting a minimum of 10 separate load priorities with each load user defined to a load priority;

.11 Load Rolling Program is to be capable of supporting a minimum of 12 separate "Tariff Targets" defining amount of energy by which demand must be reduced;

.12 system is to equip user with a Load Tab that displays all demand limiting and load rolling parameters for any selected load;

.13 system is to be complete with a Load Summary that displays all loads associated with 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 Load Summary is to include a load summary runtime view listing 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.

2.6 NETWORK AUTOMATION ENGINES

.1 Network automation engines are to be ULC listed and labelled, BACnet Testing Labs (BTL) certified and labelled, fully user programmable supervisory controllers to monitor a network of a minimum of 100 distributed application-specific controllers for a global strategy and direction and to communicate on a peer-to-peer basis with other network automation engines.

.2 Each network automation engine is to have ability to deliver a web based user interface as specified above, and computers connected physically or virtually to automation network are to have access to web-based user interface. Additional characteristics/requirements are as follows:

.1 web-based user interface software is to be imbedded in each network automation engine;

.2 each network automation engine is to support a minimum of 4 concurrent users;

.3 user is to be capable of accessing all system data through one network automation engine;

.4 remote users connected to network through an internet service provider or by telephone dial-up are also to have total system access through one network automation engine;

.5 each network automation engine is to be capable of generating web-based user interface graphics, and this capability is to be imbedded in network automation engine;

.6 user interface is to support 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 network automation engine is to permit temporary use of portable devices without interrupting normal operation of permanently connected modems.

.3 Each network automation engine is to be a multi-tasking, multi-user, microprocessor-based real time digital control processor sized to meet requirements of system with a minimum word size of 32 bits, and standard operating systems.

.4 Each network automation engine is to have sufficient memory to support its own operating system, databases, and control programs to provide supervisory control for control level devices.

.5 Each network automation engine is to include an integrated, hardware based real time clock.

.6 Each network automation engine is to be equipped with LED indicators to identify 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 Network Automation Engines;

.7 Run, NAE Running/NAE in Start-up/NAE 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, NAE Modem Receiving Data;

.12 Modem TX, NAE Modem Transmitting Data.

.7 Each network automation engine 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 2 USB ports;

.2 2 URS-232 serial data communication ports;

.3 2 RS-485 ports;

.4 one Ethernet port.

.8 Each network automation engine 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 In event of loss of normal power each network automation engine is to continue to operate for a user adjustable period of up to 10 minutes after which there is to be an orderly shut-down of all programs to prevent loss of database or operating system software, and:

.1 during a loss of normal power, control sequences are to go to normal system shutdown conditions, and critical configuration data is to be saved into Flash memory;

.2 upon restoration of normal power and after a minimum off-time delay, controller is to automatically resume full operation through a normal soft-start sequence without manual intervention.

2.7 FIELD EQUIPMENT CONTROLLERS

.1 Each field equipment controller is to be a fully user programmable BACnet Testing Labs (BTL) 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 controller in place.

.2 Each controller is to employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences, and is to be factory programmed with a continuous adaptive tuning algorithm that sense changes in physical environment and continually adjusts loop tuning parameters appropriately.

.3 Each field equipment controller is to:

.1 include troubleshooting LED's to identify 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 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 following:

.1 dry contact maintained mode;

.2 pulse counter mode.

.4 support analog outputs configured to output either of following:

.1 analog output, voltage mode;

.2 analog output, current mode.

.5 support binary outputs, 24 VAC Triac;

.6 support configurable outputs capable of following:

.1 analog output, voltage mode;

.2 binary output mode.

.7 have 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 field controllers and 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 field controller and furthest connected device.

.8 have 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 bus is to support a minimum of ten devices per trunk;

.2 bus is to operate at a maximum distance of 365 m (1200') between field controller and furthest connected device.

.9 capability of executing complex control sequences involving direct wired input/output points as well as input and output devices communicating over field controller bus or sensor-actuator bus;

.10 support, but not limited to, 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 6 key keypad as an integral part of field controller or as a remote device communicating over sensor-actuator bus to permit user to view monitored points without logging into system, and to view and change set-points, modes of operation, and parameters.

2.8 INPUT/OUTPUT MODULES

.1 Input/output modules to facilitate additional inputs and outputs for use in field equipment controllers are to be similar to field equipment controllers but less display and with a minimum of 4 and a maximum of 17 points.

2.9 SYSTEM CONFIGURATION TOOLS

.1 System configuration tool is a software package supplied with BAS to enable a computer platform to be used as a stand-alone engineering configuration tool for a network automation engine and to permit programming of field equipment controllers. Configuration tool is to provide an archive database for configuration and application data and is to have same look and feel at user interface regardless of whether configuration is being done online or offline. Additional features and characteristics are as follows:

.1 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 tool is to have capability to automatically discover field devices on connected buses and networks;

.3 tool is to be capable of configuring from a library of standard applications, simulating to verify applications, and commissioning field equipment controllers and field devices;

.4 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 automation network.

.2 Bluetooth Wireless Technology converter is to provide temporary wireless connection between sensor-actuator bus or field-controller bus and a wireless enabled portable computer. Converter is to be powered through a connection to either sensor-actuator bus or the field-controller bus and is to support downloading and troubleshooting field equipment controllers and field devices from portable computer over wireless connection. Converter is to be complete with LED indicators for 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.

2.10 WIRING MATERIALS

.1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in Division 26 - Electrical.

3 Execution

3.1 GENERAL RE: INSTALLATION OF THE BAS

.1 Provide a complete building automation system in accordance with requirements of this Section of the Specification, Section 25 05 01 - Automatic Control Systems, drawings, and the input/output points list(s).

.2 Unless otherwise specified, perform BAS work in accordance with system manufacturer’s instructions.

3.2 INSTALLATION OF DIRECT DIGITAL CONTROL SYSTEM COMPONENTS

.1 Provide required direct digital control hardware, software, accessories, and wiring for a complete BAS. Refer to drawing control diagrams and sequences, points list(s), and Section 25 05 01 - Automatic Control Systems.

.2 Provide operator workstation in a location as directed by the Owner.

.3 DDC work is to be performed by skilled technicians, properly trained and are qualified for this work.

.4 Materials and equipment used are to be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. Systems and components are to have been thoroughly tested and proven in actual use.

.5 System is to be modular, permitting expansion by adding hardware and software without changes in communication or processing equipment.

.6 Provide new communications bus as required complete with required ancillaries. Connect and extend existing communications bus.

.7 Provide 1 supervisory controller (SC) per cabinet fan (air handler). Provide necessary field equipment controllers (FEC).

.8 Provide necessary quantity of SC to accomplish requirements of this specification, and to minimize number of mechanical systems that would be inoperative in event of a FEC failure. A maximum of 2 major mechanical systems are to be controlled by 1 FEC.

.9 Surface wall mount SC and FEC control units in Mechanical Rooms ensuring they are not mounted on vibrating surfaces, and connect to 15A-1P circuit breakers dedicated for control system applications, in branch panel circuit boards in adjacent spaces. Power wiring from control units to circuit breakers is to be the responsibility of the controls contractor. Wiring is to be in conduit and conduit and wiring are to be in accordance with standards and requirements of Division 26 - Electrical. Refer to electrical drawings for locations of branch circuit panelboards with dedicated circuits for controls system applications.

.10 Indicate via number, and systems controlled by SC and FEC. Indicate via a lamacoid label mounted inside panel the identification number of electrical panel supplying power to SC and FEC.

.11 Submit schedule(s) of input/output points to Consultant for review. Directly connect each SC and FEC to point devices in accordance with control diagrams and schedule of miscellaneous control points as shown on drawings. Sensor wires for each analogue input are to be No. 18 AWG twisted-shielded cable. Other types of wire required are to be as recommended by system supplier.

.12 Provide required sensors, remote devices, etc., and required interface accessories. Mount duct and/or plenum sensors half-way across duct or plenum.

.13 Differential pressure sensor used to provide space pressurization control through regulation of return air quantities must be mounted with snubbers on indoor pressure leg to prevent sudden fluctuations caused by door openings, etc. Mount outdoor air ports in locations that minimize effects of abnormal surface flow conditions and wind gusts.

.14 Supply and turn over to Consultant prior to application for a Certificate of Substantial Performance of the Work, reports to be used in assisting Owner in defining and debugging DDC programs. These reports are to consist, as a minimum, of following:

.1 process control language (PCL) logs;

.2 control loop logs;

.3 PCL master point.

.15 Submit Point Data Input forms to Consultant that Owner will fill out with DDC system supplier's assistance. Input this point data into the system.

.16 Contacts will be supplied as part of mechanical work or electrical work for alarm and status points for systems and equipment other than building environmental systems and equipment. Connect to DDC system in accordance with point schedule.

3.3 IMPLEMENTATION OF ENERGY MANAGEMENT PROGRAMS

.1 Implement energy management programs indicated for building equipment and systems.

.2 Ensure energy management program adjustable parameters are accessible to and adjustable by building operations personnel at operator's workstation.

.3 Configure energy management programs so they may be enabled/disabled on an individual basis for each system to which they apply.

3.4 CONTROL WIRING

.1 Perform required control wiring work for control systems except:

.1 power wiring connections to equipment and panels, except as noted below;

.2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;

.3 starter interlock wiring.

.2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2') connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.

.3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.

.4 Wiring work is to be in accordance with BAS manufacturer's certified wiring schematics and instructions, and wiring standards specified in electrical work Division of this Specification.

3.5 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

.1 Refer to Section 20 05 00 – Common Work Results for Mechanical.

.2 Identify BAS equipment as follows:

.1 enclosures: engraved laminated nameplates with lettering such as BAS Panel CP2, or BAS Relays, or BAS E/P Transformers, with all wording listed and approved prior to manufacture of nameplates;

.2 panel points: a weather-proof input/output layout sheet for each controller with the name of each point connected to controller, and associated wire labelling information;

.3 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings;

.4 interface components: a weather-proof layout sheet clearly illustrating/identifying purpose of each component within enclosure such that an operator or service technician can quickly identify exact use of each relay, transducer, contactor, etc., with each sheet fastened securely to back of enclosure door.

3.6 TESTING, ADJUSTING, CERTIFICATION, START-UP, AND TRAINING

.1 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.2 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.3 Include for demonstration and training sessions for each of 2 groups of Owner's operating and maintenance personnel as follows:

.1 3 full, 8 hour day orientation sessions at system manufacturer's office to educate personnel on BAS architecture, hardware, and software, with an overview of BAS operation and capabilities including but not limited to operational programmes, equipment functions (both individually and as part of a total integrated system), BAS commands, advisories, alarms, and appropriate operator intervention required in responding to BAS operation;

.2 2 full, 8 hour day sessions at site using BAS for a "hands-on" demonstration of BAS functions and features with instruction regarding chronological flow of information from field devices, contacts and sensors to operator's workstation, an overview of communications network describing interplay between initiating devices, field hardware panels, systems communications, and their importance within operating BAS, and alarm indications and appropriate responses;

.3 2 full, 8 hour day seasonal (summer-winter) site sessions to perform additional instruction regarding seasonal changes and how they affect BAS.

.4 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full day to provide additional system training as required.

3.7 PROJECT CLOSEOUT WORK

.1 Record "as-built" drawings are to include:

.1 schematic outline of BAS for quick reference of overall system scope;

.2 adequate record of work as installed, including locations and routing of system wiring.

.2 O&M Manual is to include:

.1 hardware specification manual which gives a functional description of hardware components;

.2 operator's manual which outlines concise instructions for operation of system and an explanation and recovery route for system alarms;

.3 engineering manual which outlines and defines system set-up, definition and application;

.4 data manual which indicates applications data programmed into system;

.5 system software documentation.

End of Section

Energy Management Guide and Compendium

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Prepared by:

Energy Management
Facilities, Services and Operations,
Community Services Department

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DOCUMENT HISTORY

Version	Date	Revisions
1.0	September 6, 2019	Indoor Pool, Gymnasium and Administration Spaces
1.1	October 29, 2019	Transit Facilities
1.2	January 21, 2020	Building Control and Automation
1.3	April 1, 2020	Building Control and Automation Appendices Revised TOC Layout for Design, Implementation & Operations
2.0	April 22, 2020	Operations Section
2.1	April 21, 2021	Update to BAS Vendors list

Section I. Introduction

Chapter 1. Energy Management Mandate

The Energy Management Team's mandate is to minimize energy and emissions and maximize cost recovery for the City's portfolio of owned and managed facilities.

Chapter 2. Purpose of A Zero Carbon Transition

As a Green City, Brampton has committed to zero carbon and high performance facilities. This commitment for *A Zero Carbon Transition* has been formalized through the City of Brampton's latest 5-year Energy and Emissions Management Plan for 2019-2024. The plan outlines the action plan to achieve a zero carbon transition for the City's new and existing corporate facilities. In accordance with the Paris Agreement, Brampton has adopted the provincial and federal greenhouse gas (GHG) emission reduction targets of 30% and 80% for 2030 and 2050, respectively, using a 2010 baseline. The City has set an interim target of 20% GHG emissions reduction by 2024. The Energy Management (EM) Team at the City is committed to the following three key objectives under this plan: to minimize emissions intensity, to minimize energy intensity, and to maximize cost recovery.

The standard approach for decreasing facility GHG emissions is the reduction of fossil fuel use required to heat, cool and power buildings through energy efficiency. As a result of energy conservation measures implemented in City owned facilities and decreasing emission factors due to the elimination of Ontario's coal plants for the production of electricity, GHG emissions for City facilities have decreased over time. However, in order to meet the aggressive targets of the City's 2019-2024 Energy and Emissions Management Plan, and federal and provincial GHG reduction commitments, there is a need to drive GHG reductions at a much faster rate. To do this, both energy use and carbon emissions need to be reduced simultaneously by transitioning to zero carbon. The transition includes design, construction and operating practices, which are all covered within this guide.

Chapter 3. About this Guide and Compendium

3.1 Intended Audience and User Groups

This guide is intended to provide guidance to the following identified user groups:

Internal to the City of Brampton:

- Community Services
    - Recreation
    - Building Design & Construction (BDC)
    - Facilities Operations and Maintenance (FOM)
    - Facilities Maintenance (FM)
        - Outside Service Contracts
    - Facilities Services and Operations (FSO)
        - Energy Management Team
    - Capital Planning and Asset Management
- Public Works and Engineering
- Transit
- Fire and Emergency Services

External to the City of Brampton:

- Consultants
- Architects
- Engineers
- Contractors

Why have these groups been identified?

- To ensure that energy performance is more than just an afterthought, it needs to be raised to the same level as corporate financial targets and operating objectives. This will facilitate commitment and buy-in from all stakeholders involved.
- To facilitate an integrated design process[1]
- A project's failure to reach a zero energy goal can be the result of roadblocks that occur at any stage. At each stage, roadblocks can clog the path to zero energy and prevent the project from achieving its potential. A successful team navigates each of these roadblocks and has strategies and lessons learned to overcome each challenge. They carry ownership of the zero energy goal from stage to stage and elevate the priority of building energy performance. [2]
    - Including zero energy in the City's preferences during the request for proposals (RFP) stage greatly increases the likelihood that teams with zero energy expertise will be selected.
    - Proper oversight of the estimating team during the project can eliminate errors due to unfamiliarity with energy efficiency and renewable systems and keep the project on path.
    - Maintaining and communicating the priority of the zero energy goal throughout the process
    - Through the final bid and value-engineering stages ensures that the systems and components necessary for achieving that goal will not be eliminated from the project.
    - Through the operation of the facility, the operational staff and end-users play a crucial role in running the facility with a conservation and zero carbon mindset
- Architects as designers are to adopt the features of energy conservation in designing new buildings and renovating existing buildings. designing and detailing effective building envelope systems, knowledge of the increased importance of embodied carbon in building materials when targeting a net-zero carbon design[3]

While engineers play a crucial role in the design of more sustainable buildings, they often get involved too late in the design process. Many of the key decisions are taken in the earliest design stages, when building orientation, glazing ratio (ratio of area of glass to area of opaque wall), and the overall form of the building are decided. Once these critical decisions have been made, engineers can attempt to optimize a poor design, but it is difficult to arrive at low-carbon design without having engineers involved in the initial design. The challenge is to integrate engineering analysis in a manner that provides rapid feedback to architects and the rest of the design team early in the process.[4]

3.2 How to Use this Guide

This guide document aims to give various user groups guidance and recommendations to influence the City' portfolio of existing and new construction projects on the transition to zero carbon. The guide is presented in the following four sections:

[1] This is further discussed in Section II of this guide
[2] Chapter 2, Maintaining Zero Energy Goals Throughout a Project. Advanced Energy Design Guide for Small to Medium Office Buildings – Achieving Zero Energy. ASHRAE 2019.
[3] Häkkinen, Tarja & Kuittinen, Matti & Ruuska, Antti & Jung, Nusrat. (2015). Reducing embodied carbon during the design process of buildings. Journal of Building Engineering. 4. 1-13.
[4] Ochsendorf, J. Challenges and Opportunities for Low-Carbon Buildings (2012), Massachusetts Institute of Technology.

1. **Section I: Introduction**

The Introduction provides the audience of this guide with background information on the City's Energy & Emissions Management Plan 2019-2014: A Zero Carbon Transition. In addition to providing background on the City's commitments and targets, this section also provides a high level overview of the purpose of a zero carbon transition, principles of success through energy management, and approaches to zero carbon.

2. **Section II: Design**

This section provides recommendations to encourage zero carbon or high performance energy design when compared with minimum building code requirements. This section applies to new construction and major renovation projects for City owned facilities. Recommendations in this section are presented with a considerations for an integrated design process (IDP) and energy modelling. Customized design considerations are presented by facility archetype.

3. **Section III: Implementation**

The implementation section is intended to provide recommendations to implement the design of zero carbon or high performance energy facilities. This section applies to new construction and major renovation projects that are City owned or managed.

This section is a WIP.

4. **Section IV: Operations**

The Operations section provides recommendations for the operation of zero carbon or high performance facilities. This section applies to all existing and new construction facilities that are City owned or managed.

This section provides an overview of operation processes, followed by customized facility operation strategies for various facility archetypes with a focus upon best operational practices and setpoints/schedules.

Chapter 4. Principles of Success

4.1 An Energy Management Pathway for Design, Implementation & Operations

For the pathway to be successful, the first step is creating a plan for new and existing facilities which was referenced in the Introduction. Energy targets for these individual facilities are created from the overall emissions target referenced in the City's Energy and Emissions Management plan. These targets need to be met at design, construction and most critically at the operational stages so that they persist throughout the life cycle of the building.

The World Building Design Guide recommends an integrated approach:

- "Reduce heating, cooling, and lighting demand through passive strategies such as climate-responsive design, daylighting, and conservation practices;
- Specify efficient HVAC and lighting systems that consider part-load conditions and utility interface requirements;
- Employ renewable energy sources such as solar heating for hot water, photovoltaics, geothermal space heating, and groundwater cooling, sized for the reduced building loads.
- Optimize building performance by employing energy modeling programs during design;
- Optimize system control strategies by using occupancy sensors, CO2 sensors, and other air quality alarms during operation;

- Monitor project performance through a policy of commissioning, metering, annual reporting, and periodic re-commissioning;
- Consider Retro-commissioning of buildings which were never originally commissioned; and
- Integrate water saving technologies to reduce the energy burden of providing potable water."

The first three bullets of this approach can also be used in a stepwise fashion so to maximize cost effectiveness. The capital cost of renewable energy sources or systems is significant and thus reducing the demand (bullet one) will reduce the capacity and cost of the system required to meet this demand.

Figure 1 illustrates this four step approach:

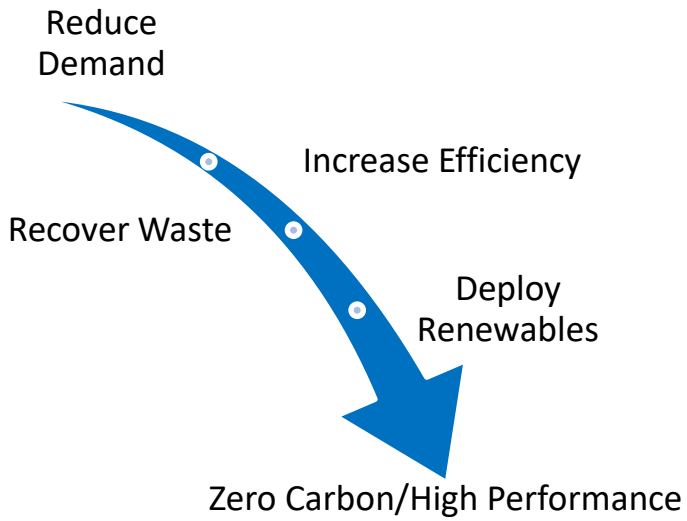


Figure 1 Four-Step Approach to an Energy Management Pathway

Chapter 5. Zero Carbon Approach

5.1 Purpose

This guide provides pathways to achieve zero carbon or high efficiency buildings, however it is acknowledged that with technology innovations there will continue to be developments for additional pathways to zero carbon that may not be covered within this guide and thus, it is a living document and will evolve over time. The recommendations in this guide are not designed to be code-enforceable. As a result, they are not intended to replace, supersede, or circumvent any applicable building codes and standards. This guide assumes that all minimum regulatory and energy code requirements are met by the project.

This guide focuses on reducing energy consumption in a building. There are also overlaps with other important aspects of sustainability. Acoustics, indoor air quality (IAQ), water efficiency and quality, landscaping, access to views, and effective space planning are just some of the other benefits of an effective design.

5.2 What is a Zero Carbon Facility?

A zero carbon facility has life-cycle GHG emissions which sum up to zero, or less. This includes the life-cycle impacts of the facility's design, construction, and operation practices.

Design & Implementation:

- Design prioritizes reducing energy demand and meeting energy needs efficiently.
- The embodied carbon of the building's structural and envelope materials is evaluated as part of the design. This includes carbon from the materials extraction, manufacturing, transportation to site, installation, disposal and end of life processing.[5]
- Install onsite renewable energy

Operations:

- The building demonstrates a zero-carbon balance in its operations. Over the course of a year, its operations contribute zero carbon emissions.
- Onsite renewable energy is used, either produced onsite or procured from offsite
- Tracking and reporting of the facility's energy consumption and associated GHG emissions

5.3 Zero-Over-Time (ZOT) Approach

A zero-over-time (ZOT) approach focuses on cost-effective energy efficiency and renewable energy by prioritizing projects that pay back quickly in the short term, while aligning larger energy efficiency projects with major building life-cycle events, like equipment upgrades. The ZOT approach sets commercial building portfolios on a financially viable path to achieve net zero energy.[6]

WIP

[5] Not the current focus of this guide
[6] Guide: Best Practices for Achieving Zero Over Time for Building Portfolios. Rocky Mountain Institute (2018) https://rmi.org/insight/zero-over-time-for-building-portfolios/

Section II. Design

Chapter 1. Purpose

According to the CaGBC, the cost of not adopting a zero carbon transition increases with each day[7]. Every building built today that is not designed to achieve near-zero carbon emissions is only contributing to a continued increase in carbon emissions. Facilities not built to zero carbon will require major investments in deep energy retrofits by 2050 to meet Canada's and the City of Brampton's GHG reduction targets. These retrofits will be costly and disruptive to building owner operators and tenants, and will need to occur before the normal 25 to 40-year cycle of significant re-investment in a building's infrastructure and major equipment[8].

1.1 Purpose

This design section is intended to provide recommendations to encourage zero carbon or high performance energy design when compared with the minimum building code requirements. This section applies to new construction and major renovation projects for City owned facilities.

This section will provide customized strategies as applicable for the following classifications with example archetypes shown in brackets.

- Recreation (e.g. community centres, including multi-purpose facilities with pools, ice rinks, gymnasiums, dance studios etc.)
- Transit & Works Operation (e.g. Transit Facilities, Public Works Yard)
- Corporate (e.g. Administrative Facility)
- Library
- Fire & Emergency Services (e.g. Fire Station Facility)

1.1.1. Benefits of Zero Carbon & High Performance Design

Zero carbon and high performance design will reduce corporate facility energy usage, minimize emissions and promote a culture of sustainability. This guide is also meant to provide the following additional benefits: improve life cycle costs and efficiency promote innovation, increase occupant comfort and satisfaction, and drive energy awareness amongst the audience and user groups mentioned previously.

Improve Life Cycle Costs and Efficiency

- Zero carbon design helps to provide long-term lower maintenance and operational costs for facilities as a direct result of energy efficient design and optimized building control and operation
- Commissioning of new facilities ensures facilities are constructed and will perform as designed.
- Buildings not built to zero carbon can undergo very costly future retrofits whereas zero carbon buildings have lower life-cycle costs and continue to conserve resources throughout the lifetime of the building
- Zero carbon provides resilience to owner-operators from future energy and carbon cost risks as there is a potential for the rise in cost of carbon emissions and the cost of traditional fuel sources

[7] The CaGBC found that zero carbon buildings on average can provide a positive financial return of 1% with an 8% capital cost premium. Over 25 years, the averaged cost of carbon pollution used for the CaGBC's study was $150/tonne. The starting cost was $50/tonne and an annual increase of $8/year was applied over 25 years. Reference: Making the Case for Building to Zero Carbon (2019), CaGBC. Accessed at: https://www.cagbc.org/cagbcdocs/advocacy/Making_the_Case_for_Building_to_Zero_Carbon_2019_EN.pdf

[8] Making the Case for Building to Zero Carbon (2019), CaGBC. Accessed at: https://www.cagbc.org/cagbcdocs/advocacy/Making_the_Case_for_Building_to_Zero_Carbon_2019_EN.pdf

Increasing Occupant Comfort, Satisfaction & Health[9]

- Properly designed and constructed, better insulated and tighter envelopes mean a quieter, more thermally comfortable workspace and a more durable building
- Some aspects of occupant satisfaction, such as physical and visual comfort, access to daylighted spaces, views to the outdoors, and natural ventilation, are achieved through effective building design and operation
- Productivity of occupants can be improved with a healthy, comfortable, energy-efficient environment
- Better building envelopes eliminate cold surfaces and drafts, reduce discomfort from higher heating and cooling demands, and provide views and daylighting while reducing glare and hot spots caused by thermal gain. They also ensure there are no health issues associated with moisture intrusion
- Better distribution of heating and cooling reduces temperature differences from one area to another. Air is provided at a lower velocity and at a temperature closer to that of the ambient air.
- Ventilation systems provide adequate fresh air to all spaces, and enhanced controls adjust to fluctuating occupancy rates to maintain temperature and air quality.

Drive Energy Awareness

- The development of a culture and mindset that moving towards higher performance and zero carbon building design is a good financial investment
- The development of this culture development needs to begin when the project is first conceived, and extend through design and construction into operation of the facility
- There are greater chances of successful operation if the building occupants and facility operational staff themselves are advocates for energy efficient building performance
- With a mindset of loving towards zero carbon the operational staff and occupants can be relied upon to provide ideas for increasing performance. If the occupants have not embraced the zero carbon culture, the chances of achieving zero carbon operations are significantly reduced.

1.2 Project Initiation

WIP

1.3 Design Reviews

WIP

Chapter 2. Process

Linking to the four step process in the previous chapter, this chapter describes an integrated design process that often uses energy modelling as a tool to explore demand reductions, efficiency increases, waste energy recovery and renewable energy deployment. It closes with a section on how recommended targets can be set to the deliver operational energy performance within the integrated design process. This process has applications to existing buildings, new facilities, and major renovations.

2.1 Integrated Design Process

Historically, facilities have been designed, constructed and commissioned using different teams in a linear fashion and with little to no integration between teams. While this process may be successful in less complex building projects, it rarely takes into account energy design considerations. This is a result of the

[9] Advanced Energy Design Guide for Small to Medium Office Buildings – Achieving Zero Energy. ASHRAE 2019.

teams responsible for these considerations being isolated from the rest of the project team and/or being brought in too late in this linear process.

The integrated design process can address this process gap. Some definitions of the process follow below:

> *A systematic and staged approach that ideally requires support from an interdisciplinary team of engineering, architecture and building science professionals. Working in concert, these professionals will optimize overall energy and cost savings from your project while enhancing the indoor environmental quality for your building occupants. (NRCan, 2016)*
>
> *An integrated process is highly collaborative. This approach requires the whole project team to think of the entire building and all of the systems together, emphasizing connections and improving communication among professionals and stakeholders--including user groups--throughout the life of a project. It breaks down disciplinary boundaries and rejects linear planning and design processes that can lead to inefficient solutions. (USGBC, 2014)*

These design processes that can lead to inefficient solutions may also lead to significant cost increases during the post-construction document stage, as illustrated by line 2 in Figure 2. In contrast, if effort is concentrated at the pre-construction document stage during pre-design, schematic design, and design development then the ability to impact cost and functional capabilities is much greater. This will likely lead to reduced cost of design changes, which is also shown by line 2.

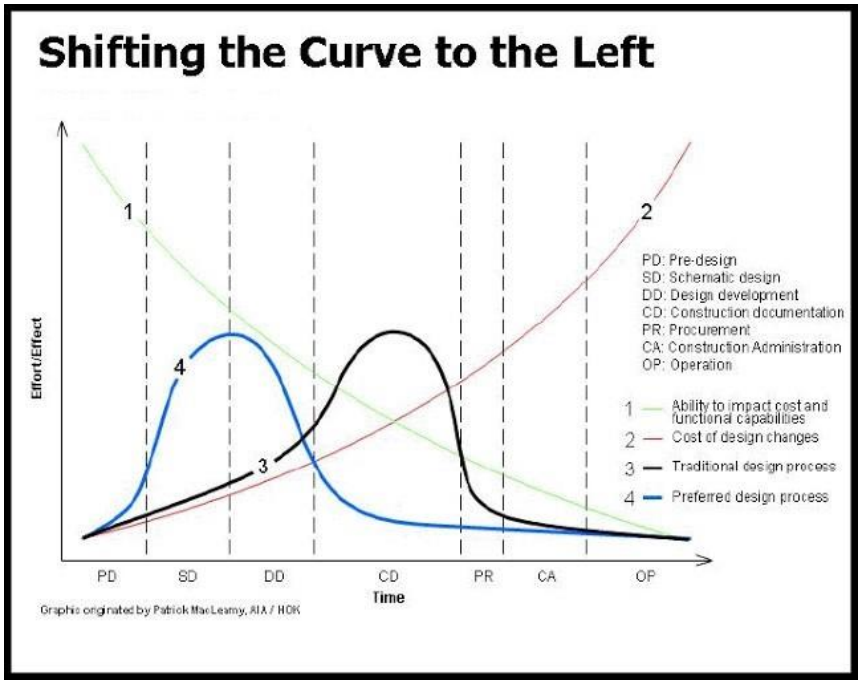


Figure 2 Shift in the Integrated Design Process

2.2 Energy Modelling

A common tool in the integrated design process is building energy modeling. Building energy modelling is a physics-based software simulation of energy use[10]. Some examples of inputs into this software include: building geometry, construction materials, HVAC, domestic and service water heating, lighting and control strategies. Controls strategies may also include schedules for occupancy, lighting, receptacle loads, and thermostat setpoints. The inputs are combined with local weather data and the program calculates heating and cooling loads, a response to those loads, and the resulting energy use. Other considerations such as thermal comfort and energy costs can also be determined by the program. The simulation is an hour by

[10] https://www.energy.gov/eere/buildings/about-building-energy-modeling

hour analysis and also accounts for interactive effects. One example is the interaction of pool water heat loss and evaporation with ambient temperature and relative humidity in an indoor setting.

Using energy modelling in the early stages of design—concept or schematic design—is recommended since it can quickly inform stakeholders on building massing and orientation that are favorable to high performance and occupant comfort. Once massing and orientation are established, mechanical and electrical systems can be added to the modelling mix to determine options that can meet energy targets as well as augment comfort. As system options are further evaluated and eliminated, a final model with fully developed systems can be created during the final stages of design development to confirm target and comfort compliance. This process can be used for energy code compliance and with high performance targets, code compliance should easily be met.

While the process outlined above is for new buildings, a similar process can be followed with existing buildings with the first step being model calibration to historical utility bill and energy sub-meter data so that its behaviour mirrors existing building energy consumption and demand. After this step, compliance with target and comfort goals can be determined.

2.3 Energy Targets

Energy targets for individual facilities are set based on the City of Brampton's Energy and Emissions Management Plan, which has an overall emissions reduction target of 20% by 2024 relative to a 2010 baseline for facilities where the City of Brampton is directly responsible for energy costs. Each facility target will contribute to the overall target and it is recommended that an early stage model be created during concept or schematic design.

To ensure that targets are met in design, construction and operation, individual targets are created for each facility and language for the target and early stage energy modeling are inserted into procurement documents in the case of new facilities and major renovations. The following sub-section is an example of this procurement language using moderate and higher performance targets, where moderate can be used as a minimum target. The language also details a format for an early stage energy model report including costs for different options.

2.3.1. Procurement Language

Provide early stage energy modelling with parametric analysis using a parallel coordinates plot to evaluate and illustrate the effect of building envelope, lighting, and HVAC parameters that influence both energy performance and occupant comfort. The use of tilt-unspecialized construction materials and methods is to be evaluated in the parametric analysis and to take into account thermal mass storage of building assemblies. The following parameters are to be used:

1. Window to wall ratio
2. Roof insulation
3. Wall insulation
4. Slab on grade insulation
5. Windows heat transfer
6. Overhead doors and door heat transfer
7. Window solar gain
8. Infiltration rate /air tightness
9. External shading percentage
10. Lighting system
11. HVAC system
12. Estimated Annual Energy Costs

This iterative energy modelling process is to generate data on energy consumption which will provide inputs for cost estimation.

The Zero Carbon Building Design Standard has Energy Modelling Guidelines that provides three approaches to demonstrate energy efficiency. The first approach provides the greatest flexibility for most projects, with requirements for thermal energy demand and overall energy use. The second approach recognizes projects that pursue more aggressive thermal energy demand reductions, putting additional emphasis on the building envelope and ventilation strategies. The third approach provides a path for projects that wish to achieve zero carbon in their annual operations without relying on purchased measures like carbon offsets or green power products such as a renewable energy certificates (RECs).

- **OPTION 1 Flexible Approach:** Thermal energy demand intensity (TEDI) of 30-40 kWh/m^2/year, as a function of climate zone; and site energy use intensity (EUI) 25% better than the National Energy Code for Buildings (NECB) 2017.
- **OPTION 2 Passive Design Approach:** Thermal energy demand intensity (TEDI) of 20-30 kWh/m^2 /year, as a function of climate zone.
- **OPTION 3 Renewable Energy Approach:** Thermal energy demand intensity (TEDI) of 30-40 kWh/m^2 /year, as a function of climate zone; and Zero carbon balance for operational carbon achieved without green power products or carbon offsets.

In addition to compliance with one of the above three options, the successful Proponent shall develop energy efficiency requirements as it relates to electricity consumption. These requirements shall minimize electricity use intensity so that when this intensity is combined with TEDI, the overall energy use intensity is 25% better than NECB 2017 as per Option 1.

Provide a report including:

- Data visualization graphic (parallel coordinates plot) with axes showing the effect of each of the eleven parameters listed.
- Estimated costing for building compliance, and the options discussed above
- Lifecycle payback for significant parameters
- Occupant comfort commentary on the relative merits of different envelope, lighting and HVAC systems on thermal and comfort performance of the facility. This commentary can be based on known industry studies.
- Overall comparison of options, a recommendation on which option to proceed with and how to integrate the bundle of parameters into the project.
- Highlight potential issues and risks associated with parameters.

2.4 Building Automation Systems

2.4.1. Building Automation Design Principles

The BAS Guideline design principles provides a high level description of the purpose and structure of the BAS Guidelines. This section includes the City of Brampton BAS design principles,

2.4.2. Integrated Design Vision

A Building Automation System is a series of networked controllers and a software headend designed to monitor and control the environment in a building. It controls all aspects of the HVAC and can extend to include lighting, sub-metering, security and more. It ensures the operational performance of the building systems as well as ensuring the comfort and safety of the building's occupants. The City of Brampton intends for its building automation systems to be an integral part of Energy Management by reducing energy consumption and GHG emissions.

Additionally, it is the goal of the city to shift design, construction and commissioning processes from a linear, individualized approach to an integrated and collaborated approach. It is the intention of this guideline that all aspects of the BAS design and implementation is considered holistically and applied through an iterative

process. This involves looking at the interoperation of disparate systems and considering how these systems are to work together.

2.4.3. BAS Design Goals

As a Green City, Brampton has committed to zero carbon and high performance facilities. This commitment for A Zero Carbon Transition has been formalized through the City of Brampton's latest 5-year Energy and Emissions Management Plan for 2019-2024. The plan outlines the action plan to achieve a zero carbon transition for the City's new and existing corporate facilities. In accordance with the Paris Agreement, Brampton has adopted the provincial and federal greenhouse gas (GHG) emission reduction targets of 30% by 2030 and 80% by 2050, respectively, using a 2010 baseline. The federal target has since been updated to net-zero emissions by 2050 (re-affirmed by the Minister of Environment and Climate Change at the 2019 UN Climate Change Conference)[11]. The City has set an interim target of 20% GHG emissions reduction by 2024.

The design and implementation of Building Automation Systems is intended to support the three objectives of the Zero Carbon Transition Plan:

1. Minimize energy use
2. Minimize emissions
3. Maximize cost recovery

To achieve these 3 objectives, CoB has outlined **6 principles for the design of BAS**:

1. **Reliable control of systems which also includes alarms and trend logs must be provided in a BAS**
   The ultimate quality of a control system is primarily dictated by the components that sense, execute logic for, actuate and document the systems they are controlling[12]
2. **Require sufficient instrumentation** the designer is responsible for ensuring specified equipment will meet sequences.
   The designer must require instrumentation to support both the sequence of operations, and the data acquisition capability to support equipment performance monitoring and building diagnostics analysis. A listing generally establishing minimum instrumentation requirements is included with the specifications. This identifies minimum instrumentation for common types of system. The designer is responsible for requiring additional instrumentation as necessary to support the sequence of operations and necessary data acquisition capabilities.
3. **Environmental control for indoor conditions and some examples include: temperature, humidity and air quality**
   The measure of an environmental control system and how well it functions with other building wide systems is determined by occupant comfort, satisfaction, and well-being.
4. **Building wide and energy efficient control of systems and examples include: HVAC, envelope and lighting**
   A key measure of the system's energy management capabilities is its ability to communicate and exchange data with other building systems to achieve efficient and effective energy usage with consideration for GHG emissions and energy cost
5. **User friendly control which can be easily accessed and understood by operators**
   Ensuring ease of operations increases the usability of the BAS which leads to better operational performance. This also includes graphics that increase Energy Awareness through better designed and easier to understand graphics and public facing portals.

[11] https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/progress-towards-canada-greenhouse-gas-emissions-reduction-target.html
[12] https://getrede.ca/five-principles-for-building-automation-systems/

6. **<u>Integration capable control</u> that can incorporate disparate systems together to operate as a whole**
   Examples of these disparate systems include but are not limited to BAS, metering, and security. This type of control is usually hosted on a software platform that can combine disparate systems

2.4.4. BAS Vendors

The following is a listing of approved BAS vendors for existing buildings. These vendors provide preventative and demand maintenance services for existing BAS systems at existing facilities:

1. Johnson Controls Canada LP
2. ESC Automation Inc.
3. Automated Logic Canada Ltd.

In 2020, the City of Brampton completed a prequalification process of BAS vendors to supply and install building automation systems (BAS) with native BACnet protocols. The prequalification enables pre-qualified vendors to bid on projects for a three (3) year period (currently up to December 31, 2023).

The types of projects will include: retrofitting existing buildings with new BAS, expanding BAS for existing facilities, and new BAS required for new construction facilities. Below is a list of prequalified vendors:

1. Johnson Controls Canada LP
2. ESC Automation Inc.
3. Siemens Canada

2.4.5. BAS Design Considerations

Design and construct Building Automation System (BAS) for building services with open protocol communications (BACnet).

New and existing installations use BACnet for all aspects of communication, including workstation, field panel, custom application controller and unitary controller communications and are commonly referred to as native BACnet systems.

When applicable, potential integration to be thoroughly discussed with City of Brampton.

The system shall allow for future integration of other systems (Card Access, Lighting, Intrusion Monitoring etc.) on the network proposed in this document, and also share a common infrastructure for network communications, time scheduling, alarm handling, history logging, monitoring and system control.

The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type (i.e. HVAC, lighting, and security devices should easily coexist on the same network channel without the need for gateways).

Sequences of operations should be designed and implemented to ASHRAE Guideline 36

Incorporate sequences that utilize energy conserving strategies. This includes, but is not limited to; demand based economizer control, supply air temperature reset, duct static pressure reset, occupant based demand control, chilled plant optimization control, boiler plant optimization control, free cooling control, etc. All major ventilation equipment to have a morning start-up and evening shutdown sequence. All equipment in manual over ride to switch back to automatic control after a stipulated time interval.

2.5 Archetypes

2.5.1. Community Centres

This section provides how-to strategies for the design and implementation of best practices applicable to classifications and facility archetypes (as referenced in Section 1.1). For this version of the guide, the following archetype is included:

- Community Centres with Indoor Pools
- Community Centres with Ice Rinks **(WIP)**
- Community Centre with Gymnasium & Fitness Areas **(WIP)**

Strategies specific to each facility archetype are provided for the following system categorizations:

- Building Envelope
- HVAC
- Lighting & Plug Loads
- Building Control and Automation

Strategies that apply to other programming and associated activities are also discussed within this chapter.

Community Centres – With Indoor Pools

Energy consumption in community centres with indoor pools is high due to high indoor air temperatures, increased ventilation heat losses and energy-intensive water technology. Energy consumed in swimming pool operation can be greatly reduced through a number of different best practices. These practices encompass: efficient operational procedures, program changes, use of alternative forms of energy, and energy efficient upgrades.

Building Envelope

Due to the humid and warm indoor climate, energy flows in swimming pool buildings are different from those in buildings with typical indoor conditions. These flows impact moisture control and the lack of moisture control may lead to unnecessary energy consumption by HVAC systems attempting to compensate from a poorly designed envelope. A key concept to control moisture is the dew point temperature. This temperature is the point at which moisture condenses out of the air. An example is when moisture condenses on the inside of a cold window in winter due to temperature and humidity differences. In an indoor pool environment, there is an elevated dew point temperature which means the potential for condensation is higher. This potential affects every aspect of the facility and thus, the building envelope must be designed to ensure the entire structure is suitable for a high-dew-point application. Some design measures that can be implemented for better moisture control are:

- Sufficient insulation such that no exterior wall and roof surface falls below the space dew-point temperature in cold weather
- Properly installed vapor retarder to impede the moisture flow through the wall assembly and protect the building envelope from condensation damage
- Thermally broken window and door frames and lower glazing U-values to decrease the transmission heat losses
- Better airtightness of the building envelope provides improved protection against moisture damage
- Airtightness tests should be scheduled in the construction process when essential elements of an airtight envelope and their penetrations are still easily accessible.
- Cooler gymnasium space types should be thermally separated from warmer areas of the building
- Kitchen spaces should be insulated from all sides due to the potential for moisture and high humidity

HVAC

Indoor Pool Water Temperatures and Relative Humidity

Indoor pools and spas require the relative humidity level be maintained between 40% and 60%.

The recommended pool water temperature for various activities are[13] :

- Recreational swimming: 82.5^0F (28^0 C)
- Infant swimming and therapy: 86^0F -94^0F (30^0 C -34.4^0 C)
- Children instructional classes: 84^0F -90^0F (29^0 C -32.2^0 C)

Competitive swimming and diving, including training and fitness swimming: 78 ^{0}F -80.5^0F (25.5^0 C -27^0 C)

Spas: 104^0F (40^0 C)

Ventilation

Space heating and ventilation accounts for a large proportion of energy use in pool halls which means that there are significant opportunities for savings. However, it is also important to ensure that the primary functions of the heating, ventilation and air conditioning system are satisfied. These are to comply with heating, cooling and outdoor air requirements as well as provide occupant comfort. Some recommended measures are:

- Ventilation air should be calculated as the minimum amount recommended as per the current ASHRAE Standard 62.1

- Pool areas should have a slight negative pressure to prevent the contaminated air from migrating into adjacent areas of the building[14]

- Where mechanical dehumidification is provided, air delivery rate should be established to maintain temperature and humidity level at appropriate conditions[15]. The following air change rates are recommended.

Pool areas	4 to 6 air changes per hour
Spectator areas	6 to 8 air changes per hour
Therapeutic pools	4 to 6 air changes per hour

Regarding indoor air circulation, the design must consider the following items[16]:

- Humidity control
- Ventilation requirement for air quality (outdoor and exhaust air)
- Air distribution
- Air duct design
- Evaporation rates
- Pool water chemistry

As with building envelope, poorly designed circulation may also lead to unnecessary energy use.

The balance between ventilation air and exhaust must always be controlled. Third-party commissioning should be performed to ensure the desired performance of the building is achieved.

In other areas of the building such as showers, changing rooms, lobby and staff rooms, demand control ventilation (DCV) based on moisture and/or CO_2 is suitable for reducing air flow volumes. The lower air flow

[13] Pool-Spa Operators Handbook-National-Swimming Pool Foundation 2009
[14] Pool-Spa Operators Handbook-National-Swimming Pool Foundation 2009
[15] Chapter 6 –Indoor swimming pools-2019 AHSRAE Handbook HVAC Applications
[16] Pool-Spa Operators Handbook-National-Swimming Pool Foundation 2009

volumes lead to reduced energy use. Also incorporate DCV strategy into other areas such as the gymnasium and kitchen. If feasible, consider heat recovery from kitchen exhaust air.

Heating Demand

It is advisable to examine on a project-specific basis whether it is feasible to use other types of waste heat (e.g. emitted by HVAC equipment) and solar heat for meeting the heating demand of the pool water.

The heating demand for domestic hot water (e.g. showers) depends on the distribution and storage losses as well as the amount of hot water required. Water-saving fixtures with controlled operating times for showers, and well insulated pipes form the basis for optimization. Due to the high waste water temperature of about 35 °C and frequent use, there is significant energy saving potential from heat recovery from the shower drain water.

Lighting & Plug Loads

Due to the longer operating hours and the larger spaces of indoor pools, the power requirement for lighting is often a significant energy end use. There are a number of measures that can used to minimize energy use:

- Efficient technologies such as LED that are suitable for higher temperatures
- Needs-based control strategies to reduce power consumption
- Natural daylighting from windows or roof skylights that can result in sufficient daylight to allow some artificial lighting to be switched off during the day
- For kitchen areas, clarify actual requirements and align these requirements with an appropriate cooking process that can also use high efficiency appliances.

Other Considerations

Other leisure activities are often offered in larger swimming pool facilities, resulting in additional energy consumption (e.g. kitchens, saunas, solariums, water attractions such as slides). In the case of water attractions, apart from the general optimization of pumps, it is possible to decrease energy consumption and peak loads by means of time-controlled operation (e.g. timers or intelligent controls).

- Insulate sauna cabins including additional roof insulation
- Use heat recovery and demand control ventilation for cabins, if separate ventilation units are being considered for saunas
- Operate at partial loads for pool water volumes to reduce power consumption, while complying with applicable codes and water quality requirements
- Explore solar water heating potential since solar water heating can be effective for showers and pool water and modern systems are relatively easy to connect to a conventional heating system
- Consider ventilation heat recovery and waste water heat recovery
- Replace aging conventional boilers with high efficiency condensing boilers
- Use pool covers which can reduce evaporation, thermal radiation, and convection accounting for about 95% of losses and
- Covers can also reduce dirt and debris in water which can result in reductions of chemical consumption[17]
- Check pipework regularly for leaks which can result in higher water consumption and heating costs
- Heating costs can also be reduced with properly insulated pipework and regular checks on the condition of insulation with replacement of damp or worn insulation
- Insulate boilers, hot water tanks, pipes and valves as required to prevent heat loss
- Schedule the cleaning work during the day, if possible so no additional energy is needed for lighting and ventilation

[17] Pool-Spa Operators Handbook-National-Swimming Pool Foundation 2009

- Clean windows and skylights regularly to allow maximum daylight to enter the pool hall and significantly reduce the need for electric lighting
- The indoor air temperature should be kept 2F to 5F (1°C to 2.5°C) above the temperature of the pool water to reduce evaporation[18]
- Keep doors closed between areas with different temperatures and humidity.
- Conduct regular pool backwashing and clean the pool filters to maintain good quality clean water
- Inspect system components such as fans, coils and pumps for corrosion and clean or replace if necessary
- Replace aging conventional boilers with high efficiency condensing boilers
- Utilize premium or high efficiency pump and fan motors for water treatment and ventilation systems since reducing their electrical consumption can be a source of considerable savings

Control of Building Systems

Introduction

Control and automation systems work in concert with equipment, systems and staff to ensure high performance operation of facilities. In general, automation cannot fully compensate for poorly designed systems or inexperienced staff in terms of occupant comfort or energy efficient operations.

This section is intended to provide guidance and recommendations on energy efficient operations and occupant comfort for facility systems including HVAC equipment and lighting. These recommendations may be useful during the integrated design process to inform stakeholders on how control and automation can help to achieve energy targets and comfort goals The hand-over of building automation systems (BAS) that will meet these goals requires – at minimum – designers , commissioning agents, building operators to be included in the integrated design process.

The components, specifications and strategies of building automation systems are outlined in the following sections.

Building Automation Systems

- Provide a Building Automation System that includes Smart Control Devices, Programmable Controllers, and Application Specific Controllers as needed to perform functions indicated in the input/output summaries.
- The BAS shall be based on ASHRAE BACnet technology (ASHRAE Standard 135-2016) with an open communication protocol. The system shall be capable of remote communication over the City's intra-net network with a provided webserver.
- The addendum to ASHRAE Standard 135-2016 includes BACnet Secure Connection (SC). Consideration to this virtual data link should be investigated for building automation systems

HVAC Control Strategies

In general, the implementation of control strategies requires system equipment to be operated in a sequential manner. A sequence of operation is a descriptive and detailed account of system operation and usually includes such details as exact setpoints, precise alarm limits, scheduling and time-of-day details[19]. Where applicable sequences of operations are to be designed to the standard of ASHRAE Guideline 36 – High Performance Sequences of Operations for HVAC Systems (latest version).

A general strategy is to avoid simultaneous heating and cooling operation which can be achieved by interlocking heating and cooling controls. The following list are some strategies recommended by Energy Management:

[18]

[19] http://www.pcs-engineering.com/files/Sequence_of_Operation_Instructions.pdf

- **Economizer Controls** save electrical energy by avoiding mechanical cooling. These are recommended to be provided for air handling equipment to use outdoor air for cooling instead of the mechanical cooling when outdoor conditions are favorable.

- **Variable Speed Drives** save electrical energy by allowing motors to run at lower frequencies. These are recommended to be provided on centrifugal pump motors, variable air volume fan motors and cooling tower pump motors. Variable speed drives are to be properly engineered with due consideration of harmonics, need for filters and interference with surrounding delicate instrumentation. The impact on power factor correction capacitors and protection from power surges and spikes must be evaluated. In a retrofit application the designer is responsible to determine whether speed control is appropriate and whether the selected technique is suitable for the existing motors configuration.

- **Heating Water Reset** allows water temperature to lower and saves natural gas as the water does always not need to be heated to the higher temperature. It is recommended to implement heating water reset when heating water is the main heat source for a space. Resetting heating water temperature based on the outside air temperature allows the water temperature to be raised in extreme cold applications and lowered in more mild conditions.

- **Duct Static Pressure Reset** allows fan speed to be lowered based upon zone demand, which saves electrical energy. It is recommended in situations in which there are multiple zones with VAV control. The duct static pressure can be reset satisfy zones with the highest airflow demand.

- **Outdoor Temperature Cut-off** saves energy in the form of natural gas when the heating system is turned off. It is recommended to be considered for heating systems so that heating is automatically shut off during unoccupied periods when outdoor air temperature is high enough that there is no risk to freezing items in the building.

- **Demand Control Ventilation** saves energy as it lowers the amount of unconditioned air being brought into the space based on the demand. It is recommended to be considered for air handling equipment. The outside air volume is modulated based upon the demand from the space as using CO2 instead of running at a designed constant outdoor air volume.

- **Scheduling of Equipment** ensure sequences have considered: start, stop, night setback, request based logic, and demand level adjustment of setpoints. All major ventilation equipment is recommended to be designed with a morning startup and evening shutdown sequence. If the facility is 24-hour or close to 24-hour occupancy consult with the design team prior to removing this functionality from design. All major ventilation equipment is recommended to be designed with a morning startup and evening shutdown sequence.

- **Pool Circulation Pump** saves electrical energy by allowing the pump to run at a lower rate when demand is lower. A pool circulation pump can be modulated based on demand. In this case demand can be determined by water turbidity. This strategy looks at the composition of the water to determine how much chlorine needs to be added and varies the pump speed based on this.

- **Temporary Manual Override** ensures that BAS systems are not left in manual override which can potentially waste energy. It is recommended to include a virtual timer for switch back to automatic control after a time interval selected by building operations staff.

- **Sequential lead/lag controls** helps to extend the life of the equipment. These controls are recommended to be provided where a bank of equipment services the same space. Lead equipment is recommended to cycle to provide equal wear and tear for all equipment. Examples are hot water heating boilers, domestic hot water boilers, chillers, associated pumps, cooling tower fans etc.

Table 1 lists control descriptions for specific systems and mechanical services. Where strategies may not be applicable, it is recommended that these strategies be reviewed with the with the City of Brampton design team including but not limited to Energy Management, Facility Operations and the Building Design and Construction Department during the design development stage.

Table 1 – BAS Control Descriptions

Equipment Description	BAS Function/Strategy
Pool circulation pump	Speed modulation based on turbidity
Pool water heater	Reset of pool heating water temperature based on usage
Unit Heaters	Programmable setpoint thermostats with occupancy override
Zone Control	Occupancy sensing to shut off constant volume or variable volume boxes plus lights.
Outdoor lighting	Schedule
	Trim schedule using photo sensor
	Trim schedule using sunset-sunrise calculation
Lighting	Schedule
	Photo sensor control
Exhaust fans	Schedule
	Occupancy override to schedule
Hot Water Boilers	Start/stop and modulated firing controls, minimize short cycling of heaters. Minimum runtime of 15minutes
	Reset water temperature.
	Boilers to run in lead/lag function switching weekly to ensure equal runtime. Alternatively, utilize boiler manufacture sequencer.
	Ensure complete modulating control or proper hi-low control.
	Maintain one setpoint and stage using time interval rather than error from setpoint.
	Stop circulating water through non-firing boilers.
DHW recirculation pumps	Start/stop based on weekly schedule with override based on flow switch

Equipment Description	BAS Function/Strategy
DHW	Start/stop and modulated firing controls, minimize short cycling of heaters.
	Schedule recirculation pump for occupied periods only
	Reduce setpoint to minimum required temperature
	Profile tank water temperature-lower temperatures will lower recirculation heat loss
	If tank separate from heater, do not circulate water through non-firing heater
	Maximize on-time by 1st on 1st off
Air systems	Supply air temperature reset from outside air temperature.
	Control outside air volume to occupancy requirement using CO2
	Trim supply air temperature setpoint with feedback from spaces.
	Mixed air control - calculate and control to minimum ventilation
	Integrated economizer (provide required supply air temperature)
	Scheduling - minimize scheduled time
	Scheduling - optimal start
	Scheduling - no outside air when systems operate in unoccupied hours
	Occupancy sensing - operate fan or open outside air dampers only when occupied
	Set relative humidity to as per ASHRAE guidelines,
	Reset humidity at very low temperatures
	Space pre-cool (morning)

Lighting Control

Lighting controls are important to ensure that lights are only on when they are necessary. Switch controls may allow lights to exceed their intended operating hours leading to unnecessary energy consumption. It is recommended by Energy Management that lighting systems be installed with controls to ensure operating hours are not higher than necessary.

- Occupancy Sensors are recommended to control lighting in areas of intermittent occupancy. Typical areas include meeting rooms, washrooms, locker rooms, change rooms and storage areas. Ultrasonic sensors are preferred.

Photocell Controls are recommended in large glazed areas that receive adequate natural lighting during the day. Peripheral can also benefit from day-lighting controls wired on separate circuits.

- Provide local switches in all offices, meeting rooms and spaces where building users can switch off lights when leaving the space. Larger spaces shall be divided into smaller zones of 10 to 12 light fixtures and controlled by a manual switch or computerized control.
- Lighting circuits for gymnasiums are recommended to be designed to provide 100%, 50% and 25% light levels with conveniently located master switches to allow for reduced light levels during periods of maintenance and non-use.
- Photocell and Timer Control are recommended on all external security lighting.

Refer to ASHRAE 90.1-2013, Table 9.6.1 for lighting control requirements for specific space types such as office spaces and stairwells.

- Lighting control systems shall seamlessly connect and be prepared for future integration with Building Automation Systems (BAS).

2.5.2. Transit Facilities

This section provides how-to strategies for the design and implementation of best practices applicable to classifications and facility archetypes (as referenced in Section 1.1). For this chapter, the following archetype is included:

Transit Facilities

Strategies specific to this facility archetype are provided for the following system categorizations:

- HVAC & Building Control and Automation
- Lighting

Strategies that apply to other programming and associated activities are also discussed within this chapter.

Introduction

HVAC Systems play an integral role in the safe and comfortable operation of Transit Facilities. A well designed and optimized HVAC system can allow for considerable energy savings. This section is intended to provide best practices for the design of a high performance HVAC system.

There main space types that this chapter will focus on:

- bus storage garages,
- bus maintenance garages,
- fueling & wash bays,
- associated office, lunch spaces, meeting and training rooms

Bus storage and maintenance garages use similar strategies to meet space temperature and ventilation requirements. The key difference between the storage and maintenance garages is maintenance garages should be kept at a higher temperature as maintenance garages are an occupied workspace compared to storage where occupancy is transitional. Fueling and washbays need to consider regulatory requirements to ensure appropriate ventilation for life safety.

Control and automation systems work in concert with equipment, systems and staff to ensure that high performance operation of facilities. In general, automation cannot fully compensate for poorly designed systems or inexperienced staff in terms of occupant comfort or energy efficient operations.

This section is intended to provide high level recommendations on how to improve energy efficient operations and occupant comfort for facility systems including HVAC equipment and lighting. These recommendations may be useful during the integrated design process to inform stakeholders on how control and automation can achieve energy targets and comfort goals. The hand-over of building automation systems (BAS) that will meet these goals requires an interdisciplinary team and all stakeholders to be included in the process as referenced in Chapter 3.0.

- Provide a Building Automation System that includes Smart Control Devices, Programmable Controllers, and Application Specific Controllers as needed to perform functions indicated in the input/output summaries.
- The BAS shall be based on ASHRAE BACnet technology (ASHRAE Standard 135-2016) with an open communication protocol. The system shall be capable of remote communication over the City's intra-net network with a provided webserver.

HVAC Control Strategies

In general, the implementation of control strategies requires system equipment to be operated in a sequential manner. A sequence of operation is a descriptive and detailed account of system operation and usually includes such details as exact setpoints, precise alarm limits, scheduling and time-of-day details[15]. Where applicable sequences of operations are to be designed to the standard of ASHRAE Guideline 36 – High Performance Sequences of Operations for HVAC Systems (latest version).
A general strategy is to avoid simultaneous heating and cooling operation which can be achieved by interlocking heating and cooling controls.

The following sub-sections provide HVAC and control strategies recommended by Energy Management for the typical space types found within transit facilities.

Storage, Maintenance Garage, and Fueling & Wash Bays

Transit storage and maintenance garages use similar strategies for conditioning air in the space. The key difference between these two spaces is not how the HVAC and control systems are designed but how they are operated. Storage garages are required to maintain buses at an adequate temperature to ensure winter start-up and provide shelter for the buses during unused hours. Maintenance garages, however, have more stringent requirements in terms of temperature setpoint and air circulation as they are occupied workspaces.

HVAC Design Considerations

- Design is recommended to consider heavy-duty industrial air curtains above overhead doors to minimize infiltration through open overhead doors.
- Where applicable, design to include high-speed exterior doors to achieve maximum environmental control and separation at the door opening. High-speed doors minimize exposure to outdoor conditions and minimize energy used to heat or cool outdoor air.
- In areas where feasible, incorporate radiant heating (potentially garage area). Radiant floor heating systems must be expandable without cutting the slab previously installed.[20]
- Investigate feasibility of geothermal systems to provide a source heating energy for radiant floor system.
- Investigate the feasibility of incorporating solar thermal to preheat domestic hot water systems.
- Due to the higher ventilation requirements in transit facilities, heat recovery can be significant when selecting air-handling systems. Designer should complete a thorough investigation of all available heat source and the feasibility to recover heat from all applicable equipment. It is recommended to ensure that supply and exhaust air streams are strategically located so that heat recovery can be easily implemented. Systems should be designed as well with the ability to bypass heat recovery so that free cooling can be implemented in the shoulder seasons. There may be additional structural considerations that should be investigated due to the weight of heat recovery systems.
- Install destratification fans to circulate conditioned air and/or move warmer air towards the occupied space during heating season.

[20] http://www.gosite.ca/engineering_public/DRM_Manual.pdf

- In spaces where radiant floor heating is impractical consider infrared radiant heaters since they warm only specific areas and objects and can be more efficient than air based heating systems.

Controls Considerations

- **Demand Limiting and Load Shifting** program for the purpose of limiting peak energy usage and reducing overall energy consumption, where applicable
- **Destratification Fan Control** meant to operate differently based on whether it is heating or cooling season. The BAS allows for seamless change over from heating to cooling based on outdoor air temperature.
- **Modulating Gas Valve** allows for slow ramping up and ramping down of burner on a roof top unit based on the demand for heating. This saves natural gas as a burner does not need to either in full heat or off.
- **Outside Air Temperature Reset** allows water temperature to lower and saves natural gas as the water does always not need to be heated to the higher temperature. This can apply to high temperature water or low temperature water used in radiant floor systems. It is recommended to implement heating water reset when heating water is the main heat source for a space. Resetting heating water temperature based on the outside air temperature allows the water temperature to be raised in extreme cold applications and lowered in more mild conditions.
- **Scheduling of Equipment** ensure sequences have considered: start, stop, night setback, request based logic, and demand level adjustment of setpoints. All major ventilation equipment is recommended to be designed with a morning startup and evening shutdown sequence. If the facility is 24-hour or close to 24-hour occupancy consult with the design team prior to removing this functionality from design. All major ventilation equipment is recommended to be designed with a morning startup and evening shutdown sequence.
- **Temporary Manual Override** ensures that BAS systems are not left in manual override which can potentially waste energy. It is recommended to include a virtual timer for switch back to automatic control after a time interval selected by building operations staff.
- **Sequential lead/lag controls** help to extend the life of the equipment. These controls are recommended to be provided where a bank of equipment services the same space. Lead equipment is recommended to cycle to provide equal wear and tear for all equipment. Examples are hot water heating boilers, domestic hot water boilers, chillers, associated pumps, cooling tower fans etc.

Associated Office, Lunch Spaces, Meeting and Training Rooms

Administrative spaces offer an opportunity for energy savings as they are not occupied 24/7 and they can be zoned more effectively than storage and maintenance garages. This allows for load matching sequences of operations to be implemented that provides better energy performance. Some examples demand control, and static pressure reset.

HVAC Considerations

- If the room is on an exterior wall, insulating glass shall be fully tempered tinted low-E glass
- Perimeter radiation is recommended and one example are baseboard heaters.
- All areas should be heated and air-conditioned by energy efficient, premium quality air handling units meeting the latest edition of ASHRAE 90.1 requirements.
- Investigate the feasibility of Variable Refrigerant Flow (VRF) technology with heat recovery option. There may be varying load applications which allow for energy savings in administration spaces.
- Designer should complete a thorough investigation of all available heat source and the feasibility to recover heat from all applicable equipment. It is recommended to ensure that supply and exhaust air streams are strategically located so that heat recovery can be easily implemented. Systems should be designed as well with the ability to bypass heat recovery so that free cooling

can be implemented in the shoulder seasons. There may be additional structural considerations that should be investigated due to the weight of heat recovery systems.

- If a more efficient technology is not feasible investigate high efficiency rooftop units (RTUs) that utilize condensing combustion technology. "Condensing heating technologies extract additional heat from combustion products by using a second heat exchanger to condense the water vapor produced. This additional heat exchanger allows condensing appliances to increase their thermal efficiency."[21]

Controls Considerations

- **Economizer Controls** save electrical energy by avoiding mechanical cooling. These are recommended to be provided for air handling equipment to use outdoor air for cooling instead of the mechanical cooling when outdoor conditions are favorable.
- **Variable Speed Drives** save electrical energy by allowing motors to run at lower frequencies. These are recommended to be provided on centrifugal pump motors, variable air volume fan motors and cooling tower pump motors. Variable speed drives are to be properly engineered with due consideration of harmonics, need for filters and interference with surrounding delicate instrumentation. Ensure harmonic filters are installed if necessary to reduce the impact on power factor correction capacitors and protection from power surges and spikes must be evaluated. In a retrofit application the designer is responsible to determine whether speed control is appropriate and whether the selected technique is suitable for the existing motors configuration.
- **Duct Static Pressure Reset** allows fan speed to be lowered based upon zone demand, which saves electrical energy. It is recommended in situations in which there are multiple zones with VAV control. The duct static pressure can be reset satisfy zones with the highest airflow demand.
- **Outdoor Air Temperature Cut-off** saves energy in the form of natural gas when the heating system is turned off. It is recommended to be considered for heating systems so that heating is automatically shut off during unoccupied periods when outdoor air temperature is high enough that there is no risk to freezing items in the building.
- **Demand Control Ventilation** saves energy as it lowers the amount of unconditioned air being brought into the space based on the demand. It is recommended to be considered for air handling equipment. The outside air volume is modulated based upon the demand from the space using CO2 levels instead of running at a designed constant outdoor air volume.

Table 2 lists control descriptions for specific systems and mechanical services. Where strategies may not be applicable, it is recommended that these strategies be reviewed with the with the City of Brampton design team including but not limited to Energy Management, Facility Operations and the Building Design and Construction Department during the design development stage.

Table 2 – BAS Control Descriptions

Equipment Description	BAS Function/Strategy
Infrared Heaters	Programmable setpoint thermostats with occupancy override and configurable nighttime setbacks.
Unit Heaters	Programmable setpoint thermostats with occupancy override and configurable nighttime setbacks.
Zone Control	Occupancy sensing to shut off constant volume or variable volume boxes plus lights.
Outdoor lighting	Schedule

[21] https://www.gti.energy/wp-content/uploads/2018/11/Condensing-Roof-Top-Units-Technology-Snapshot-02-2017.pdf

Equipment Description	BAS Function/Strategy
	Trim schedule using photo sensor
	Trim schedule using sunset-sunrise calculation
Lighting	Schedule
	Photo sensor control
Exhaust fans	Schedule
	Occupancy override to schedule
Hot Water Boilers	Start/stop and modulated firing controls, minimize short cycling of heaters. Minimum runtime of 15minutes
	Reset water temperature.
	Boilers to run in lead/lag function switching weekly to ensure equal runtime. Alternatively, utilize boiler manufacture sequencer.
	Ensure complete modulating control or proper hi-low control.
	Maintain one setpoint and stage using time interval rather than error from setpoint.
	Stop circulating water through non-firing boilers.
DHW recirculation pumps	Start/stop based on weekly schedule with override based on flow switch
DHW	Start/stop and modulated firing controls, minimize short cycling of heaters.
	Schedule recirculation pump for occupied periods only
	Reduce setpoint to minimum required temperature
	Profile tank water temperature-lower temperatures will lower recirculation heat loss
	If tank separate from heater, do not circulate water through non-firing heater
	Maximize on-time by 1st on 1st off
Air systems	Supply air temperature reset from outside air temperature.
	Control outside air volume to occupancy requirement using CO2 (other gases)
	Use of modulating
	Trim supply air temperature setpoint with feedback from spaces.

Equipment Description	BAS Function/Strategy
	Mixed air control - calculate and control to minimum ventilation
	Integrated economizer (provide required supply air temperature)
	Scheduling - minimize scheduled time
	Scheduling - optimal start
	Scheduling - no outside air when systems operate in unoccupied hours
	Occupancy sensing - operate fan or open outside air dampers only when occupied
	Set relative humidity to as per ASHRAE guidelines,
	Reset humidity at very low temperatures
	Space pre-cool (morning)

Lighting

Lighting is an important consideration in transit facilities as safety is of paramount concern. Lighting should be designed to provide clear paths throughout the facility while considering energy efficiency. The large areas requiring high lighting levels allows for opportunities to demonstrate energy efficiency.

- Install LED light fixtures in all areas. The levels and quality of lighting for the various types of areas shall be as outlined to meet the latest edition of the Illuminating Engineering Society of North America (IES) Lighting Handbook, Ontario Building Code and Ontario Electrical Safety Code.

Lighting controls are important to ensure that lights are only on when they are necessary. Switch controls may allow lights to exceed their intended operating hours leading to unnecessary energy consumption. It is recommended that lighting systems be installed with controls to ensure operating hours are not higher than necessary.

- Ensure occupancy sensors are to be provided in the following areas: bus storage garage, service rooms, outdoor lighting, offices and other areas as required. Ultrasonic sensors are preferred.
- The interior design should promote natural daylighting. Maximize the use of natural light by using photo sensor and /or daylight harvesting controls and dimming in large glazed areas that receive adequate natural lighting during the day. Peripheral can also benefit from day-lighting controls wired on separate circuits.
- Provide local switches in all offices, meeting rooms and spaces where building users can switch off lights when leaving the space. Larger spaces shall be divided into smaller zones of 10 to 12 light fixtures and controlled by a manual switch or computerized control.
- Photocell and Timer Control are recommended on all external security lighting.
- Refer to ASHRAE 90.1-2013, Table 9.6.1 for lighting control requirements for specific space types such as office spaces and stairwells.
- Lighting control systems shall seamlessly connect and be prepared for future integration with Building Automation Systems (BAS).

2.5.3. Corporate Office Facilities

WIP

2.5.4. Library

WIP

2.5.5. Fire Station

WIP

Section III. Implementation

This implementation section is intended to provide recommendations to implement the design of zero carbon or high performance energy facilities. This section applies to new construction and major renovation projects that are City owned or managed.

This section is a WIP.

Section IV. Operations

Chapter 1. Purpose

1.1 Purpose

The Operations section of the EM Guide & Compendium provides recommendations for the operation of zero carbon or high performance facilities. This section applies to all existing and new construction facilities that are City owned or managed.

The targeted audience for this section is the facility operational staff within the following organizational groups:

- Facilities Operations & Maintenance
- Recreation
- Transit
- Fire and Emergency Services
- Public Works and Engineering

This section provides an overview of operation processes, followed by customized facility operation strategies for various facility archetypes with a focus upon best operational practices and setpoints/schedules.

1.2 Operation of Zero Carbon and High Performance Facilities

One of the most cost-effective strategies for ensuring optimal equipment performance and maximum building efficiency is effective facility operation. Operations are services required to ensure equipment and systems are operating as designed or at a level that achieves the facility management team's operational goals. The operational phase of a commercial building is substantially longer than its design and construction phase. 60% to 85% of a building's total lifecycle cost is attributed to by the lifecycle cost of the operational life, where as 5% to 10% is comprised from the design and construction.

It is necessary to practice systems-thinking, for both building systems and organizational systems, in order to achieve successful high performance facility operation. Operating facilities at high performance involves proactive management processes for energy, emissions, and maintenance.

Chapter 2. Process

2.1 Facility Startup

WIP

2.2 Energy Efficiency vs. Energy Conservation

Throughout this section there are references to the terms *energy efficiency* and *energy conservation*. These terms are closely related as they are both used to describe specific mechanisms for reducing energy consumption, however the differences between energy efficiency vs energy conservation should be noted.

Efficiency and conservation are different, but related[22]:

- **Energy efficiency** is using technology that requires less energy to perform the same function. Using a light-emitting diode (LED) light bulb that requires less energy than an incandescent light bulb to produce the same amount of light is an example of energy efficiency.

[22]Use of energy explained: Energy efficiency and conservation (https://www.eia.gov/energyexplained/use-of-energy/efficiency-and-conservation.php Accessed April 2020)

- **Energy conservation** is any behaviour that results in the use of less energy. Turning the lights off when leaving the room and recycling aluminum cans are both ways of conserving energy.

2.3 Operator and Tenant Engagement

The success of all energy efficiency initiatives depends on people as much as or even more than technologies implemented within a facility. To maximize the energy savings and emissions reduction potential of all COB managed facilities, it is important to raise the awareness of everyone involved, including operational staff, tenants, and all facility occupants and visitors.

Technology alone cannot achieve optimal savings; changes in operations and maintenance practices, as well as management systems, are integral in achieving significant savings. The figure below illustrates how organizational, technological and behavioural change interact with each other as a continuous, dynamic process. Integrating an energy management culture with operational and technological actions is required for optimal results. Employee behaviour is also crucial because it puts people in the "feedback loop" and is supported by celebration and recognition of results.

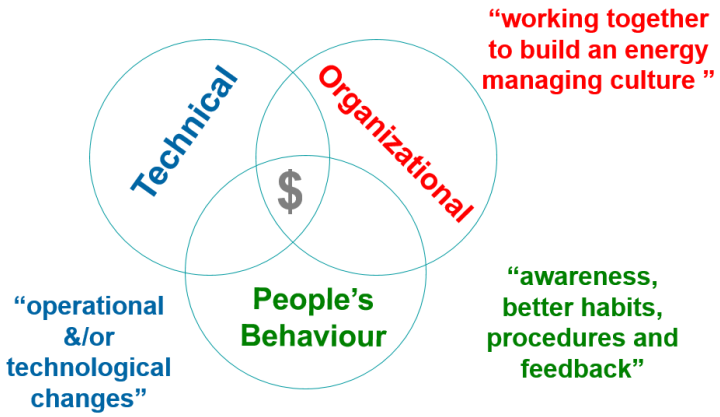


Figure 3 - The Challenge is more than technical[23]

Major benefits of operator and tenant engagement on energy efficiency and energy conservation include:

- increased thermal comfort levels from optimal temperature control management and the reduction of employee eye strain caused from inefficient lighting is shown to be linked to increased productivity in the workplace[24]
- collaborating to achieve a common goal can lead to enhanced employee morale
- lowered GHG emissions and air pollutants can lead to an improved environment which benefits human health as air pollutants and rising temperatures are linked to respiratory and cardiovascular problems and certain types of cancers[25]
- increased stakeholder understanding of energy efficiency advantages can lead to greater acceptance of future energy initiatives
- having an increased understanding of relationship between an individual's energy use and potential savings can allow employees to independently identify energy savings opportunities

[23] Dollar to $ense Workshop Training, CIET (2019)
[24] Loftness, et al. "Linking Energy to Health and Productivity in the Built Environment." Center for Building Performance and Diagnostics, Carnegie Mellon, 2003.
[25] Greenhouse gas emissions: drivers and impacts (https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions-drivers-impacts.html Accessed April 2020)

- learning about behavioural changes in building users' energy consumption can lead to the transfer of workplace behaviours to the home and community
- achieving our energy targets can lead to the enhanced reputation of our municipality as a local leader in environmental stewardship
- an energy management philosophy integrated into policy and processes across the organizational structure, with delegated responsibilities clearly outlined, can lead to a solid foundation for future initiatives

To create a culture of energy conservation and to provide operational staff with the tools necessary for managing high performance facilities, the EM team encourages participation in the following EM organized activities/events:

- Dollars to $ense Energy Savings Program
- Energy Conservation Challenge Program
- Technology Specific Training Sessions

Operational staff and tenants are also encouraged to identify additional training opportunities and think critically about the following questions:

1. How does my building use electricity and natural gas and contribute to the City's energy costs
2. How does my building use electricity and natural gas and contribute to City's overall GHG emissions?
3. What are some common actions that I can take to reduce energy and emissions within my facility?
4. What are some creative ways to save both natural gas and electricity and how can I involve the City's EM team in implementing my ideas?

2.4 Organizational Communication

To truly operate and maintain a high performance facility requires the synthesis of people, process and technology using a systems-thinking approach. This requires knowledge transfer from different areas of expertise, including but not limited to the following organizational groups:

- Energy Management (EM)
- Asset Management & Capital Planning
- IT
- Building Design & Construction
- Realty Services

In order to facilitate a strong working relationship between EM and operational staff for City owned and managed facilities, it is important to ensure clear and consistent communication regarding any operational changes that may impact a facility's energy consumption. This includes but is not limited to the following potential changes:

- Equipment Purchases
- Schedule
- Operational Staff
- Occupancy
- Building Control and Automation
- Facility Programming or Shutdown Periods
- Construction

2.5 Utility Bill Review

On an annual basis, the City's Corporate Performance Team tracks KPIs for energy usage and energy intensity (usage per unit area) within City owned and managed facilities. In addition to this, under O.Reg 507/18, all Ontario public agencies must report their annual energy use and greenhouse gas emissions each year by July 1. The City of Brampton must comply with this regulation as a municipality.

It is recommended that operational facility staff review their utility bills for electricity, natural gas, and water to understand the charges and to assist the Energy Management team in identifying and resolving any utility bill anomalies. These anomalies may be caused by a number of reasons including but not limited to changes in day-to-day facility operation (as discussed in the previous sub-section), phantom loads (devices that continue to consume energy even when turned off), malfunctioning utility meters, malfunctioning facility equipment, or billing errors.

All facility operational staff have a role to play in managing energy usage to meet Corporate Performance team targets to minimize energy usage and energy intensity across City facilities. Keeping engaged and aware of your facility's monthly utility costs is one of the actions that can lead to the more timely identification of these types of errors and the identification of energy efficiency and conservation opportunities.

2.6 Thermal Comfort Considerations

One of the main purposes for the operation of high performance facilities is to provide thermal comfort for a particular facility within in a particular climate. Thermal comfort and providing a productive, safe and healthy indoor environment cannot be sacrificed to save energy. It is important to maintain a balance between energy efficiency, energy conservation and thermal comfort to ensure that efficiency and conservation efforts do not affect thermal comfort of the facility occupants.

Thermal comfort is a subjective assessment by a person expressing their satisfaction with their local thermal environment. In practice, there are a number of variables that influence the body's heat balance with the environment, and in turn that person's perception of thermal comfort, including the following:

Table 3 – Factors Affecting Thermal Comfort

Personal Factors	Environmental Factors
• Occupant Activity • Clothing • *Age* • *Gender* • *Health* • *Culture* • *Personal control, and expectations.*	• Air temperature • Air Velocity • Radiant temperature • Humidity

Air temperature is a key environmental factor for determining thermal comfort. However, temperature is not the only factor, and other factors affect the processes of heat exchange on the human body such as humidity, air velocity, and radiation. The environmental factors presented above are measurable variables, as are occupant activity and clothing from the list of personal factors however it should be noted that the additional personal factors affecting a particular individual body heat balance or response to their environment are difficult to measure including but not limited to age, gender, health, culture, personal control, and expectations.

To determine if building occupants are comfortable, operational staff are encouraged to employ the following basic approaches:

- Monitor the number of comfort complaints (hot/cold calls) logged for the building or certain areas of a building

- Perform a comfort survey of all building occupants

For a more advanced approach in meeting thermal comfort needs, details can be found within *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Standard 55, "Thermal Environmental Conditions for Human Occupancy,"* a recognized industry standard providing guidance on thermal comfort parameters for building occupants. This guide provides details regarding Predicted Mean Vote' (PMV) and adaptive comfort criteria.

PMV thermal comfort criteria is an approach whereby a band of interior temperature and humidity ranges is prescribed to meet the needs of a minimum of 80% of building occupants. This approach was developed in laboratory settings, where people were passive recipients of environmental stimuli and not visually or thermally connected to the outdoor environment, or provided with thermal controls in their environment (e.g. operable windows). For naturally ventilated spaces, where the occupant has access to and control of an operable window, the more recent adaptive thermal comfort regimen recognizes that a wider range of interior temperatures can be acceptable for occupants, particularly where occupants will adapt to changing exterior conditions and dress in accordance. In adaptive comfort conditions, interior temperatures vary to allow for slightly higher interior temperatures in the warmest periods of the year, and slightly cooler for cooler periods of the year.

2.7 Domestic Hot Water Considerations

High performance Domestic Hot Water (DHW) considerations are consistent throughout most operational archetypes.

Best Operational Practices

- ❖ Ensure tanks are properly insulated
- ❖ Follow best practice maintenance guidelines from manufacturer
- ❖ Ensure hot water pipes are insulated appropriately

Best Practice Set-Points

Although ASHRAE Standard 100-2006 recommends a domestic hot water temperature of 49°C (120°F), organizations such as the Canada Safety Council and Canadian Standards Association (CSA) state that a common bacteria, legionnaire's disease bacteria, has a high risk of colonization in hot water tanks between 40°C and 50°C (104°F and 122°F)[26]. Therefore, in order to be energy efficient and lower the risk of scalding and bacteria growth, the following temperature settings listed in Table 4 are recommended.

Table 4 – Best Practice Domestic Hot Water Temperature Settings[26]

Setting Type	Temperature (°C)	Temperature (°F)
Storage Tank Temperature	60	140
Delivery Temperature	49	120

2.8 New or Innovative Technology Considerations

Advanced technologies found in high performing facilities may cause challenges to building operators and facility managers. These challenges arise when operators, technicians, and managers do not have the opportunity to learn about the specialties of high performance technologies.

For the parties involved, a feedback loop is appropriate for communication of what systems and equipment are working as intended and where further improvement is required. A feedback loop for high performance facilities is particularly essential since specialized technologies are not standard practice, leading to several, and at times conflicting, opinions on which systems and equipment should be used in these facilities.

[26] Canada Safety Council (https://canadasafetycouncil.org/heated-debate-about-hot-water/ Accessed April 2020)

Installing highly energy efficient systems and equipment creates only the foundation for achieving efficient, high-performance operation. Moreover, the processes implemented to operate and maintain these buildings have a larger cost and environmental impact that the design and construction process.

Energy Management has been adopting new technologies for energy savings and operational efficiencies. In 2019, a pilot project was completed that involved using proprietary cartridges in the closed chilled water loop at Civic Centre. The preliminary results of this pilot appear to have yielded energy savings.

If your facility is selected for a technology pilot project it is expected that operations will collaborate with Energy Management to ensure that the pilot is completed successfully. This may include site visits, training on new technologies, data collection and analysis, and other tasks related to project coordination.

Chapter 3. Operations by Archetypes

This chapter presents the operational considerations by archetype. For each archetype the following details are provided:

- **Best Operational Practices:** This sub-section provides suggested tips and guidance for the efficient operation of the particular facility archetype. For community centres, these tips are provided for specialized operations. For all other facility types these tips are categorized into the following categories: Behaviour, Operations and Maintenance HVAC, Plug Loads, Lighting.
- **Best Practice Set-Points:** This sub-section provides recommended occupied and unoccupied temperature set-points including set-points for specialized operations.

3.1 Community Centres

Community Centres are comprised of the largest energy users for the City of Brampton (and most municipalities in general). These are typically complex facilities that can include combinations of indoor swimming pools, ice rinks, gymnasiums and fitness areas, and public meeting spaces. These combinations usually with longer operating hours present unique opportunities for significant energy and cost savings.

In this section the community centre archetype is further broken down into the following use categorizations:

- Pool
- Ice Rink
- Gymnasium & Fitness Centres
- Administrative Spaces, Community Room, and Common Areas

3.1.1. Pool

Indoor pool facilities are energy intensive spaces and have specialized environmental requirements, due to the need to provide comfortable pool water and surrounding temperatures for user groups and also to avoid poor air quality and potential damage to the building envelope due to condensation. The equipment within these spaces is operated and maintained in a manner to promote address the aforementioned two points. The optimized operation of pool facilities requires a balance of pool temperature, air temperature, and humidity; a small change in any of these factors can impact the balance, causing major energy and comfort impacts. Additionally, operational issues caused by HVAC equipment can lead to unnoticed excessive energy use, such as using excessive amounts of outside air and the breakdown of heat-recovery equipment. The combination of the number of facilities, energy-intensity, and sensitivity of energy use in several equipment leads to a substantial and achievable cost-effective savings potential in indoor pool facilities[27].

[27] Operator's Guide to Energy Efficient Indoor Public Pool Operations (http://mn.gov/commerce-stat/pdfs/card-guide-pool-operations.pdf Accessed April 2020)

Best Operational Practices

The following list of best practices provides energy efficient considerations for high performance pool operations[27]:

- **Test and Verify Control Systems:** For controls systems related to the below points it is recommended that operations teams make efforts to verify the functionality of the control systems. Some warning signs may be present if there are issues with the sequences of operations. For dehumidification systems an issue with the sequences can lead to condensation build up. If operational staff notice major issues persisting reach out to the appropriate internal manager and Energy Management Supervisor. Subject to approval, contact controls and mechanical contractors for further investigation. Contractors are to ensure that controls systems are performing as per manufacturers specifications.
  - Humidity Control: Outdoor air conditions are often favourable for free dehumidification. There is an opportunity to dehumidify pools by using dry outdoor air. This can be done by proper setup of the dehumidification unit and verification by the service provider.
  - Schedule pool equipment properly:
    - Reduce pool water temperatures based on the type of activity**.**
    - Turn off special pool features such as slides when not needed**.**
- **Ventilation Requirement for Air Quality (Outdoor and Exhaust Air)**: Ensure outdoor air damper is functioning properly as per design with a manual check of the damper position. See below ventilation section for further information regarding air changes in pool areas.
- **Evaporation Rates:** See Table 5 for settings to reduce evaporation. Reducing evaporation helps to decrease the amount of makeup water necessary and reduces the load on the pool dehumidification unit.
- **Reduce Makeup Water**
  - Backwash pool filters only when necessary
  - Ensure lifeguards are trained to reduce splashing from bathers to reduce makeup water.
  - Check to ensure the pool is not above user load capacity and that makeup water is being added based on an accurate bather load.
  - If feasible, use pool cover to reduce evaporation rate and associated makeup water.
- **Ensure appropriate operations and maintenance activities are completed as per manufacturers schedules**
  - Check that heat recovery units are operating properly. Have service contractor ensure proper operations.
  - Ensure regular cleaning and replacement of pool filters
  - Check that all pool boilers are functioning properly
  - Verify sequences of pool dehumidification unit and ensure operations are as per designed intent

❖ **Manage Shower Water Temperature**

- "The shower water system shall have one or more tempering devices capable of being adjusted to ensure that water supplied to shower heads does not exceed 40°C."[28]

Best Practice Set-Points

The recommended pool water temperature for various activities are:

Table 5 – Best Practice Water Temperature Settings for Pools[29]

Type of Pool	Air Temperature °C (°F)	Water Temperature °C (°F)
Recreational	23.9 to 29.4 (75 to 85)	23.9 to 29.4 (75 to 85)
Therapeutic	26.7 to 29.4 (80 to 85)	29.4 to 35 (85 to 95)
Competition	25.6 to 29.4 (78 to 85)	24.4 to 27.8 (76 to 82)
Elderly Swimmers	28.9 to 32.2 (84 to 90)	29.4 to 32.2 (85 to 90)
Whirlpool/Spa	26.7 to 29.4 (80 to 85)	36.1 to 40 (97 to 104)

"To minimize evaporation and operating costs, the air temperature should be kept as warm as is practical, ideally at or above the water temperature, with a maximum of 86°F db, which is generally understood to the maximum for human comfort. "[29]

According to the National Swimming Pool Foundation, adjusting the water temperature 0.5°C (1°F) can save up to 10% in energy cost savings.

Controlling humidity levels reduces the risk of mold, corrosion, structural damage and an uncomfortable pool environment. According to Department of Energy (DOE), adjusting the pool space temperature 1.5°C to 5.5°C (3°F to 10°F) can save 5% to 12% in energy cost savings.

The recommended humidity settings for pool facilities are

Table 6 – Best Practice Humidity Settings for Pool Facilities[29]

Season	Humidity (%)
Summer	50 to 60
Winter	50 to 60

Pool Ventilation

Space heating and ventilation accounts for a large proportion of energy use in pool halls which means that there are significant opportunities for savings. However, it is also important to ensure that the primary functions of the heating, ventilation and air conditioning system are satisfied. These are to comply with heating, cooling and outdoor air requirements as well as provide occupant comfort. Some recommended measures are[30]:

- Ventilation air is recommended to be calculated as the minimum amount recommended as per the current ASHRAE Standard 62.1
- Pool areas are recommended to have a slight negative pressure to prevent the contaminated air from migrating into adjacent areas of the building[30]

[28] Ontario Regulation Building Code (https://www.ontario.ca/laws/regulation/120332 Accessed April 2020)
[29] 2019 ASHRAE Handbook HVAC Applications – Chapter 6 – Indoor Swimming Pools
[30] Pool-Spa Operators Handbook-National-Swimming Pool Foundation 2009

- Where mechanical dehumidification is provided, air delivery rate should be established to maintain temperature and humidity level at appropriate conditions. The following air change rates are recommended:

Table 7 – Recommended Air Change Rates for Pool Ventilation[29]

Area	Air Change Rates
Pool areas	4 to 6 air changes per hour
Spectator areas	6 to 8 air changes per hour
Therapeutic pools	4 to 6 air changes per hour

3.1.2. Ice Rink

A significant amount of electricity is required to run an ice rink facility, typically ranging from 300,000 kWh for a single sheet seasonal area to 970,000 kWh for multi-sheet, extended season facilities[31]. The energy savings that an ice rink facility contributes substantially impacts the City utility's budget because of their high building and operating costs.

The main energy and environmental requirements in an ice rink facility are:

- Creating and maintaining the ice surface.
- Providing a comfortable environment for facility staff and occupants.
- Heating to appropriate levels in different facility areas for spectators, administrative offices, eating and change rooms, and maintenance areas
- Providing hot water for showering and ice resurfacing where hot ice resurfacing is used.
- Lighting to appropriate levels in various facility areas for different activities and areas
- Delivering good air quality in the different areas of the facility
- Providing kitchen facilities with the capabilities to provide food for both spectators and staff
- Optimizing dehumidification to avoid potential condensation on the ice and various facility activity areas

Upholding these requirements requires financial commitment since energy consumption is directly proportionate to energy costs of an ice rink facility. Thus, to reduce the building and operating costs, reducing the facility's consumption is essential. This can be accomplished through proper system design that will maintain high-quality ice and operations.

Best Operational Practices

The following is a list of some steps to consider to reduce the energy consumption in the ice rink facility[31]:

- **Test and Verify Control Systems:** For controls systems related to ice rinks including dehumidification and rink controllers it is recommended that operations teams make efforts to verify the functionality of the control systems. Some warning signs may be present if there are issues with the sequences of operations. For dehumidification systems an issue with the sequences can lead to condensation build up. If operational staff notice major issues persisting reach out to the appropriate internal manager and Energy Management Supervisor. Subject to approval, contact controls and mechanical contractors for further investigation. Contractors are to ensure that controls systems are performing as per manufacturers specifications.

[31] Refrigeration Manual: Ice Rink Applications published by Ontario Recreation Facilities Association (ORFA), 2008.

- **Lower Resurfacing Water Temperature:** Rink resurfacing water temperature can be lowered from the standard setting of 180°F (82°C) to between 130°F and 140°F (54°C and 60°C) while still maintaining the ice surface quality. This saves money and energy by reducing the amount of energy required to raise the temperature of the resurfacing water and reducing the refrigeration load of the ice surface.
- **Raise Secondary Refrigerant Temperature**: The secondary refrigerant circulating beneath the ice surface absorbs heat from the concrete slab and ice surface and carries it away. To accomplish this, the secondary refrigerant must be colder than the ice surface. If it becomes colder than needed, the compressor will have to work harder than required to maintain this heat exchange process. Optimum secondary refrigerant temperature for both occupied and unoccupied periods for the average Canadian ice rinks are 15 to 18°F (-9.40°C to -7.8°C) for occupied periods and 18 to 22°F (-7.8°C to -5.5°C) for unoccupied periods. A temperature increase 2 to 3 degree Celsius during unoccupied periods and small increase of 1 to degree during occupied periods reduces compressor energy consumption by a substantial amount. To implement nightly ice temperature set up, the facility refrigeration system must be capably of decreasing the temperature from the non-occupied setting swiftly in the morning for occupied periods.
- **Optimize Ice Thickness:** Maintaining the ice thickness at an optimal thickness of between 1 to 1.5 inches (25.4 and 38.1 mm) requires less energy consumption by the refrigeration system. Optimizing the ice thickness reduces the load on the refrigeration system, resulting in an increase of the refrigeration system's overall capacity. The equipment's life expectancy is also increased because of less mechanical work and increased efficiency. Several factors affect the optimal ice thickness for a particular rink, such as the capacity of the refrigeration system and the usage pattern of the ice rink. Some trial and testing will be necessary to determine the optimal ice thickness for each rink. In most arenas, reducing the energy used by the refrigeration system results in a reduction of the amount of heat recoverable by the space heating system. To balance the lowered cost of refrigeration with a higher cost of HVAC, the services of a qualified refrigeration engineer are necessary.
- **Optimize Ventilation:** Indoor air quality an important feature for ice rink facilities since proper ventilation is critical at all times. Conversely, an abundance of ventilation results in an increase in energy consumption towards running the fans, an increase in heating and dehumidification demands, and an increases the heat load on the ice surface without any improvement in air quality. Optimizing ventilation results in a double benefit of a reduction in energy required to operate the ventilation system and a reduction of conductive transfer of heat from the air to the ice sheet caused by lower rates of air change.
    - There are three means of optimizing ventilation:
        - Shutting down the ventilation systems when facility is vacant and air quality is not a critical issue
        - Install carbon dioxide and carbon monoxide sensors (to monitor indoor air quality linked to the HVAC system to match the ventilation system operation to actual indoor air requirements as outlined by legislated regulations.
        - Minimize ventilation requirement by using weather-stripping to restrict the entry of humid air.
- **Optimize Dehumidification:** It is vital to control humidity levels in ice rink facilities, especially during warmer seasons. An excess of moisture results in poor ice quality caused by

condensation, which also causes an additional load on the refrigeration system. It also leads to building degradation through condensation, mold and impacts the comfort of customers. Many existing technologies are able to dehumidify the air. Assistance from an HVAC engineer will be required to choose the best dehumidifier technology.

- **Management of Electrical Power Demand:** Management of electrical power demand lowers a facility's peak demand, avoiding peak demand charges. Facility operators can administer the peak demand by implementing the following changes;
  - Reschedule operations to avoid running equipment at the same time, including overlooked equipment such as kitchen equipment, coffee makers, computers, printers and office lights.
  - Shut down non–essential equipment
  - Replace older, inefficient motors with new high efficiency motors that use less energy at the same horsepower rating and load.
- **Optimize Compressor Operation (Compressor Sequencing):** The compressor is the largest energy consumer in a refrigeration system. With appropriate design and proper operation of the compressor configuration, savings of up to 15% are possible. To achieve energy efficiency, it is necessary to choose the optimal configuration of compressor type and sizes for a specific facility, such as multiple units operating in sequence with only the most efficient compressor operating at any point in time. Optimizing the operation and using only one compressor when necessary extends the equipment life cycle while also minimizing maintenance costs.
- **Optimize Compressor Energy (Head Pressure Reset):** Efficient heat transfer from the hot refrigerant gas to the outside air at the condenser is attained by maintaining a proper temperature differential between the two. The temperature differential can be maintained using controls that reduce the condensing temperature by resetting the head pressure as the outside temperature decreases. Generally, a minimum temperature that must be maintained to ensure adequate operation of the refrigeration system is specified by the equipment manufacturer. Continuously floating condensing temperature and its associated head pressure increases the refrigeration system's capacity by over 10% and reduces compressor energy consumption by 25%.
- **Optimize Circulating Pumps Operation:** In most ice rink facilities, there are pumps that circulate a secondary refrigerant though pipes that are enclosed in the concrete slab. The pumps are a part of the refrigeration system's energy consumption directly because of their operation and indirectly because of their contribution of heat to the system. Modifications can be made to the operation of the secondary refrigerant pump to be cycled and directly controlled by ice temperature by installing infrared sensors rather than secondary refrigerant temperature sensors. The refrigeration system and the secondary refrigerant pump turn on only when the ice temperature rises above a set point. This results in a reduction of the secondary refrigerant pump's operation from 24 hours to 10 to 12 hours per day.
- **Power Factor Correction:** It is recommended to conduct a cost benefit analysis if a facility's metered power factors are lower than 90% to determine what equipment and operational changes must be implanted to increase the power factor to a percentage that prevents charges. This will result in a reduction in the overall electric demand costs, a reduction in the heat losses within the motor windings of the equipment, and minor improvement in the facility equipment's life expectancy since there are lowered heat losses in the machinery.

Lighting

The lighting system of an ice rink facility has both a direct and indirect impact on its energy consumption. Lighting also contributes to the heat load of the ice surface, which further increases the energy demand of the refrigeration system. The following energy efficient lighting system tips are suggested to reduce these costs:

- **Install More Efficient and Flexible Lighting Fixtures:**
  - LED lights contribute significantly less heat load than other types of lighting technology including fluorescent
  - Install lighting to match the ongoing activity on the ice while maintaining acceptable lighting levels.
- **Reduce Lighting Levels:**
  - Reduce the number and output of light fixtures required to achieve necessary lighting levels. This can be accomplished by using bright light-reflecting wall paint and highly reflective low-emissivity ceiling materials.
  - Utilize daylighting where and when possible to reduce electrical lighting consumption

Table 8 provides Ice Rink Activity Light Levels as Recommended by Illuminating Engineering Society of North America (IES).

Table 8 – Ice Rink Activity Light Levels as Recommended by IES[32]

Activity	Professional Hockey	Amateur Hockey	Recreational Skating
Light Level (Lux)	1,000	500	200

The content in the Ice Rink section was adapted from Refrigeration Manual: Ice Rink Applications published by Ontario Recreation Facilities Association (ORFA), 2008.

Best Practice Set-Points

- **Matching the Ice Surface Temperature to the Activity:** Adjusting the ice surface temperature to a level appropriate to the ongoing activity will lower the energy consumption of the ice rink. Energy consumption increases by about 10,000 kWh/year for each °F in the average temperature of the ice sheet. An ice sheet maintained at 23 °F (-5°C) will require 20,000 kWh/year more energy than one maintained at 25 °F (-4°C).

Table 9 – Recommended Ice Temperatures for Different Skating Activities[32]

Activity Type	Ice Temperature °C	Ice Temperature °F
Hockey	-6 to -5	21 to 23
Figure skating	-4 to -3	25 to 27
Free skating	-3 to -2	27 to 28

[32] Refrigeration Manual: Ice Rink Applications published by Ontario Recreation Facilities Association (ORFA), 2008.

Activity Type	Ice Temperature °C	Ice Temperature °F
No activity	-2 to -1	28 to 30

- **Lower Air Temperature at Night:** At night, approximately 50% to 60% of the load on the refrigeration system is convective load. This is caused by the movement of warm, moist air through and around the arena. Lowering the thermostat as per the below Table 10 will reduce the refrigeration system's energy consumption by an average of 3000 kWh each month. This saving is in addition to the direct savings on heating costs[32]. During colder months, the facility is recommended to maintain temperature levels high enough to prevent equipment damage or frozen pipes. Additionally, 25% to 35% of the refrigeration load at night is radiative heat from the ceiling. A well-insulated ceiling heated by building heating system will radiate heat to the ice surface. Lowering the air temperature lowers this radiative heat load.

Table 10 – Recommended Air Temperature Setpoints in Ice Rinks

Occupancy	Temperature (°C)	Temperature (°F)
Occupied	10	50
Unoccupied	-1.1 to 4.5	30 to 40

The content in the Ice Rink section was adapted from Refrigeration Manual: Ice Rink Applications published by Ontario Recreation Facilities Association (ORFA), 2008.

3.1.3. Gymnasium and Fitness Centres

Gymnasiums and fitness centres are energy intensive spaces due to the high level of plug loads and HVAC requirements. The activities conducted in these spaces lead to increased metabolic rate by as much as 5 to 7.6 times compared to sitting[33]. Higher rate of activity leads to users desiring a cooler space, which leads to a higher space cooling load and can lead to reduced space heating if equipment operates properly.

Best Operational Practices

The following is a list of major measures to consider to reduce the energy consumption in gymnasium and fitness centres:

- **Optimize Control Sequences:**
  - Control sequences for building automation systems are often programmed during a facility's construction phase and not revisited until issues are present. However, there is a need for optimization as best practice control sequences do change over time. It is recommended that operations teams work with Energy Management to investigate if updating sequences is worthwhile for your facility.

    For Gymnasiums the main high performance sequence of operations that is recommended is Demand Control Ventilation.

[33] ASHRAE Standard 55-2017

- **Demand Control Ventilation:** The minimum airflow in a space is reset based on demand for outdoor air in the space (this requires a return air CO_2 sensor). This is a useful strategy in gymnasiums as the occupancy can vary greatly based on the activity.

❖ **Minimize Plug Loads:**

- Check that all equipment has been turned off as part of closing procedures to avoid unnecessary electrical consumption overnight
- Turn off televisions when not needed
- Consider selecting gym equipment that is ENERGY STAR® rated or self-powered

❖ **Reduce Water Usage:**

- Use low flow aerators and shower heads in the change rooms
- Ensure taps and other plumbing fixtures are not leaking

❖ **Conduct Regular Inspections:**

- Keep equipment well maintained and clean to maximize equipment efficiency and produce less heat
- Ensure thermal imaging is completed on regular basis to identify air leakage, thermal bridges, and other building envelope anomalies
- Conduct regular inspection of outdoor air dampers for Air Handling Unit / Roof Top Units to ensure that damper position is consistent with control sequences

❖ **Check High Volume/Low Speed (HVLS) Fan Operations:**

- Ensure that HVLS fans are maintained and operated appropriately based on the time of year. In winter season fans are intended to be operated at low speed to destratify air. In summer season the fans can be run at high speed to cool occupants.
- Destratifying air helps to ensure thermal comfort in the occupant range.

Best Practice Set-Points

The recommended space temperature settings for Gymnasiums are:

Table 11 - Best Practice Space Temperature Settings for Gymnasiums

Season	Occupancy	Temperature (°C)	Temperature (°F)
Summer	Occupied	23.3-25.8	74-78.5[34]
	Unoccupied	28	82
Winter	Occupied	20.3	68.5 - 74[34]
	Unoccupied	16	61

According to NRCan, adjusting the temperature down 1°C (1.8°F) in the winter can save up to 3% of the heating bill. Also, by adjusting the temperature up 1°C (1.8°F) in the summer, one can save up to 1% of the cooling bill[35].

[34] ASHRAE Handbook 2019 HVAC Applications – Chapter 8 – Educational Facilities
[35] Dollars to $ense Energy Management Training Workshop-1 (2010). Natural Resources Canada.

The recommended humidity settings for Gymnasiums are[34]:

Table 12 – Best Practice Humidity Settings for Gymnasiums

Type	% Relative Humidity
Gymnasium without Wood Floor	30 to 60
Gymnasium with Wood Floor	35 to 50*

*For Gyms with Wood Floor 35-50% RH is suggested to be at ALL times

3.1.4. Administrative Spaces, Community Rooms, and Common Areas

Refer to Section 3.3.1 for operational considerations of office area spaces.

3.2 Transit Facilities

Transit facilities have high energy intensities due to 24/7 operating hours in many spaces with bus storage and maintenance spaces needing to re-condition air escaping from large bay doors. These facilities are comprised of a large gross floor area and made up of several space types. There is a lot of potential for energy savings due to the large amount of equipment and high ventilation requirements.

The majority of the space is taken up by two (2) classifications, storage garages and maintenance garages. Other spaces within transit facilities include office and administrative areas including kitchens, lounge for drivers, etc. The following sub-sections provide a breakdown of best operational practices and setpoints for these classifications.

3.2.1. Storage Garage and Maintenance Garages

Transit storage and maintenance garages use similar strategies for conditioning air in the space. The key difference between these two spaces is not they type of HVAC and control systems that are installed but how they operated. Storage garages are required to maintain buses at an adequate temperature to ensure winter start-up and shelter for the buses during unused hours. Since maintenance garages are occupied spaces for maintenance they have more stringent requirements in terms of temperature setpoint and air circulation which can lead to higher energy demand.

Best Operational Practices

Behaviour

This sub-section includes tips to change staff behaviour for to minimize energy use during operations.

- **Training:**
  - Educate City staff and building occupants about behaviour change and its effect on energy use.
  - Ensure that team members from every department are informed of the importance of energy management and basic energy-saving practices by holding regular staff meetings on energy use, costs, objectives, and employee responsibilities. These staff meetings can result in energy savings which can in turn save money for the City and assist in meeting our energy related corporate performance targets.
- **Getting Involved:**
  - Encourage employees to participate in energy reduction and energy-related behaviour change by rewarding energy-efficient behaviours and habits.

Operations and Maintenance

This sub-section includes tips for Operations and Maintenance low cost and no cost measures that can be implemented to optimize operations and save energy.

- **Perform Regular Audits:**
  - Conduct a nighttime audit to determine unnecessary after hours usage.
  - Ensure thermal imaging is completed on annual basis to identify air leakage, thermal bridges, and other building envelope anomalies that contribute to poor energy performance.
  - Work with the Energy Management team to have energy audits completed to identify areas for energy conservation and optimized efficiency performance.
- **Perform Building Commissioning:**
  - Establish an existing building commissioning process at regular intervals to ensure current facility requirements are being met and systems are optimized to meet these current requirements
- **Perform Regular Preventative Maintenance:**
  - Check heating and cooling equipment to ensure efficient operation. This can be done through scheduled preventive maintenance program completed by contractor.
  - Regularly change or clean HVAC filters every month during peak points of cooling or heating season. Dirty filters have a higher pressure differential causing fans to work harder, clean filters will not overwork the equipment and will improve indoor air quality.
- **Complete Regular Inspections:**
  - Visually inspect for insulation damage, such as tears, compression, and stains on all piping, ducting, and equipment.
  - Ensure weather stripping is in good condition and is acting as an air barrier between thermal zones. Weather stripping can be added to doors and windows to reduce the loss of conditioned air saving money and energy.
- **Optimize Water Usage**:
  - Use low flow aerators and ensure that taps and other plumbing fixtures are not leaking.
  - Install low flow plumbing fixtures (urinal, water closet, shower head, etc.)

HVAC

This section provides insight into optimal operations for HVAC equipment including no and low cost tips and tricks.

- **Optimize Control Sequences**[36]**:**
  - Control sequences for building automation systems are often programmed during a facility's construction phase and not revisited until issues are present. However, there is a need for optimization as best practice control sequences do change over time. In 2018, ASHRAE published *ASHRAE Guideline 36 – High Performance Sequences of Operations for HVAC*

[36] ASHRAE Guideline 36 - 2018

Systems. This guideline includes the latest best practice sequence of operations for air side HVAC equipment. It is recommended that operations teams work with Energy Management to investigate if updating sequences is worthwhile for your facility.

Before updating sequences, the following questions can be asked to determine if the HVAC system is designed for part loading:

- Is air handling equipment currently equipped with variable speed fans?
- Does the area in consideration have variable air volume boxes?

- Strategies that would be considered for control sequence optimization include:

  - **Dual Maximum VAV Logic:** This strategy places a maximum temperature on discharge air temperature in reheat applications and allows airflow to increase (instead of discharge air temperature) if the setpoint is not met. This reduces stratification and the energy necessary for reheat.
  - **Dynamic Demand Control Ventilation:** The minimum airflow in a space is reset by zone based on demand for outdoor air in that zone (this requires zone CO_2 sensors)
  - **Trim and Response Logic for Static Pressure Reset:** Zones issue airflow "requests" based on VAV damper position. For example, a 100% open damper position would send a request to the air handling unit that would in turn increase the static pressure setpoint to provide more air to the requesting zone. This works to decrease the setpoint as well when a damper is at minimum position.
  - **Trim and Response Logic for Discharge Air Temperature Reset:** Zones issue temperature "requests" based on heating or cooling demand. For example, an unsatisfied heating setpoint would generate a request to the air handling unit that would in turn increase the heating valve position to provide more heating to the requesting zone.

❖ **Control System Maintenance:**

- Review occupied and unoccupied setpoint temperatures and ensure that temperature setbacks are functional.
- Review and make any necessary adjustments to temperatures for seasonal changes, this includes removing any overrides.
- Ensure maintenance contractors calibrate sensors and thermostats to provide accurate ambient temperature readings.
- Conduct regular inspection of outdoor air dampers for Air Handling Unit / Roof Top Units to ensure that damper position is consistent with control sequences.

❖ **Control Solar Heat Gain:**

- Control direct sunlight through windows using the shades and blinds control heat gain depending on the season and local climate. See the lighting section for tips on use of windows to lower lighting loads.
- Install window films and add insulation or reflective roof coating to reduce energy consumption.

❖ **Complete Regular Preventative Maintenance:**

- Clean the evaporator and condenser coils on heat pumps, or air-conditioners. Dirt on heating and cooling coils can have a significant impact on building energy use. Dirty coils reduce airflow, decrease heat exchanger efficiency, and reduce HVAC system capacity
- Repair leaks and adjust pressure in compressed air systems.
- High speed roll up doors between thermal zones are recommended to be properly maintained. These thermal zones include interior to exterior as well as between storage and maintenance garages.
- Ensure air curtains are functioning properly on overhead doors between spaces with different thermal zones.
- Service heating, ventilation, and air conditioning (HVAC) systems with a regular maintenance contract.

❖ **Check High Volume Low Speed (HVLS) Fan Operations:**

- Ensure that HVLS fans are maintained and operated appropriately based on the time of year. In winter season fans are intended to be operated at low speed to destratify air. In summer season the fans can be run at high speed at cool occupants.
- Destratifying air helps to ensure thermal comfort in the occupant range.

❖ **Conduct Regular Reviews of Systems:**

- Ensure that areas in front of vents are clear of obstructions
- Plug air leaks with weather stripping and caulking.
- Keep exterior doors closed when HVAC equipment is in operation.
- Repair damaged insulation and replace missing insulation.

Plug Loads

This sub-section includes information for minimize existing plug and process loads as well as information on selecting new equipment when necessary.

❖ **Minimize Existing Plug Loads:**

- Enable the power management function on office computers, printers, copiers, fax machines, scanners, and multifunction devices to automatically put equipment to sleep mode when not in use[37]
- Plug electronics into a "smart" power strip that allow for power designation for electronics depending on their usage priority.

❖ **Selecting New Equipment:**

- Purchase energy-efficient products such as ENERGY STAR® certified office equipment, electronics, and commercial cooking equipment.

[37] Put Your Computers to Sleep (www.energystar.gov/powermanagement Accessed April 2020)

Lighting

This sub-section provides information to optimize lighting systems. This includes strategies to maximize efficiency and to reduce on time.

- **Reduce Unnecessary On Time:**
  - Turn off lights when not in use or take advantage of sufficient natural daylight to reduce lighting costs by 10% to 40%.
  - Install occupancy sensors to reduce lighting usage in storage rooms, meeting rooms, and other low-traffic areas.
  - Use daylight in place of lights whenever possible this can be done manually with blind or can be automated with photocells.
- **Optimize Existing Lighting:**
  - Use task lighting where feasible instead of overhead lighting for better lighting and reduced energy consumption
  - Remove unnecessary lamps in over lit areas. Check your light levels against standards from the Illuminating Engineering Society (IES) to determine appropriate lighting levels for each room.
- **Upgrade Old Technology:**
  - Replace fluorescent and incandescent lighting with energy-efficient lighting systems that improve light quality, reduce heat gain, and increase intervals between replacements.
  - Install LED exit signs to reduce maintenance, replacement, and annual electricity costs.
  - Install LED bulbs wherever possible
  - Consider switching from high-pressure sodium lamps or metal halide lamps to LED in parking lots and for outdoor signage.

The content in this section was adapted from ENERGY STAR®[38]

Best Practice Set-Points

The recommended space temperature settings for Storage and Maintenance Garages are:

Table 13 – Best Practice Space Temperature Settings for Storage & Maintenance Garages

Space Type	Season	Temperature (°C)	Temperature (°F)
Storage	Summer	24	75
	Winter	16	61
Maintenance	Summer	24	75
	Winter	20	68

[38] Take a comprehensive approach (https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/comprehensive-approach Accessed April 2020)

According to NRCan, adjusting the temperature down 1°C (1.8°F) in the winter can save up to 3% of the heating bill. Also, by adjusting the temperature up 1°C (1.8°F) in the summer, one can save up to 1% of the cooling bill[39].

3.2.2. Office Areas

Refer to Section 3.3.1 for operational considerations of office area spaces.

3.3 Corporate Office Facilities

Corporate office facilities that are owned and managed by the City are less energy intensive than the City's largest consumers within the community centre and transit archetypes. However, corporate office facilities still present a number of opportunities to save energy through operational changes, behaviour, and technology improvements within the various space types that can be found in these facilities.

The following sub-sections provide best practice recommendations for areas within corporate office facilities that have distinct energy needs, including: office areas, kitchen areas, and data centres.

3.3.1. Office & Administrative Areas

Office and administration spaces are common to both dedicated corporate office facilities and the other facility archetypes noted within this document. Office areas include open office areas, enclosed offices and meeting rooms. In office spaces, energy usage is largely comprised of space heating and cooling needs, lighting, computers and office equipment, and other miscellaneous plug loads. The energy efficient operation of office spaces not only saves on energy costs, but also improves working conditions which is shown to improve employee health and productivity[23].

Best Operational Practices

Behaviour

This sub-section includes tips to change staff behaviour for high performance operations.

- **Training:**
  - Educate City staff and building occupants about behaviour change and its effect on energy use.
  - Ensure that team members from every department are informed of the importance of energy management and basic energy-saving practices by holding regular staff meetings on energy use, costs, objectives, and employee responsibilities. These staff meetings can result in energy savings which can in turn save money for the City and assist in meeting our energy related corporate performance targets.
- **Getting Involved:**
  - Encourage employees to participate in energy reduction and energy-related behaviour change by rewarding energy-efficient behaviours and habits.

Operations and Maintenance

This section includes tips for Operations and Maintenance low cost and no cost measures that can be implemented to optimize operations and save energy.

- **Perform Regular Audits:**

[39] Dollars to $ense Energy Management Training Workshop-1 (2010). Natural Resources Canada.

- Conduct a nighttime audit to determine unnecessary after hours usage.
- Perform energy audits to identify areas for energy conservation and optimized efficiency performance.
- Ensure thermal imaging is completed on annual basis to identify air leakage, thermal bridges, and other building envelope anomalies that contribute to poor energy performance.
- Re-commission the building to ensure original purpose for operations is being sustained.
- Work with the Energy Management team to have energy audits completed to identify areas for energy conservation and optimized efficiency performance.

❖ **Perform Regular Preventative Maintenance:**

- Improve operations and maintenance practices by maintaining equipment and ensuring efficient functionality on a regular basis.
- Regularly perform maintenance of heating and cooling equipment to ensure efficient operation.
- Optimize start-up time, power-down time, and sequencing to applicable equipment.

❖ **Optimize Water Usage:**

- Repair leaking faucets and equipment.

❖ **Complete Regular Inspections:**

- Visually inspect insulation for insulation damage, such as tears, compression, and stains, on all piping, ducting and equipment.
- Make sure weather stripping is in good condition and is acting as an air barrier between thermal zones. Weather stripping can be added to doors and windows to reduce the loss of conditioned air saving money and energy.

❖ **Other:**

- Revise janitorial practices to reduce number of usage hours for lighting.

HVAC

This section provides insight into optimal operations for HVAC equipment including no cost and low cost tips and tricks.

❖ **Optimize Control Sequences[40]:**

- Control sequences for building automation systems are often programmed during a facility's construction phase and not revisited until issues are present. However, there is a need for optimization as best practice control sequences do change over time. In 2018, ASHRAE published *ASHRAE Guideline 36 – High Performance Sequences of Operations for HVAC Systems*. This guideline includes the latest best practice sequence of operations for air side HVAC equipment. It is recommended that operations teams work with Energy Management to investigate if updating sequences is worthwhile for your facility.

[40] ASHRAE Guideline 36 - 2018

Before updating sequences, the following questions can be asked to determine if the HVAC system is designed for part loading:

- Is air handling equipment currently equipped with variable speed fans?
- Does the area in consideration have variable air volume boxes?

- Strategies that would be considered include:

  - **Dual Maximum VAV Logic:** This strategy places a maximum temperature on discharge air temperature in reheat applications and allows airflow to increase (instead of discharge air temperature) if the setpoint is not met. This reduces stratification and the energy necessary for reheat.
  - **Dynamic Demand Control Ventilation:** The minimum airflow in a space is reset by zone based on demand for outdoor air in that zone (this requires zone CO_2 sensors)
  - **Trim and Response Logic for Static Pressure Reset:** Zones issue airflow "requests" based on VAV damper position. For example, a 100% open damper position would send a request to the air handling unit that would in turn increase the static pressure setpoint to provide more air to the requesting zone. This works to decrease the setpoint as well when a damper is at minimum position.
  - **Trim and Response Logic for Discharge Air Temperature Reset:** Zones issue temperature "requests" based on heating or cooling demand. For example, an unsatisfied heating setpoint would generate a request to the air handling unit that would in turn increase the heating valve position to provide more heating to the requesting zone.

❖ **Control System Maintenance:**

- Review occupied and unoccupied setpoint temperatures and ensure that temperature setbacks are functional.
- Review and make any necessary adjustments to temperatures for seasonal changes, this includes removing any overrides.
- Ensure maintenance contractors calibrate sensors and thermostats to provide accurate ambient temperature readings.
- Conduct regular inspection of outdoor air dampers for Air Handling Unit / Roof Top Units to ensure that damper position is consistent with control sequences.
- Calibrate thermostats to provide accurate ambient temperature readings.

❖ **Control Heat Gain:**

- Control direct sun through windows using the shades and blinds to prevent or encourage heat gain depending on the season and local climate. See the lighting section for tips on use of windows to lower lighting loads.
- Install window films and add insulation or reflective roof coating to reduce energy consumption.

❖ **Complete Regular Preventative Maintenance:**

- Regularly change or clean HVAC filters every month during peak points of cooling or heating season. Dirty filters have a higher pressure differential causing fans to work harder, clean filters will not overwork the equipment and will improve indoor air quality.
- Service heating, ventilation, and air conditioning (HVAC) system with a regular maintenance contract.
- Clean the evaporator and condenser coils on heat pumps, chillers, or air-conditioners. Dirt on heating and cooling coils can have a significant impact on building energy use. Dirty coils reduce airflow, decrease heat exchanger efficiency, and reduce HVAC system capacity
- Repair leaks and adjust pressure as required in compressed air systems.

❖ **Conduct Regular Review of Systems:**

- Ensure that areas in front of vents are clear of obstructions
- Plug air leaks with weather stripping and caulking.
- Keep exterior doors closed when HVAC equipment is in operation.
- Repair damaged insulation and replace missing insulation.

Plug Loads

This sub-section includes information for optimizing existing plug and process loads as well as information on selecting new equipment when necessary.

❖ **Minimize Existing Plug Loads:**

- Enable the power management function on office computers, printers, copiers, fax machines, scanners, and multifunction devices to automatically put equipment to sleep mode when not in use[41]
- Plug electronics into a "smart" power strip that allow for power designation for electronics depending on their usage priority.

❖ **Selecting New Equipment:**

- When purchasing new equipment select energy-efficient products such as ENERGY STAR® certified office equipment, electronics, and commercial cooking equipment.

Lighting

This sub-section provides information to optimize lighting systems. This includes strategies to maximize energy efficiency and conserve energy with the reduction of on time.

❖ **Reduce Unnecessary On-Time:**

- Turn off lights when not in use or take advantage of sufficient natural daylight to reduce lighting costs by 10% to 40%.
- Only light occupied areas of the facility during cleaning rather than having large unoccupied areas lit after-hours

[41] Put Your Computers to Sleep (www.energystar.gov/powermanagement Accessed April 2020)

- Install occupancy sensors to reduce lighting usage in storage rooms, meeting rooms, and other low-traffic areas.
- Employ bi-level switching where applicable. Bi-level switching allows you to control a lighting system in groups of fixtures or lamps. For example, bi-level switching allows you to turn off half of the lights in a room off when full illumination is not required. This is useful in rooms like meeting rooms where the lighting levels may vary based on the meeting type and the use of presentation equipment.
- Use daylight in place of lights whenever possible this can be done manually with blind or can be automated with photocells.

❖ **Optimize Existing Lighting:**

- Use task lighting where feasible, such as periods of reduced occupancy where overhead lighting can be turned off.
- Ensure all light fixtures lenses are well maintained and clean to ensure lighting levels are adequate
- Check your light levels against standards from the Illuminating Engineering Society (IES) to determine appropriate lighting levels for each room. Remove unnecessary lamps in over lit areas.
- Ensure proper performance of occupancy sensors. Ensure sensors turn on lights when the room is occupied. If there are issues it may be due to the positioning of the occupancy sensor or the sensor settings.
- Ensure that exterior lights are turned off during daylight hours. Use an astronomical timer. It can be set to adjust itself for daylight savings.

❖ **Upgrade Old Technology:**

- Replace old fluorescent and incandescent lighting with energy-efficient lighting systems that improve light quality, reduce heat gain, and increase intervals between replacements.
- Install LED exit signs to reduce maintenance, replacement, and annual electricity costs.
- Install energy efficient light bulbs in desk and floor lamps.
- Consider switching from high-pressure sodium lamps or metal halide lamps to LED in parking lots and for outdoor signage.

The content in this section was adapted from ENERGY STAR®[42].

Best Practice Set-Points

The recommended temperature settings for office areas are:

[42]Take a comprehensive approach (https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/comprehensive-approach Accessed April 2020)

Table 14 - Best Practice Space Temperature Settings for Offices

Season	Occupancy	Temperature (°C)	Temperature (°F)
Summer	Occupied	23.3-25.6	74-78[43]
	Unoccupied	28	82
Winter	Occupied	21.1-23.3	70-74[43]
	Unoccupied	16	61

According to NRCan, adjusting the temperature down 1°C (1.8°F) in the winter can save up to 3% of the heating bill. Also, by adjusting the temperature up 1°C (1.8°F) in the summer, one can save up to 1% of the cooling bill[44].

The recommended humidity settings for office areas are:

Table 15 – Best Practice Space Humidity Settings for Office[43]

Season	Humidity (%)
Summer	50 to 60
Winter	20 to 30

Low levels of humidity, which mainly occur during the winter can increase the number of paper jams and static electricity. High levels of humidly during the summer increases, the “feels like” temperature and the chance of mould growth within the office environment. In areas with high levels of glazing, humidity levels that are too high in the winter may cause condensation. If this occurs, consider resetting the humidity setpoint based on outdoor air temperature and humidity using a reset schedule. Contact Energy Management for more information.

3.3.2. Kitchen Areas

Kitchen areas have high exhaust rates and large amount of heat load from cooking equipment. Due to the high energy intensive nature of this area, it is very important to provide adequate conditioned make-up air. It is recommended to perform regular maintenance on all kitchen systems including all exhaust and supply air units.

Best Operational Practices

Behaviour

This sub-section includes tips to change staff behaviour for high performance operations.

- **Training:**
  - Educate City staff and building occupants about behaviour change and its effect on energy use.
  - Ensure that team members from every department are informed of the importance of energy management and basic energy-saving practices by holding regular staff meetings on energy use, costs, objectives, and employee responsibilities. These staff meetings can result in energy savings which can in turn save money for the City and assist in meeting our energy related corporate performance targets.

[43] ASHRAE Handbook 2019 HVAC Applications – Chapter 3 – Commercial and Public Buildings
[44] Dollars to $ense Energy Management Training Workshop-1 (2010). Natural Resources Canada.

❖ **Getting Involved:**

- Encourage employees to participate in energy reduction and energy-related behaviour change by rewarding energy-efficient behaviours and habits.
- Use cold water in place of hot water wherever possible

Operations and Maintenance

This sub-section includes tips for Operations and Maintenance low cost and no cost measures that can be implemented to optimize operations and save energy.

❖ **Reduce Water Usage:**

- Ensure that low flow faucet aerators are installed to reduce hot water usage
- Encourage the reporting of any water leaks and fix identified leaks as even small leaks may add up to increased energy costs for hot water

❖ **Complete Regular Equipment Maintenance:**

- For existing refrigerators, clean refrigerator coils twice a year and replace door gaskets if a dollar bill easily slips out when closed between the door's seals.

HVAC

This sub-section provides insight into optimal operations for HVAC equipment including no cost and low cost tips and tricks.

❖ **Optimize Equipment Operation Time:**

- Ensure cooking exhaust systems are used only when necessary

❖ **Ensure Equipment Is Operating Efficiently:**

- Maximize the exhaust hood overhang by pushing cooking appliances as close to the wall as possible.[45] This ensures that exhaust air is directed properly and clean air is not exhausted.
- Clean oven surfaces to ensure proper heat transfer
- Ensure air distribution areas such as louvers, grilles, etc. are left unobstructed.

❖ **Complete Regular Preventative Maintenance:**

- Ensure HVAC equipment is maintained by HVAC contractor

Plug Loads[46]

This sub-section includes information for optimizing existing plug and process loads as well as information on selecting new equipment when necessary.

❖ **Ensure Optimal Setpoints are Used:**

- Adjust the refrigerator thermostat. If your thermostat is set for colder than it needs to be, your fridge may be consuming up to 25% more energy than necessary. For best results, the

[45] ENERGY STAR ® Guide for Commercial Kitchens (https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/energystar/Commercial-Kitchen-Guide_E_acc.pdf Accessed April 2020)
[46]Energy Savings Tips for Small Businesses (https://www.energystar.gov/sites/default/files/tools/Small_Business_Offices_0.pdf Accessed April 2020)

refrigerator is recommended to be set within the 2.5 – 4.5 degrees C range, and the freezer to between -18 to -15 degrees C.

❖ **Ensure Equipment is Properly Functioning:**

- Use dishwashers only when full to conserve energy, water, and detergent as most dishwashers use the same amount of water and energy whether they're run full or half-full.
- Maintain an air-gap of at least three inches between the back of refrigerators, water coolers, and freezers and the wall

❖ **Schedule Equipment:**

- Use timers to ensure that coffee maker heating elements are not operating during off hours.

❖ **Replace Old Equipment:**

- Consider retrofitting existing refrigerators and display cases with anti-sweat door heater controls, and variable speed evaporator fan motors and controls.
- When purchasing new equipment select energy-efficient products such as ENERGY STAR® certified office equipment, electronics, and commercial cooking equipment.

Lighting

This sub-section provides information to optimize lighting systems. This includes strategies to maximize efficiency and to reduce on time.

❖ **Reduce Unnecessary On Time:**

- Turn off lights manually in seldom-used rooms and/or install motion detector switches to ensure electricity is not used to light unoccupied spaces such as closets, storage or break rooms, restrooms and even walk-in refrigerators. For refrigerators, look for low-temperature-specific, sealed sensors. [47]

❖ **Optimize Existing Lighting:**

- Inspect lenses and reflectors for dust, rust or damage that could cause inefficient transmission or reflection of light. [47]

❖ **Replace Old Technology:**

- Ensure LED bulbs and fixtures are installed wherever feasible

Best Practice Set-Points

The recommended temperature settings for kitchen areas are:

[47] ENERGY STAR ® Guide for Commercial Kitchens (https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/energystar/Commercial-Kitchen-Guide_E_acc.pdf Accessed April 2020)

Table 16 – Best Practice Space Temperature Settings for Kitchen Areas[48]

Season	Occupancy	Temperature (°C)	Temperature (°F)
Summer	Occupied	28.9-31.1	84-88
Winter	Occupied	21.1-23.3	70-73.5

No humidity control is provided in kitchen areas.[49]

According to NRCan, adjusting the temperature down 1°C (1.8°F) in the winter can save up to 3% of the heating bill. Also, by adjusting the temperature up 1°C (1.8°F) in the summer, one can save up to 1% of the cooling bill[50].

3.3.3. Data Centres

WIP

3.4 Library

WIP

3.5 Fire Stations

WIP

[48] ASHRAE Handbook 2019 HVAC Applications – Chapter 3 – Commercial and Public Buildings
[49] ASHRAE Handbook 2019 HVAC Applications – Chapter 3 – Commercial and Public Buildings
[50] Dollars to $ense Energy Management Training Workshop-1 (2010). Natural Resources Canada.

APPENDIX – BAS DESIGN AND IMPLEMENTATION PRINCIPLES

The BAS Guideline Methodology provides a high level description of the purpose and structure of the BAS Guidelines. This section includes the City of Brampton BAS design and implementation principles, overviews of the different sections within the BAS Guidelines as well as the intended audience for the different sections.

Chapter 1. Principles of BAS Design and Implementation

1.1 Integrated Design Vision

A Building Automation System is a series of networked controllers and a software headend designed to monitor and control the environment in a building. It controls all aspects of the HVAC and can extend to include lighting, sub-metering, security and more. It ensures the operational performance of the building systems as well as ensuring the comfort and safety of the building's occupants. The City of Brampton intends for its building automation systems to be an integral part of Energy Management by reducing energy consumption and GHG emissions.

Additionally, it is the goal of the city to shift design, construction and commissioning processes from a linear, individualized approach to an integrated and collaborated approach. It is the intention of this guideline that all aspects of the BAS design and implementation is considered holistically and applied through an iterative process. This involves looking at the interoperation of disparate systems and considering how these systems are to work together.

1.2 Guideline Goals

As a Green City, Brampton has committed to zero carbon and high performance facilities. This commitment for A Zero Carbon Transition has been formalized through the City of Brampton's latest 5-year Energy and Emissions Management Plan for 2019-2024. The plan outlines the action plan to achieve a zero carbon transition for the City's new and existing corporate facilities. In accordance with the Paris Agreement, Brampton has adopted the provincial and federal greenhouse gas (GHG) emission reduction targets of 30% by 2030 and 80% by 2050, respectively, using a 2010 baseline. The federal target has since been updated to net-zero emissions by 2050 (re-affirmed by the Minister of Environment and Climate Change at the 2019 UN Climate Change Conference)[51]. The

City has set an interim target of 20% GHG emissions reduction by 2024.

The design and implementation of Building Automation Systems is intended to support the three objectives of the Zero Carbon Transition Plan:

1. Minimize energy use
2. Minimize emissions
3. Maximize cost recovery

1.1 Six Principles of BAS Design

1. **Reliable control** of systems which also includes alarms and trend logs must be provided in a BAS
   The ultimate quality of a control system is primarily dictated by the components that sense, execute logic for, actuate and document the systems they are controlling[52]
2. **Require sufficient instrumentation** the designer is responsible for ensuring specified equipment will meet sequences.
   The designer must require instrumentation to support both the sequence of operations, and the data acquisition capability to support equipment performance monitoring and building diagnostics

[51]

[52] https://getrede.ca/five-principles-for-building-automation-systems/

analysis. A listing generally establishing minimum instrumentation requirements is included with the specifications. This identifies minimum instrumentation for common types of system. The designer is responsible for requiring additional instrumentation as necessary to support the sequence of operations and necessary data acquisition capabilities.

3. **Environmental control** for indoor conditions and some examples include: temperature, humidity and air quality
   The measure of an environmental control system and how well it functions with other building wide systems is determined by occupant comfort, satisfaction, and well-being.
4. **Building wide and energy efficient control** of systems and examples include: HVAC, envelope and lighting
   A key measure of the system's energy management capabilities is its ability to communicate and exchange data with other building systems to achieve efficient and effective energy usage with consideration for GHG emissions and energy cost
5. **Accessible control** which can be easily accessed and understood by operators
   Ensuring ease of operations increases the usability of the BAS which leads to better operational performance. This also includes graphics that increase Energy Awareness through better designed and easier to understand graphics and public facing portals.
6. **Integration capable control** that can incorporate disparate systems together to operate as a whole
   Examples of these disparate systems include but are not limited to BAS, metering, and security. This type of control usually hosted on a software platform that can combine disparate systems

1.2 Two Implementation Principles

1. **Highly qualified** manufacturers and installers with extensive experience are expected to complete all BAS work.
   Qualifications should ensure that a quality contractor with an extensive proven track record is specified; and that effective, thorough commissioning of the control systems by that contractor is essential. Given this, there lies a challenge to the designer to fairly restrict installers to those that can deliver effectively within the context of both the construction and the service/support arenas.
2. **Fully documented** control installation is expected with nothing required to fully operate and maintain the system withheld.
   Point naming conventions, programming logic, network configuration requirements, security information, etc. must be strictly adhered to and totally documented. No element for the continued operation and maintenance of the control system may be withheld in any way. No part of the installation may be considered confidential or proprietary information.[2]

1.3 Guideline Layout

The intended audience includes the project team and for a new building, the readers would primarily be system designers, contractors and members of the operations teams. Although, system designers do not usually include architects and may not include all members of the design development team, Energy Management recommends that the architect or design lead review the Energy Management Guidelines and the BAS chapter in order to engage appropriate resources at critical junctures of the integrated design process. For a major renovation project, the intended audience may vary slightly depending on project details, however, the same BAS design principles apply and thus, engagement of team staff would follow these principles.

The guideline identifies Implementation Guidelines (Appendix 1.0), Product Requirements (Appendix 1.1) and Execution Guidelines (Appendix 1.2) that CoB wants implemented throughout a BAS projects. It is the intention that users of this guideline will incorporate its aspects of procedure, construction, and building operation into the applicable design process.

The guideline is separated into 3 sections; Design and Implementation, Product, and Execution. A brief description of each of these sections follows to direct readers to their primary work scope.

1.4 Design and Implementation Guidelines (Designer, Installer, Operator):

This section covers information that is pertinent to many stakeholders throughout the design process, such as:

1. Expectations of preventative and demand maintenance contractors,
2. Requirements for IT networking
3. Trend log requirements

Construction handover processes

This section also includes discussions around the BAS architecture, including use of IP, MSTP, POE networks, the integration into other control systems such as a CMMS, itemizing of gateways with 3rd party devices and any software requirements should be considered.

Finally, items such as permits and fees and close out procedures are to be discussed at the beginning of the design rather than the end.

1.5 Product (Designer, Installer):

In this section, the CoB's functional requirements of equipment are outlined. In short, the BAS shall be based on ASHRAE BACnet technology (ASHRAE Standard 135-2016) and to be capable of remote communication over the City's intra-net network. CoB has provided a detailed section on the feel and flow of the graphics of the BAS with the intention of having some specific information always available. The network requirements, sensors and wiring guidelines are also defined here.

1.6 Execution (Designer, Installer, Operator):

This section is geared towards methods and hand-over procedures of implementation. Designers, commissioning agents, building operators to be included in the integrated design process from the very beginning. The process of this discussion is laid out in detail. A detailed section provides information towards how commissioning agents are to be engaged in CoB BAS projects. Consultants, BAS Vendors and Commissioning Agent are to work coherently. It is the intention of CoB that all parties are aware of major decisions well ahead of the execution phase. This increase in communication ensures less deficiencies during the commissioning phase.

Another important section is preventative maintenance contracts. The CoB has instituted a new process where the BAS preventive maintenance contractor will provide the list of rectified issues at the end of the site visit. If this is not approved by the corresponding building operations staff, and energy management staff, the invoicing will not be approved.

Chapter 2. Implementation Guidelines

2.1 Acceptable vendors

2.1.1. Vendor Listing

The following is a listing of approved BAS vendors for existing buildings. These vendors provide preventative and demand maintenance services for existing BAS systems at existing facilities:

1. Johnson Controls Canada LP
2. ESC Automation Inc.

3. Automated Logic Canada Ltd.

In 2020, the City of Brampton completed a prequalification process of BAS vendors to supply and install building automation systems (BAS) with native BACnet protocols. The prequalification enables pre-qualified vendors to bid on projects for a three (3) year period (currently up to December 31, 2023).

The types of projects will include: retrofitting existing buildings with new BAS, expanding BAS for existing facilities, and new BAS required for new construction facilities. Below is a list of prequalified vendors:

1. Johnson Controls Canada LP
2. ESC Automation Inc.
3. Siemens Canada

2.1.2. Design and construct Building Automation System (BAS) for building services with open protocol communications (BACnet).

2.1.3. New and existing installations use BACnet for all aspects of communication, including workstation, field panel, custom application controller and unitary controller communications and are commonly referred to as native BACnet systems.

2.2 Vendor Quality Assurance

2.2.1. BAS vendor to provide City of Brampton pricing options for 3 year maintenance and annual maintenance Installer must be within 50km of project site

2.2.2. Installer must be able to respond within 3 hours for critical failures, and within 24hrs for non-critical failures. Definition of critical and non-critical shall follow these guidelines as provided in Appendix B

2.3 Network

2.3.1. All BACnet devices (controllers, sensors, actuators, etc.) shall be integrated into one common network infrastructure utilizing a common network management tool and creating a single BACnet network database.

2.3.2. All systems should be complete with a dedicated controller and enclosure. For example, AHUs, Chiller Plant, Boiler Plant, Compartment Units will have a dedicated panel.

2.3.3. Provide a Facility Management and Control System incorporating BACnet, Direct Digital Control (DDC), equipment monitoring, and control consisting of microprocessor based plant control processors interfacing directly with sensors, actuators, and environmental delivery systems (i.e. HVAC units); electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels, sensing devices; a primary communications network to allow data exchange between microprocessor based devices.

2.3.4. The system will consist of an open architecture that utilizes the latest ANSI/ASHRAE 135 BACnet protocol as the common communication protocol between all controlled and controlling devices. Where necessary or desired, BACnet packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth.

2.3.5. The entire system network shall be a WAN. All nodes shall communicate with each other utilizing the latest ANSI/ASHRAE 135. There will be no consideration given to any network which does not use BACnet as the primary communications network. Controllers shall be capable of sharing standard network variable data with other WAN-based/BACnet devices.

2.3.6. For Non-IP based field controllers, the network is to follow a 2-tier structure

2.3.7. BCs and AWS to be on Tier1. These are to be IP-Based controllers and connected directly to CoB's base network infrastructure.

2.3.8. AACs, ASCs, and other field controllers to be on Tier 2. These are non-IP controllers and to be connected through MS/TP infrastructure originating from the BCs

2.3.9. For fully IP (and/or POE) Based BAS infrastructures, all components of the infrastructure (AWS, BC, AAC, ASC, etc.) to reside on the CoB base-building network infrastructure.

2.3.10. The network infrastructure shall conform to the BACnet published guidelines for network wiring and system architecture. Wire type, distance, termination, and use of routers shall strictly conform to the BACnet wiring standards. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.

2.3.11. All system controllers shall utilize a peer-to-peer communications scheme to communicate with each other and with the PC-type (browser based) monitoring computer(s) if applicable. All controllers shall utilize BACnet's network as defined by BACnet. Controllers shall implement BACnet device profiles as appropriate. All devices shall be provided with a twisted wire plug-in configuration utility.

2.4 Integration

2.4.1. When applicable, potential integration to be thoroughly discussed with City of Brampton.

2.4.2. The system shall allow for future integration of other systems (Card Access, Lighting, Intrusion Monitoring etc.) on the network proposed in this document, and also share a common infrastructure for network communications, time scheduling, alarm handling, history logging, monitoring and system control.

2.4.3. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type (i.e. HVAC, lighting, and security devices should easily coexist on the same network channel without the need for gateways).

2.4.4. Use of ANSI/CEA-852 layer 3/BACnet transparent routers is the only acceptable method spanning multiple channels and is the recommended method for system scalability. These components shall share common software for network communications, configuration, time scheduling, alarm handling, history logging, and custom programming. Any routers required by the system shall be supplied and commissioned as part of this guideline.

2.4.5. Vendor to integrate Asset Management and Capital Planning's CMMS platform. Primary use-case would be the BAS pushing alarms to CMMS.

2.5 Gateway

2.5.1. Gateways shall not be used unless specifically authorized in writing. Use of a gateway requires submittal of the documentation as required by the owner (Energy Management, City of Brampton) or owner's representative. It is the intent of this guideline that gateways be limited to integrating legacy systems where applicable. Acceptance of gateways is at the sole discretion of the owner.

2.5.2. If gateways are used, the following form is to be filled out by the user and submitted to the owner

System Name: For example- RTU1

Purpose of System: For example- Serves Auditorium

Protocol used by system: *For example- Modbus*

The BAS controller to which this system is connected to: *For example- BC1*

	BACnet Object name	3rd party Protocol slave address	BACnet object type	BACnet instance number	BACnet unit of measure	3rd Party protocol scale	BACnet scale mapped
Example Point1	Supply Air Flow	40001	Analog Input	1004	L/S	0 - 4800	0 - 4000
Point2							

2.5.3. Software Requirements

2.5.4. System Monitoring shall be provided through the installation of Graphical User Interface (GUI) software applications (B-AWS) that support Native BACnet database. It must be BTL listed product. The GUI shall provide complete access to any point in the system at any time. A complete and fully commissioned BACnet's network database must be delivered for use with the GUI as a specific deliverable as defined on the project schedule. This database must include ALL node definitions, all channel and subnet definitions, all router and repeater definitions, and all bindings etc.

2.5.5. The control system shall be designed such that mechanical and/or electrical equipment will be able to operate under stand-alone control. Functional methodology such as, but not limited to scheduling, trending, and alarming shall be outlined fully in your submittal documentation. Methodology must follow pertinent and applicable BACnet guidelines. Controllers that require a master computer or controller to perform basic functions are not acceptable. In the event of a network communication failure, or the loss of any other controller on the network, the control system shall continue to independently operate under control of the resident program stored in nonvolatile memory as detailed herein.

2.5.6. Historical data logging, alarm monitoring and management, and scheduling shall be accessible and managed via the GUI. The system may utilize specific controllers on the system to perform these functions or it may be performed by a host computer, or a combination of both. The final data to be stored on the server.

2.5.7. System shall utilize BACnet defined standard network and command messaging for all system data, shop drawings and approvals

2.5.8. All shop drawings provided by the vendor is to be submitted to the engineering consultant for review. Following the consultant's review, it is to be submitted to the Energy Management department at CoB for review

2.5.9. If there is no engineering consultant, vendor to submit directly to Energy Management department at CoB for review.

2.5.10. Following approval of shop drawing, vendor to provide sample graphics which are also to be approved by the consultant and/or CoB Energy Management team. Graphics to include typical AHU, VAV, and the Boiler or Chiller plant

2.6 Naming Convention

2.6.1. CoB has standardized on Project Haystack naming convention. All newly created points to follow this convention regardless of new building or retrofit. Haystack naming convention to apply to all representations of the points, whether it is the graphics, BACnet name or any other.

2.6.2. Each point is to be preceded by a 3 letter abbreviation of the building name and an underscore.

2.6.3. Vendor to provide owner with functionality to export all point list

2.7 Sequence of Operation

2.7.1. Sequences of operations designed and implemented to ASHRAE Guideline 36

2.7.2. Provide automatic control for system operation as described herein, although word "automatic" or "automatically", is not used.

2.7.3. Provide control devices, control software and control wiring as required for automatic operation of each sequence specified.

2.7.4. Manual operation is limited only where specifically described; however, provide manual override for each automatic operation.

2.7.5. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.

2.7.6. Functions called for in sequence of operations are minimum requirements and not to limit additional capabilities the DDC system can be provided with.

2.7.7. Minimum of the Basic Energy Efficient Sequences. Discuss Advanced Energy Sequences with the city during kick-off meeting.

2.7.8. Provide the following functions which are not specifically mentioned in each sequence of operation for each item of equipment:

1. Start-Stop, manual, and scheduled

2. On-Off status of each piece of equipment
3. Run-time
4. All set-points shall be adjustable
5. Feedback should be provided for all relevant outputs
6. Sequenced starting of all motors

2.8 Basic Energy Management

2.8.1. Provide Intelligent Control Devices, Programmable Controllers, and Application Specific Controllers as herein specified, as needed to perform functions indicated in the input/output summaries and sequences of operation, and/or indicated on the mechanical and electrical drawings.

2.8.2. Implement start, stop, night setback, request based logic, and demand level adjustment of setpoints

2.8.3. Incorporate sequences that utilize energy conserving sequences. This includes, but is not limited to; demand based economizer control, supply air temperature reset, duct static pressure reset, occupant based demand control, chilled plant optimization control, boiler plant optimization control, free cooling control, etc.

2.8.4. All major ventilation equipment to have a morning startup and evening shutdown sequence

2.8.5. All equipment in manual over ride to switch back to automatic control after a stipulated time interval.

2.8.6. BAS to have 3 levels of occupancy schedules: Unoccupied, Occupied and High-Occupancy. Setpoints, flowrates, timing to all be adjustable to suit the needs of the 3 states.

2.9 Demand Response

2.9.1. All components of this section is to be discussed with Energy Management team at CoB and will be potentially applicable to any building with a potential demand more than 1MW of electrical energy.

2.9.2. The BAS will be linking to the IESO (Independent Electricity System Operator) website for automatic demand reduction when prices are high. Provide a focused set of energy. Required information includes, but shall not be limited to:

- Site energy overview
- Equipment runtime
- Load profile
- Electrical energy
- Simple energy cost
- Energy production
- Consumption
- Reports shall be selectable by date, time, area and device. Each report shall include a color visual summary of essential energy information.

2.9.3. The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.

2.9.4. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy. The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target.

2.9.5. Software shall be provided to configure and implement optimal start and stop programs based on existing indoor and outdoor environmental conditions as well as equipment operating history.

2.9.6. Use a peak demand alarm: an announcement that the peak demand is being approached will allow operators to take action to avoid consumption during peak demand.

2.10 BAS Alarm Configuration

2.10.1. Alarms to be configured on all inputs corresponding to output points which are controlled by the BAS through a setpoint or command. The reference points for the alarms to be the setpoint. By default, alarm to be raised if input feedback deviates from setpoint by 20% or feedback does not match command for more than 10 minutes continuously.

2.10.2. Vendor to provide functionality to allow owner to export all alarms in an XLS format

2.10.3. Color code the of critical and non-critical alarms to follow the guidelines

2.10.4. BAS vendor to discuss with Energy Management group for further information regarding Alarm Levels.

2.10.5. Alarms to be sent to applicable building operators. If operators do not answer alarms, escalate alarm to the next level as determined by operations teams.

2.10.6. Alarms to be written in the following format:

2.10.7. Name. For example AHU1

2.10.8. Issue: For example: System Command does not meet Status

2.10.9. Provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

2.10.10. Shall be able to route any alarm condition to any defined User location whether connected to a local network or remote via or wide-area network.

2.10.11. Alarm generation shall be selectable for annunciation type and acknowledgement requirements.

2.10.12. Control equipment and network failures shall be treated as alarms and annunciated.

2.10.13. Alarms shall be annunciated via email notification to specific, configurable email address.

2.10.14. Alarms shall be visually identified via the HTML5 graphics pages. Overrides and set point changes shall be configured via the HTML5 interface.

2.10.15. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text
2. Email or Text messages
3. Graphic with flashing alarm object(s)

2.10.16. Alarms shall be logged for a period of no less than 1 week

2.10.17. Alarm logs shall be able to be transferred from the web server to a host

2.10.18. The following shall be recorded by the Web Server for each alarm (at a minimum):

1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment (air handler number, access way, etc.)

2.11 Warranty

2.11.1. All installed systems and their pertaining components, including but not limited to labour, material and configuration should have a 1 year warranty.

2.11.2. All warranty packages to be sent to City of Brampton Energy Management Team

2.12 Computerized Maintenance Management System (CMMS)

2.12.1. BAS to be integrated with the work order system. BAS vendor to reach out to Asset Management and Capital Planning's to configure integration where applicable.

2.13 Remote Access

2.13.1. The owner shall provide an appropriate connection (static IP) to the Internet to enable remote system access. The owner agrees to pay monthly access charges for connection and ISP.

2.14 BAS as a Web service

2.14.1. All BAS to be installed on City of Brampton's virtual servers

2.14.2. Servers shall be capable of executing application control programs to provide:

1. Hosting of the graphical HTML5 pages
2. Calendar functions
3. Scheduling
4. Data Logging
5. Alarm monitoring and routing
6. Time synchronization
7. Soap/XML interface
8. Static or Dynamic IP addressing
9. SMTP Server for alarm email notification
10. Messages and message management

2.14.3. The Software License for the Web Server(s) must be open and enable any Systems Integrator to engineer, change or modify the application once the project is complete. Restrictive engineering access to the Web server will not be acceptable. City of Brampton's Digital Innovation Team will review the

license to ensure that all applicable procurement laws and regulations have been followed (e.g., renewal period, copyright, limited warranty, liabilities and other terms & conditions). All credentials, access rights and passwords will be provided to the City.

1. Include all applicable items for 3rd party systems as well, such as, but not limited to RTU configurations tools or other packaged controls systems.

2.14.4. The system shall be capable of supporting unlimited simultaneous client connections using a standard Web browser such as, but not limited to Microsoft Edge™, Firefox™, or Google Chrome™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture- specific browsers shall not be acceptable.

2.14.5. The Web browser shall provide a view of the system, in terms of graphics, schedules, calendars, logs, etc. Systems that require different views or that require different means of interacting with objects such as, but not limited to schedules, or logs, shall not be permitted.

2.15 Data Logging and Storage

2.15.1. Vendor to setup BAS such that it creates trendlogs of all Inputs, Outputs and Setpoints.

2.15.2. All binary trended values to be logged at each Change of Value (COV)

2.15.3. All analog trended value to follow the guidelines as provided in Appendix B

2.15.4. BAS to be setup to store trend logs for a minimum of 2 years. The first year to be held as a benchmark.

2.15.5. Trend logs interface name and BACnet name to match the BAS point name as seen on the graphics.

2.15.6. The BAS shall have the ability to collect data for any Inputs, Outputs and Setpoints and store this data in the City BAS Server for future use. Data logging shall be performed either by a dedicated logger on the control network, via a combined web server/data logger, or by a maximum of 1 central host PC attached to the network. Whichever way data logging is to be performed it must:

1. Automatically update the host storage PC that the logs are approaching their full level
2. Data logs shall be able to be transferred from the web server to a host
3. Be easily able to append a new log to a previously saved log

2.15.7. Data to be property of CoB

2.15.8. Data to be available in .CSV format at the very least for CoB to be accessed anywhere within the network

2.15.9. Data to be automatically graphed in the BAS and normalized accordingly.

2.16 Security and User Administration

2.16.1. Communications between the Web Server and Web Browser to be secured according to CoB's latest Digital Innovation Team standards. Vendor to reach out to CoB Digital Innovation Team department for more information.

2.16.2. A license allowing for unlimited amount of user accounts should be provided to the CoB.

2.16.3. All accounts to be authenticated using CoB active directory. Vendor to communicate with Energy Management department to create authentication.

2.17 Main (Virtual) Server for all BAS

2.17.1. All BAS vendors are responsible to upgrade the existing BAS server with the latest version during the execution of this contract/project.

2.17.2. A City of Brampton Virtual Server for all BAS operation is will be allocated to vendor.

1. Virtual Server is owned by the City of Brampton and will house all software pertaining to the BAS.
2. City of Brampton's Digital Innovation Team will provide access to the BAS vendor to the existing server to install, interface and configure the new/existing BAS.

2.17.3. Server supplied by vendor for BAS operations is not acceptable. BAS Vendor is responsible to interface the new/existing BAS to the available server.

2.17.4. All trends, graphs and database will be residing in the existing Virtual Server. Contact Energy Management group for details.

2.18 BAS Workstation

2.18.1. A BAS workstation is not to be provided because the City of Brampton utilizes a Virtual Server model, the BAS shall be accessed remotely from any terminal.

2.18.2. A BAS Workstation's purpose is to provide a remote terminal to access the BAS which is installed in the server.

2.19 Permits and Fees

2.19.1. It is the responsibility of the contractor to apply for, obtain and pay for all permits, licenses, inspections, certificates, examinations and fees as required.

2.19.2. Vendor to arrange for inspection of all work by the authorities having jurisdiction over the Work. The final certificate of the inspecting authorities are to be presented to the Engineer for approval.

2.19.3. Comply with the requirements of the latest edition of the applicable ULC or CSA standards, the requirements of the Authorities, Federal, Provincial/Territorial and Municipal Codes, the applicable standards of ULC and all other authorities having jurisdiction. These Codes and Regulations constitute an integral part of these Specifications.

2.19.4. In case of conflict, applicable Codes take precedence over the Contract Documents.

2.19.5. Before starting any work, submit the required number of copies of documentation to the authorities for their approval and comments. Comply with any changes requested as part of the Contract, but notify the Engineer immediately of such changes, for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required.

2.20 Close Out Procedures, Documentation and Submittals

2.20.1. The contractor shall provide all required hardware and software necessary to implement the functions shown or as implied in the contract documents.

2.20.2. If a dedicated configuration tool is provided, it is preferable that it be launched from within the applicable Network Management Software. If not, any software required for controller configuration shall be included as a leave-behind tool with enough license capability to support the installation and future operational troubleshooting.

2.20.3. Upon job completion, complete the following checklist to ensure all documents have been provided:

Item#	Reference	Comment
1.	Warranty Letter	☐ Received
2.	Resource files with sequences and configuration files	☐ Received
3.	Start-up Reports for Equipment	☐ Received ☐ No Deficiency
4.	Balancing Report (if applicable)	☐ Received ☐ No Deficiency
5.	O&M Manual	☐ Received Final No Comments
6.	As-Built	☐ Received Final Electrical Version

Chapter 3. Product Guidelines

3.1 General

3.1.1. This section defines the Basic Materials and Methods provided by the Controls Contractor and used in the installation of BACnet Control products to provide the functions necessary for control of the mechanical systems on this project. Please be advised that the requirements of this guideline will be strictly enforced. Systems that do not meet the requirements of the guideline as outlined below will not be accepted.

3.1.2. The contractor shall provide all controls and sequence of operations as required by these guidelines and by the drawings. Provide all required devices, sensors, hardware, software, wiring, controllers, etc. including any required and not specifically addressed in this guideline but required for system functionality. It shall be the responsibility of the contractor to provide a complete and functional system.

3.2 Hardware

3.2.1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135 (latest), and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.

3.2.2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135 (latest).

3.2.3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135 (latest), and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

3.2.4. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135 (latest), and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.

3.2.5. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135 (latest), and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

3.2.6. Controllers shall implement the full ANSI/ASHRAE 135 BACnet protocol (latest). Controllers must meet all of the requirements of this standard and must adhere to all of the protocol definition set forth by ANSI. All controllers shall be able to co-exist and interoperate on the BACnet network without interfering or limiting other controller's functionality. Controllers shall be able to be installed by any standard BACnet Network Services based network management tool.

3.2.7. Vendor to install BAS on city's server. A local Personal Computer may be installed on site by the City of Brampton to help aid system configuration and monitoring. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data, network management, and as a GUI. If the PC is taken off line, the control system shall continue to operate fully.

3.2.8. Controllers shall contain non-volatile memory for storage of control programs, configuration, and set-points. All such data shall be retained in the event of a power failure. At least one controller shall have an on-board (battery or "super cap" backed) real-time clock to ensure correct time-of-day operation following a power failure. Controllers that are not backed-up in the event of a power failure and that require time based operation (VAV's, heat pumps, etc.) shall be peers on the network and be able to obtain time synchronization from a power fail protected controller and/or controllers upon network power restore

3.2.9. BACnet devices

1. Only BACnet certified devices will be accepted on the control network. BACnet compatible, BACnet compliant, and variations for controllers are not acceptable. Refer to table 7.6 on what points to be accessible through BAS using BACnet integration
2. Any controller that does not meet this guideline must be stated and submitted with specific reason why it is not BACnet certified.
3. Any custom software required for controller programming shall be included as a leave-behind tool with enough license capability built into the bid to support the installation. If configuration tool not allowed to leave behind, equipment is not to be specified or installed. Refer to Appendix A, Table 9.6 regarding what points are to be accessible through BAS using BACnet integration

3.2.10. Incorporate Uninterruptible Power Supply surge transient protection in the installation of the system to protect electrical components in all BACnet controllers, remote controllers, and operator's workstations.

3.3 Network

3.3.1. BACnet routing shall be performed by BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.

3.3.2. Each SS and SA shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using MS/TP (minimum speed of 78.8 kbps) Data Link/Physical layer protocol.

3.3.3. IP switches will be specified by City of Brampton Digital Innovation Team. BAS vendor to contact City of Brampton Digital Innovation Team Department.

3.3.4. Vendor to use existing CoB Virtual servers.

3.3.5. MS/TP network design

1. Each ASC and AAC shall reside on a BACnet network using the MS/TP (minimum speed of 78.8 kbps) Data Link/Physical layer protocol.

3.4 IP Network design

1. Each ASC and AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing.

3.5 Open Protocol

3.5.1. New and existing installations use BACnet for all aspects of communication, including workstation, field panel, custom application controller and unitary controller communications and are commonly referred to as native BACnet systems.

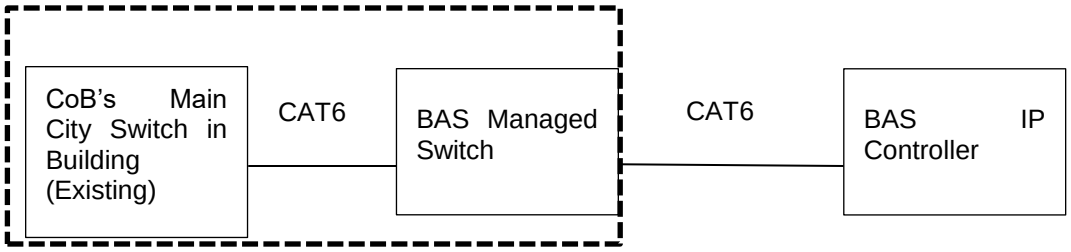
3.5.2. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

3.5.3. Provide BACnet based products that communicate on multiple channels to meet the functional guidelines as indicated on the Drawings and the dedicated product functional guidelines and profiles specified in other sections.

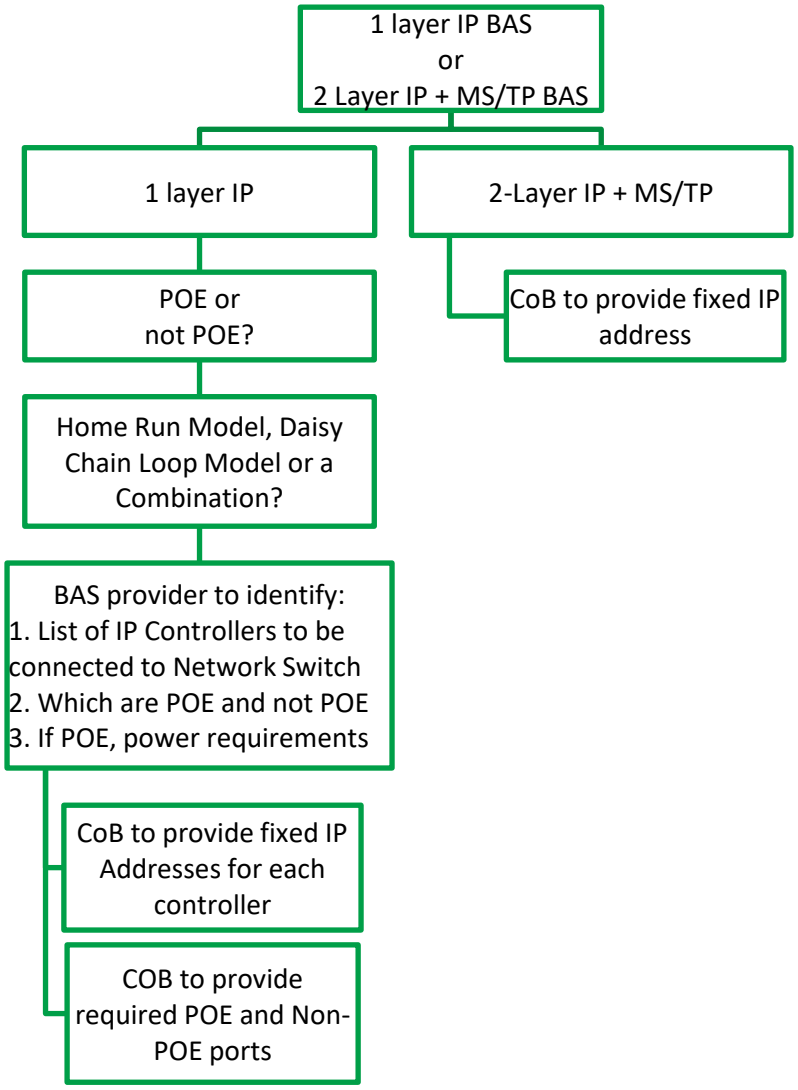
3.5.4. Provide BACnet/IP routers and repeaters as required to combine different communication channels onto a central field bus or as required to segment groups of Intelligent Devices and/or Control Units.

3.5.5. BACnet address should not be duplicated with any of the existing equipment city wide. Correct any issues with conflicting BACnet addresses on the City Network and verify with EMG for any available BACnet addresses. If the equipment is open to the network name the unit (site location/equipment name).

3.5.6. IP drops will be provided by the BAS contractor, but part of the design and selection of the equipment will be done by the City of Brampton as defined in schematic below. The cost of the entire scope to be under BAS contractor.



3.5.7. IP addresses will be provided by City of Brampton Energy Management group. Vendor to coordinate with city.



3.5.8. The wireless field bus system shall employ ZigBee 3.0 or the latest technology to create a wireless mesh network that provides wireless connectivity for BACnet devices at multiple system levels. Controls installer shall verify wireless network performance including online status verification and signal strength for all wireless connected devices and provide a printed report detailing network and wireless device status. All wireless devices shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems. Wireless devices shall be FCC compliant to CFR Part 15 subpart B Class A. Wireless devices shall operate on the 900MH / 2.4 GHZ ISM Band. (Not all BAS systems utilize wireless controls so please contact City of Brampton's Energy Management Group for further direction on wireless implementation).

3.6 Wiring and Raceway

3.6.1. Provide wire, raceway systems, 24 VDC and/or 24 VAC power supplies and final connections to nodes provided by this contract. Must comply with electrical (Division) requirements.

3.6.2. BAS Vendor to coordinate with Digital Innovation Team department to ensure all color coding matches City of Brampton's standards.

3.6.3. Conduit to be installed to accommodate the space conditions. Electrical metallic tubing EMT with compression type fittings in dry locations; cold rolled steel zinc coated or zinc coated rigid steel with threaded fittings in wet locations or where exposed to weather, such as, but not limited to the case with rooftop units. In special areas with potential exposure to chemicals, such as, but not limited to pools, install site-specific conduit

3.7 User Interface/Operator Work Station (OWS) Hardware and Telecommunication Protocols

3.7.1. City of Brampton's Digital Innovation Team department has a life cycle standard program for all Hardware and software pertaining to PC, laptop, printer and other work station's hardware. BAS Contractor is to follow the Digital Innovation Team (CoB) guidelines/guidelines for hardware, printer(s), software and telecommunications protocols.

3.7.2. Project Manager, Project Coordinator and Digital Innovation Team's Project Manager will validate the supply and installation of workstation(s) and peripheral devices.

3.8 Temperature Sensors

3.8.1. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.

3.8.2. Strap-on mountings shall not be permitted.

3.8.3. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel. In special areas with potential exposure to chemicals, such as, but not limited to pools, install site-specific enclosures.

3.8.4. Thermostats to be installed on the north wall or shaded from direct sunlight.

3.8.5. Sensors shall be with enclosure where located in finished space.

3.8.6. Sensors not to be installed close within close proximity to a diffuser.

3.8.7. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.

3.8.8. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to affect proper flow across the entire area of the well.

3.9 Graphical Requirements

3.9.1. Main Screen to have 3D image of the building with each floor identified and clickable. On the bottom of the screen, all major base-building units to be listed and upon selection, will navigate the user to that system's graphics

3.9.2. Summary screen of the main base-building items and analytics

3.9.3. Summary screen of all the field equipment

3.9.4. All sequence of operations will be on the graphics. It will be an individual screen that will be accessible through a clickable icon on the graphics page of its associated unit.

3.9.5. Alarms to be visible in a separate pane at all times

3.9.6. A tree structure on a pane always visible will provide the hierarchy of all units on the BAS. This is to be the main navigation bar and will be use to quick-navigate to any unit.

3.9.7. Each floor plan will be shown on the graphics. The floor plans will indicate the Terminal Units serving the areas and include the Terminal Unit's setpoints and current temperature. Additionally, each floor plan will be color coded to represent the AHUs serving the field equipment. This color code will be provided as a legend on the graphics.

3.9.8. Typical AHU graphics will include the name of the unit and what it serves on the top of the page. The AHU will show all its input/output points on the graphics and will also include the setpoints. OAT will be shown on the top right.

3.9.9. Field units such as, but not limited to, VAV, Radiators, and Heat Pumps to display an image of the unit and any associated equipment. All controls parameters to be displayed on the page in an orderly fashion.

3.9.10. Main Heating and Cooling system to have a dedicated graphics page.

1. In the cooling system, the evaporator side to be blue, with the supply, colder fluid being a lighter shade. In the condenser side, green color is to be used, with the cooler fluid return from the heat rejection to be a lighter shade.
2. In the heating system, red is to be used. The return, colder fluid is to be a lighter shade of red.
3. Lighter shade always to mean colder

3.9.11. All input/output points to be displayed on the graphics and will also include the setpoints.

3.9.12. Anything that is in normal operation will be in black text. Anything that is in manual override or alarm will be in red.

3.9.13. Trend logs should also be visible from the main graphics screen.

3.9.14. The entire network architecture to be provided on the graphics.

Chapter 4. Execution Guidelines

4.1 Strategical Meetings

4.1.1. BAS Vendor to schedule meetings at all milestones with the departments listed in Section4 to ensure all milestone are captured.

4.1.2. Kick-Off meeting with the owner to discuss applicable items

1. Timelines and deliverables
2. Integration with other base-building systems
3. Network Infrastructure
4. Basic versus Advanced Energy Management requirements
5. If existing building, discuss with Building Operator minimum requirements

4.1.3. Strategic Meeting with building stakeholders

1. Life Safety Guideline. Inquire about what are some life safety guidelines we should incorporate into the BAS design.
2. Discuss energy efficient sequences and their applicability to building requirements.

4.1.4. Coordination meeting with Commissioning Agent

1. Commissioning Agent to be involved with the project at all milestones.

4.2 Cabinets

4.2.1. All supervisory controllers to be installed in cabinets.

4.2.2. Cabinets must be in accessible spaces, such as, but not limited to closets, mechanical rooms allowing for operator to easily work on the system.

4.2.3. Controllers and Cabinets must be clearly marked and identified on control drawings.

4.2.4. Each cabinet must have a set of control drawings and sequence of operations specific to the systems it's controlling.

4.3 Tagging and Identification

4.3.1. Automatic Control Valve Tags

1. For valves, etc., use metal tags with a 2-inch minimum diameter, fabricated of brass, stainless steel or aluminum. Attach tags with chain of same materials. For lubrication instructions, use linen or heavy duty shipping tag.
2. Tag valves with identifying number and system. Number valves by floor level, column location and system served.
3. Prepare lists of all tagged valves showing location, floor level, and tag number use. Prepare separate lists for each system. Include copies in each maintenance manual.

4.4 Wire Tags

4.4.1. Vendor to contact with City of Brampton Digital Innovation Team to accommodate wiring standards and colors.

4.4.2. Wires will be labelled with controller instance number, point type and number and brief definition. For example: 10110.AI4.SAT

4.4.3. Conduit Tags and Equipment

1. Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this work.

4.4.4. Miscellaneous Equipment Identification

1. Screwed-on, engraved black lamacoid sheet with white lettering on all control panels and remote processing panels. Lettering sizes subject to approval.
2. Inscription (subject to review and acceptance) indicating equipment, system numbers, functions and switches. For panel interior wiring, input/output modules, local control panel device identification.

4.5 Testing and Commissioning

4.5.1. Provide field calibration, testing and commissioning of equipment as specified herein.

4.5.2. Provide detailed start-up and system commissioning report (three copies) to the client. A third password

4.5.3. Commissioning agent (CA) will commission (CX) the entire new system. The CA will provide the detailed report to the consultant/engineer for review. The CX report shall be reviewed and stamped by the consultant/ engineer to ensure that system is commissioned properly and quality is maintained as per client's guide lines and standards.

4.6 Instruction of Owner Operating Personnel (Operator's Training)

4.6.1. All training shall be by the Controls Contractor and shall utilize specified manuals, as-built documentation, the on-line help utility and any other appropriate training materials. Operator training shall include:

1. Two (2) initial eight (8)-hour sessions for a group of four (4) people.

4.6.2. The initial operator-training program shall be to establish a basic understanding of functions, commands, routines, etc. and shall assume attendees have a sound working knowledge of the Windows operating system and PC use. The training shall encompass as a minimum:

1. Troubleshooting of input devices (i.e. bad sensors)
2. Sequence of operation review
3. Trends
4. Logic
5. Sign on - sign off
6. Selection of all displays and reports
7. Commanding of points (keyboard and mouse mode)
8. Modifying label text
9. Use of all dialogue boxes and menus
10. System initialization
11. BACnet Network Management Software (if applicable)

4.6.3. Provide a single software tool for setting up the system and configuring the operator/user interface. System and user interface functions shall include system command capability, system monitoring, system diagnostics and data archiving

4.7 Preventative Maintenance

4.7.1. There will be an ongoing list where the building operators will identify issues pertaining to the BAS. The BAS vendor is to only address these issues during the preventative maintenance.

4.7.2. The BAS vendor will provide list of corrected issues at the end of the preventative maintenance visit, which will be signed off by the building operator. If a Building Operator sign off is not provided, invoice of preventative maintenance will not be approved.

4.7.3. Maintenance contractor to provide report on the same day for invoices to be approved

4.7.4. Issues to be filled in the following template

Building	Unit	Issue

4.8 Disposal of material

4.8.1. BAS vendor to contact the Energy Management team to coordinate what is to be done with the redundant material that will be disposed. For example, controllers, actuators, sensors, etc.

Chapter 5. Contact Information

This is a list of contact information within the City of Brampton that has been referenced in this guideline.

Reference	Department	Role to Contact
Energy Management Team	Facilities Operations & Maintenance	Project Coordinator, Energy Management
Asset Management Team	Facilities Operations & Maintenance	Advisor, Asset Management
Digital Innovation and Technology	Digital Innovation and Technology	Project Manager

Chapter 6. Schedule of Responsibilities

The following schedule identifies the responsible Division for the installation of the facility automation system and should be used as a general guide. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Architect.

	Item		Furnish by:	Install by:	Power by:	Control wiring by:
1	Equipment Motors		M	M	E	---
	Magnetic Motor Starters:					
2	A)	Automatically controlled with or without HOA switches	E	E	E	TCC
3	B)	Manually controlled	E	E	E	---
4	C)	Manually controlled, and which are furnished as part of factory wired equipment	M	M	E	E
5	D)	Special duty type (part winding, multi-speed etc.)	M	See note 1	E	See note 1
6	E)	Adjustable frequency drives with manual bypass	TCC	TCC	E	See note 2
7	F)	Domestic booster pump motor controls	M	M	E	TCC
8	General equipment disconnect switches, thermal overload switches, manual operating switches		E	E	E	---
9	Sprinkler system water flow and tamper switches		M	M	E	---
10	Outside fire alarm horn and light (at Siamese connection)		M	M	E	---
11	Line voltage contactors		E	E	E	TCC
12	Control relay transformers (other than starters)		TCC	TCC	E	TCC
13	Main fuel oil tank alarms (high and low level) and remote indicating lights		M	M	TCC	TCC
14	Day tank fuel oil alarms (high and low level) and remote indicating lights		E	E	E	TCC

	Item		Furnish by:	Install by:	Power by:	Control wiring by:
15	Line voltage control items (e.g.: line voltage t-stats not connected to control panel		M	E	E	E
16	Loose control and instruments furnished as part of the mech. Equip. or		M	M	M	M
17	Control and instrumentation panels		TCC	TCC	E	TCC
18	Automatic control valves, automatic dampers and damper operators/actuators,		TCC	M	E	TCC
19	Duct type fire and smoke detectors including relays for fan shut-down		TCC	TCC	E	TCC
20	Contactors for cooling tower basin heaters		M	M	E	M
21	Mechanical piping heat trace (inc. relays, contactors, t-stats etc.)		M	M	E	M
22	Emergency-Power-Off (EPO) shutdown push-button(s), (break-glass station) and		M	M	M	M
23	Control interlock wiring or software bindings between chillers, pumps and cooling		TCC	TCC	E	TCC
24	Electric radiant heating panels, un-ducted electric unit heaters and cabinet		E	E	E	E
25	Airflow control device with transmitter		TCC	M	E	TCC
26	Air terminal devices (e.g. VAV boxes)		M	M	E	TCC
	Intelligent devices and control units provided with mechanical equipment such as, but not limited to:					
27	A)	Valve and damper operators	M	M	E	TCC
28	B)	Heat pumps, AC units	M	M	E	TCC
29	C)	Fan coil units	M	M	E	TCC
30	D)	Air terminal units	M	M	E	TCC
31	E)	Boilers, Chillers, etc.	M	M	E	TCC
	Intelligent devices and control units provided with electrical systems such as, but not limited to:					
32	A)	Occupancy/motion sensors	E	E	E	TCC

	Item		Furnish by:	Install by:	Power by:	Control wiring by:
33	B)	Lighting control panels	E	E	E	TCC
34	C)	Switches and dimmers	E	E	E	TCC
35	D)	Switch multiplexing control units	E	E	E	TCC
36	Door Entry Control units		TCC	TCC	E	TCC
37	Gateway for protocol conversion with non-BACnet/ WAN based systems		TCC	TCC	TCC	TCC
38	Routers, bridges and repeaters		TCC	TCC	TCC	TCC
	Abbreviations:					
39	E	Electrical Contractor				
40	M	Mechanical Contractor				
41	Power	Power wiring connection, low and medium voltage				
42	TCC	Temperature Controls Contractor				

Notes to Schedule of Responsibilities:

I. Magnetic motor starters (special duty type) shall be set in place under electrical division except when part of factory wired equipment, in which case set in place under mechanical division.

II. Where a remote motor disconnect is required in addition to the one provided integral to an Variable Frequency Drive (VFD), the Controls Contractor shall provide the necessary control interlock between the disconnects.

III. The Controls Contractor shall inform the Mechanical Contractor and the Electrical Contractor of the additional capacity required of control power transformers.

IV. The Mechanical Contractor shall refer to the electrical specifications and plans for all power and control wiring and shall advise the Architect of any discrepancies prior to bidding. The Controls Contractor shall be responsible for all control wiring as outlined, whether called for by the mechanical or electrical drawings and specifications.

Chapter 7. **Abbreviations**

AAC	Advanced Application Controller		
AGC	Application Generic Controller	**GUI**	Graphical User Interface
ASC	Application Specific Controller	**HVAC**	Heating, Ventilating and Air
AWS	Advanced Workstation		Conditioning
BAS	Building Automation System	**ITC**	Intermediate
BMS	Building Management System		Telecommunications Closet
B-BC	Building Controllers	**I/O**	Input/Output
B-AAC	Advanced Application Controllers	**IP**	Internet Protocol
B-ASC	Application specific controllers	**WAN**	Wide Area Network
B-SS	Smart Sensors	**NSS**	Network Services Server
B-SA	Smart Actuators	**NSI**	Network Services Interface
CA	Commissioning Agent	**NFPA**	National Fire Protection
CAC	Custom Application Controller		Association
CoB	City of Brampton	**OI**	Operator interface
COS	Change of State	**OS**	Operating System
CPU	Central Processing Unit	**OWS**	Operating Work Station
CX	Commissioning	**PE**	Pneumatic-electric
DDC	Direct Digital Controller	**PID**	Proportional Integral Derivative
		POE	Power over Ethernet
DPR	Damper	**PRV**	Pressure Reducing Valve
DPU	Digital Point Unit	**PSI(g)**	Pounds per square inch (gauge)
DRF	Device Resource File	**RAM**	Random Access Memory
DWGS	Drawings	**SCADA**	Supervisory Control and Data
EMCS	Energy Monitoring Control System		Acquisition System
EP	Electric-pneumatic	**TCS**	Temperature Control System
FAS	Facility Automation System	**TCC**	Temperature Control Contractor
FPB	Fan Powered VAV Box	**UL**	Underwriters' Laboratory
FPM	Feet per minute	**VAV**	Variable Air Volume
FACP	Fire Alarm Control Panel	**VCS**	Voice Communication System
FCC	Fire Command Center	**WC**	Water Column
FMS	Fire Management System	**XIF**	External Interface File
GPM	Gallons per minute		

Chapter 8. Building Automation System Design Checklist

8.1 Best Practices - Building Automation Systems Design Checklist (Office facilities)

Equipment Description	BAS Function/Strategy	Outside air temp	Water temperature	Space temperature	Burner control	Pump control	Supply air temperature	Mixed air temperature	Htg & clg coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Humidity Control	Chiller output control	Slide valve position feedback	System suction pressure	System head pressure	Lighting control	Photo sensor	Snow Sensor
Hot water boilers	Reset water temperature.	✓	✓																		
	Boilers to run in lead/lag function switching every Tuesday to ensure equal runtime. Alternatively, utilize boiler manufacture sequencer.				✓																
	Ensure complete modulating control or proper hi-low control.				✓																
	Maintain one setpoint and stage using time interval rather than error from setpoint..		✓		✓																
	Stop circulating water through non-firing boilers.					✓															
Heating water	Reset water temperature with outside air temperature.	✓	✓																		
	Reset water temperature from building space temperatures	✓		✓																	
Air systems	Supply air temperature reset from outside air temperature.	✓					✓		✓	✓											
	Trim supply air temperature setpoint with feedback from spaces.			✓			✓		✓	✓											
	Mixed air control - calculate and control to minimum ventilation	✓								✓	✓										
	Integrated economizer (provide required supply air temperature)						✓	✓		✓											
	Scheduling - minimize scheduled time											✓									
	Scheduling - optimal start	✓		✓					✓	✓		✓									
	Scheduling - no outside air when systems operate in unoccupied hours	✓		✓					✓	✓		✓									
	Occupancy sensing - operate fan or open outside air dampers only when occupied	✓		✓						✓		✓	✓								
	Set relative humidity to minimum required. As per ASHRAE guidelines, 30% min (Winter), 60% max (Summer).													✓							
	Reset humidity at very low temperatures	✓												✓							
	Space pre-cool (morning)	✓		✓					✓	✓		✓									
DHW	Schedule recirculation pump for occupied periods only					✓															
	Reduce setpoint to minimum required temperature initially set at 60C		✓																		
	Profile tank water temperature - reduced temperatures will reduce recirculation heat loss		✓																		
	If tank separate from heater, do not circulate water through non-firing heater		✓			✓															
Cooling	Reset supply water temperature up if building systems are not variable flow		✓												✓						
	Shut off chiller when no cooling required	✓		✓											✓						
	Shut off chilled water pumps when cooling not required	✓		✓																	
	Sequence operation of different size chillers to optimize operation		✓												✓						
	Sequence operation of different size cooling towers to optimize operation.		✓									✓									
	Sequence lead-lag operation of cooling towers to operate at best efficiency.		✓									✓									
Zone control	Occupancy sensing to shut off constant volume or variable volume boxes plus lights.			✓									✓						✓		
Lighting**	Schedule																		✓		
	Photo sensor control																		✓	✓	
Snow melting	Use snow sensor				✓																✓
Outdoor lighting	Schedule																		✓		
	Trim schedule using photo sensor																		✓	✓	

Equipment Description	BAS Function/Strategy	Outside air temp	Water temperature	Space temperature	Burner control	Pump control	Supply air temperature	Mixed air temperature	Htg & clg coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Humidity Control	Chiller output control	Slide valve position feedback	System suction pressure	System head pressure	Lighting control	Photo sensor	Snow Sensor
	Trim schedule using sunset-sunrise calculation																		✓		

8.2 Best Practices - Building Automation Systems Design Checklist (Recreational Pool)

Equipment Description	BAS Function/Strategy	Outside air temp	Water temperature	Space temperature	Burner control	Heat exchanger control	Pump control	Supply air temperature	Htg & clg coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Space humidity sensor	Lighting control	Photo sensor	Turbidity sensor
Pool circulation pump	Speed modulation based on turbidity						✓										✓
Pool water heater	Reset of pool heating water temperature based on usage		✓			✓											
Air system	Start/stop based on weekly schedule and humidity sensors											✓		✓			
	Supply air temperature reset from outside air temperature.	✓						✓	✓	✓							
	Trim supply air temperature setpoint with feedback from spaces			✓				✓	✓	✓	✓						
HID Lighting	Occupancy sensors used for dimming, if Hi-Lo ballasts installed.												✓		✓		
DHW heaters	Start/stop and modulated firing controls, minimize short cycling of heaters.				✓												
DHW recirculation pumps	Start/stop based on weekly schedule with override based on flow switch						✓										
Hot Water Boilers	Start/stop and modulated firing controls, minimize short cycling of heaters. Minimum runtime of 15minutes				✓												
Heating Water circulation	Start/stop interlock with boiler and programmable delay				✓		✓										
Unit Heaters	Programmable setpoint thermostats with occupancy override												✓				
Heating water convectors	Programmable setpoints thermostats with occupancy override			✓		✓							✓				

8.3 Best Practices - Building Automation Systems Design Checklist (Arenas)

Equipment Description	BAS Function/Strategy	Outside air temp	Water temperature	Space temperature	Burner control	Pump control	Supply air temperature	Mixed air temperature	Htg & clg coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Chiller output control	Slide valve position feedback	System suction pressure	System head pressure	Lighting control	Photo sensor	Ice temperature	Brine heat exchange control	CO2 sensor
Ammonia Compressors	Reset suction pressure using brine temperature setpoint		✓													✓						
	Optimize staging using slide valve position/compressor loading													✓	✓							
	Optimize staging by varying permissible suction pressure differential													✓		✓						
	Optimize staging using load bias (varying sized compressors/condensers)													✓	✓							
Glycol brine circ. pumps	Start-stop using ice temperature					✓														✓		

Equipment Description	BAS Function/Strategy	Outside air temp	Water temperature	Space temperature	Burner control	Pump control	Supply air temperature	Mixed air temperature	Htg & clg coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Chiller output control	Slide valve position feedback	System suction pressure	System head pressure	Lighting control	Photo sensor	Ice temperature	Brine heat exchange control	CO2 sensor
	Schedule with activities					✓																
Glycol/brine heat exchanger	Reset ice temperature with scheduled activities			✓																✓	✓	
	Optimize start for scheduled activities			✓																		
	Schedule with occupancy/photocell override			✓									✓						✓			
Evaporative condenser fans	Reset condenser water temperature using outside air temperature	✓	✓																			
	Reset head pressure using outside air temperature	✓															✓					
	Optimize staging based on two-speed/variable speed fans										✓											

8.4 Best Practices - Building Automation Systems Design Checklist (Arenas) Continued

Equipment Description	BAS Function/Strategy	Outside air temp	Water temperature	Space temperature	Burner control	Pump control	Supply air temperature	Mixed air temperature	Htg & clg coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Chiller output control	Slide valve position feedback	System suction pressure	System head pressure	Lighting control	Photo sensor	Ice temperature	Brine heat exchange control	CO2 sensor
Lighting	Schedule with activities - minimize operating hours																	✓				
	Schedule with activities - use occupancy sensors to optimize												✓					✓				
	Schedule HID Hi/Low dimming with activities - minimize operating hours																	✓				
	Schedule HID Hi/Low dimming with activities - use occupancy sensors to optimize												✓					✓				
DHW	Schedule recirculation pump for occupied periods only \					✓																
	Reduce setpoint to minimum required temperature		✓		✓																	
	Profile tank water temperature-lower temperatures will lower recirculation heat loss		✓		✓																	
	If tank separate from heater, do not circulate water through non-firing heater		✓			✓																
	Maximize on-time by 1st on 1st off				✓																	
Gas-fired infrared heaters	On-off using programmable blackbody thermostats			✓	✓																	
	On-off using programmable blackbody 'stats & occupancy sensor			✓	✓								✓									
Exhaust fans	Schedule											✓										
	Occupancy override to schedule											✓	✓									
Supply air systems	Scheduling - minimize scheduled time											✓										
	Occupancy override to schedule											✓	✓									
	Scheduling - optimal start	✓		✓					✓			✓										
	Control outside air volume to occupancy requirement using CO2						✓															✓

Equipment Description	BAS Function/Strategy	Outside air temp	Water temperature	Space temperature	Burner control	Pump control	Supply air temperature	Mixed air temperature	Htg & clg coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Chiller output control	Slide valve position feedback	System suction pressure	System head pressure	Lighting control	Photo sensor	Ice temperature	Brine heat exchange control	CO2 sensor
	Integrated economizer	✓					✓	✓		✓	✓											
	Trim supply air temperature setpoint from space temperature			✓			✓															

8.5 Integration Matrix

M = monitor, C = Command and Control, S = Scheduling

	Building Automation	Lighting Control	Existing Metering (ele,H2O,gas)	Emergency Power	Fire Alarm	Access Control	Video Surveillance	Intercom	Mobile Alert System	Parking Control	Digital Signage/Advertising	Elevators	Public lobby WiFi	**Visualization – single pane of glass**	Fault Detection& Diagnostics	Building Engines - Tenant Engagement	Building Engines – Work Orders
Building Automation																	
Lighting Control	**C**																
Existing metering (ele, H2O, gas)	**M**																
Emergency Power	**M**																
Fire Alarm	M			M													
Access Control																	
Video Surveillance						**C**											
Intercom						**C**	**C**										
Mobile Alert System						**C**	**C**	C									
Parking Control																	
Digital Signage / Advertising																	
Elevators				C	C												
Public lobby WiFi	**M**																
Visualization – Single Pane of glass	**C/S**	**C/S**	**M**	**M**	**M**	**M**	**M**	**M**	**M**		**M**	**C/S**	**C**				
Fault Detection/Diagnostics	M	**M**	**M**	**M**										**M**			
Building Engines - Tenant Engagement	**S**	**S**									**M**	**C/S**					
Building Engines – Work Orders	**C**	**C**									**M**				**C**	C	

8.6 Point List Chart

	Outside air temp	Supply Water temperature	Return Water Temperature	Space temperature	Burner control	Chiller/Comp control	Pump control	Supply air temperature	Mixed air temperature	Unit Heating valves	Unit Clg Valves	Building Htg valves	Building Clg Valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Building Schedule	Slide valve position feedback	suction pressure	System head pressure	Ice temperature	Brine HX Controller	CO2 sensor	VFD on pumps	VFD on fans	Status, kW Consumption, Fault Code on station	Alarms			
																												Deviation from Setpoint	Pump/Fan Command vs Status	Time Delay (Minutes)	Priority
BOILER PLANT	B	B	B		B		B											B	P						P			10%	Y	10	HIGH
CHILLER PLANT	B	B	B			B	B					B	B					B	P						P			10%	Y	10	HIGH
RTU	V			V	V	V		B	V	V	V			V	V	B	P	P	V					P		P		20%	Y	10	MEDIUM
AHU	B	P	P				B	B	B	B	B			B	B	B	P	B	P					P	P	P		20%	Y	10	HIGH
DHW	B	B	P				B																		P			5%	Y	10	MEDIUM
VAV	B			B				P	P			B	B	B	P	B	P	B						P				10%		10	LOW
SNOW MELTING	B					B												B							P			5%	Y	10	HIGH
POOL CIRCULATION AND WATER HEATER	B	B	P	B	B		B			V							B	B							P			10%	Y	10	HIGH
AMMONIA COMPRESSOR	B	B	P	B		B	B			V	V									V	V	B	B		P			5%	Y	10	HIGH
HEAT EXCHANGERS	B	B	P x3				B			B															P			10%		10	MEDIUM
EVAPORATIVE CONDENSER FANS	B	B	B				B			B				P		B		B	P						P	P		15%	Y	10	MEDIUM
HEATPUMP	B	B		B		B										B	P	B						P		P		10%	Y	10	MEDIUM
RADIATORS	B	B	P	B			P			B							P	B						P				15%		10	MEDIUM
OIL RECEPTORS																													Y	10	LOW
LOCAL AC UNITS	P/V			B		P/V	P/V	P/V								P/V	B		P/V					P/V		P/V		10%	Y	10	LOW
EV CHARGING STATIONS																											B				

B – Basic Points to be included in all designs as a minimum

P – Premium Points to be included as required based on building's goals

V – Virtual Monitoring through integration (BACnet, MODbus)

This has been left intentionally blank.

1 General

1.1 SECTION INCLUDES

.1 Common requirements for electrical work.

.2 Mounting heights for electrical equipment and devices.

1.2 RELATED REQUIREMENTS

.1 Provisions of this section apply to all sections of Division 26, Division 27, Division 28, and sections related to electrical utilities in Division 33.

.2 Section 07 60 00 – Flashing and Sheet Metal.

.3 Section 07 84 00 – Firestopping.

.4 Section 08 31 00 – Access Doors and Panels.

.5 Section 09 91 00 – Painting.

.6 This section is to be read in conjunction with Division 00 documents, and Division 01 specification sections, which take precedence as described in CCDC 2-2008.

.1 General Conditions.

.2 Supplementary General Conditions.

.3 General Requirements.

1.3 INTENT

.1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter.

.2 Leave complete systems ready for continuous and efficient satisfactory operation.

.3 Discipline and Trade Jurisdiction

.1 In accordance with CCDC 2-2008 GC 1.1.7: Neither the organization of the Specifications nor the arrangement of Drawings shall control the Contractor in dividing the work among Subcontractors and Suppliers.

.2 MasterFormat's organizational structure used in a project manual does not imply how the work is assigned to various design disciplines, trades, or subcontractors. MasterFormat is not intended to determine which particular elements of the project manual are prepared by a particular discipline. Similarly, it is not intended to determine what particular work required by the project manual is the responsibility of a particular trade. A particular discipline or trade is likely to be responsible for subjects from multiple Divisions, as well as from multiple Subgroups.

1.4 DRAWINGS AND SPECIFICATIONS

.1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Consultant in writing before submitting Bid. If this is not done, the maximum, the most expensive alternate or option will be provided in base tender bid.

.2 All drawings and all Divisions of these specifications shall be considered as a whole, and work of this Division shown anywhere therein shall be furnished under this Division.

.3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of conductors and wiring is not assured. Exact requirements are governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or

addition of pull and junction boxes, etc. necessitated by such conditions are to be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.

.4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job.

.5 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made at no additional cost to the Owner.

.6 Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc. may not be shown, but where such items are required by other sections of the specifications of where there are required for proper installation of the work, such items are to be furnished and installed.

.7 Before ordering any conduit, cable tray, conductors, wireways, raceway bus duct, fittings, etc., verify all pertinent dimensions at the job site and be responsible for their accuracy.

.8 If obvious ambiguities or omissions are noticed when tendering refer same to the Consultant for a ruling and obtain the ruling in writing in the form of an Addendum. Claims for extras for ambiguities or omission of items brought to the attention of the Consultant after the award of a contract which, due to the nature of the ambiguity or omission, should have been brought to the attention of the Consultant during the tendering period, will not be allowed.

.9 The drawings are performance drawings, diagrammatic, and show locations for apparatus and materials. The drawings are intended to convey the scope of work and do not intend to show Architectural and Structural details. The locations shown are approximate, and may be altered, when approved by the Consultant, to meet requirements of the material and/or apparatus, other equipment and systems being installed, and of the building. Do not scale drawings.

.10 Provide any fitting, offset, transformation, etc., required to suit architectural and structural details but not shown.

1.5 WORK RESTRICTIONS

.1 Do all cutting, patching and making good to leave in a finished condition and to make the several parts of the Work come together properly. Co-ordinate work to keep cutting and patching to a minimum.

1.6 SUBSTITUTION PROCEDURES

.1 Refer to Division 01 and General Provisions of the Contract.

.2 Additionally, "Approved Equal" shall be defined as an alternate approved by the Consultant.

.3 Requests for alternates are not accepted during the bidding period.

.4 Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.

.5 This contractor, at his option, may use equipment as manufactured by the other manufacturers if listed. This contractor is responsible to ensure that all items submitted by these other manufacturers meets are requirements of the drawings and specification and fits in the allocated space. The final determination of a product being equivalent is to be determined by the Consultant when a catalog number is not listed, or listed in part.

.6 Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Consultant as described in the General Provisions of the Contract for Submittals. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of the design. The Owner or the Consultant may reject manufacture at time of shop drawing submittal.

1.7 CONTRACT MODIFICATION PROCEDURES

.1 When submitting quotations in response to changes in the contract, quotations for electrical work are to include a breakdown of all material, including material unit rates, and labour units as indicated in the NECA Manual of Labor Units (MLU).

1.8 COORDINATION

.1 Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under other trades that require electrical connection. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

.2 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.

.3 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades. Co-operate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other trades.

.4 Coordinate utility service outages with the owner. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.

.5 Co-ordinate work with all trades to ensure a proper and complete installation. Notify all trades concerned of the requirement for openings, sleeves, insets and other hardware necessary for the installation and, where work is to be integrated with the work of other trades or is to be installed in close proximity with the work of other trades, carefully co-ordinate the work prior to installation.

.6 Working Detail Drawings

.1 The contractor is to prepare working detail drawings supplementary to the contract drawings, when deemed necessary by the Consultant, for all areas where a multiplicity of materials and or apparatus occur, or where the work due to architectural and structural considerations involves special study and treatment. Such drawings may be prepared jointly by all trades affected, or by the one trade most affected with due regard for and approval of the other trades, all as the Consultant will direct in each instance. Such drawings must be reviewed by the Consultant before the affected work is installed.

.2 Carry out all alterations in the arrangement of work which has been installed without proper study and approval, even if in accordance with the contract documents, in order to make such work come within the finished lines of walls, floors and ceilings, or to allow the installation of other work, without additional cost. In addition, make any alterations necessary in other work required by such alterations, without additional cost.

1.9 SUBMITTAL PROCEDURES

.1 Before delivery to site of any item of equipment, submit shop drawings complete with all data, pre-checked and stamped accordingly, for review by the Consultant. Indicate project name on each brochure or sheet, make reference to the number and title of the appropriate specification section, type identifier such panelboard ID or luminaire type as indicated on appropriate schedule, and provide adequate space to accommodate the Consultant's review stamp(s).

.2 Verify field measurements and affected adjacent Work are coordinated, including passageway clearances for movement of equipment into location.

.3 Submit shop drawings to the Consultant in electronic (PDF) format, as coordinated after award of contract. Where submittals are derived from digital originals, do not print and rescan documents; submittals made as such will be immediately rejected.

.4 Submit a schedule of shop drawings within one week after award of contract. Group submittals by specification division as appropriate.

.5 Shop Drawings

.1 Submit for review, properly identified shop drawings showing in detail the design and construction of all equipment and materials as requested in sections of the specification governed by this Section.

.2 Obtain and comply with the manufacturer's installation instructions.

.3 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS", stamp each copy with your company name, date each copy with the submittal date, and sign each copy. Shop drawings which are received and are not endorsed, dated and signed will be returned for re-submittal.

.4 The Consultant will stamp shop drawings as follows:

.1 Reviewed ( )

.2 Reviewed as Modified ( )

.3 Revise and Re-Submit ( )

.4 Not Reviewed ( )

.5 If "REVIEWED" is checked-off, the shop drawing is satisfactory. If "REVIEWED AS MODIFIED" is checked-off, the shop drawing is satisfactory subject to requirements of remarks put on shop drawing copies. If "REVISE AND RE-SUBMIT" is checked-off, the shop drawing is entirely unsatisfactory and must be revised in accordance with comments written on shop drawing copies and resubmitted. If "NOT REVIEWED" is checked-off, the shop drawing is in error of submission, not applicable for this project.

.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 the Contractor, and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the contract documents. Be 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 as well as compliance with codes and inspection authorities such as CSA, etc.

1.10 SAFETY REQUIREMENTS

.1 Be responsible for the safety of workers and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations prevail.

1.11 REGULATORY REQUIREMENTS

.1 Codes and Standards

.1 Ontario Electrical Safety Code c/w Bulletins and Amendments.

.2 Ontario Building Code and its referenced standards.

.3 Applicable CSA and ULC Standards.

.4 All work shall be in accordance with Owner’s Design Guidelines.

.2 Permits and Fees

.1 Obtain and pay for all permits and fees required for the execution and inspection of the electrical work and pay all charges incidental to such permits. Submit to Electrical Inspection Department and Supply authority necessary number of drawings and specifications for examination and approval prior to commencement of work. Arrange and pay for any special inspection of equipment specified if and when required.

.2 Apply, pay and obtain all permits as required for the electrical work.

.3 Upon substantial completion of your work, supply and turn over to the Consultant all required inspection certificates from governing authorities to certify that the work as installed conforms to the rules and regulations of the governing authorities.

.3 Patents

.1 Pay all royalties and licence fees, and defend all suits or claims for infringement of any patent rights, and save the Owner, Architect, Project Manager and Consultants 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 REFERENCES

.1 Canadian Standards Association

.1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.

.2 CSA C235:19, Preferred voltage levels for AC Systems up to 50 000 V.

.3 Do underground systems in accordance with CSA C22.3 No. 7-15, Underground systems, except where specified otherwise.

.4 Ontario Electrical Safety Code (OESC) 27th Edition, 2018, and all bulletins.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

.3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 Electrical utility requirements and local applicable codes and regulations.

.5 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

.1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

.6 2012 Ontario Building Code.

1.13 DEFINITIONS

.1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.14 QUALITY ASSURANCE

.1 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.

.2 Ensure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

.3 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.

.4 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Consultant. Any unsatisfactory workmanship will be replaced at no extra cost.

.5 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this specification.

Electrical Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all electrical equipment and materials in dry locations.

.6 Provide foreman in charge of this work at all times.

.7 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker's Compensation, and Employer's Liability Insurance.

.8 Governing Federal, Provincial and Municipal codes and regulations will be considered minimum standards for the work and where these are at variance with the drawings and specification, the more stringent ruling will apply.

.9 Where any code, regulation, bylaw, or standard is quoted it shall mean the current edition including all revisions or amendments at the time of the tender.

.10 In case of conflict, the 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 referred to herein.

1.15 QUALITY CONTROL

.1 Provide a full time Superintendent to oversee and coordinate all sub-trades in these divisions.

1.16 TEMPORARY UTILITIES

.1 Do not use any of the permanent facility systems during construction except as may be specified, or unless written approval is obtained from the Consultant.

.2 The use of permanent facilities for temporary construction service will not affect in any way the commencement day of the warranty period.

.3 Temporary heating during the construction period will be provided as described in Division 01.

1.17 TEMPORARY FACILITIES AND CONTROLS

.1 Prior to start of each work period in occupied area, install temporary protection to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.

.2 Submit temporary protection plan to Owner's Representative for approval prior to use.

.3 Take necessary steps to ensure that required firefighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

1.18 PRODUCT REQUIREMENTS

.1 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.

.2 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical inspection Services, or other government agency.

.3 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.

.4 Materials required for performance of work shall be new and the best of their respective kinds and of uniform pattern throughout work.

.5 Materials shall be of Canadian manufacture where obtainable. Materials of foreign manufacture, unless specified, shall be approved before being used.

.6 Equipment items shall be standard products of approved manufacture. Identical units of equipment shall be of same manufacture. In any unit of equipment, identical component parts shall be of same manufacture, but the various component parts comprising the unit need not be of one manufacture.

.7 Chemical and physical properties of materials and design performance characteristics and methods of construction and installation of items of equipment, specified herein, shall be in accordance with latest issue of applicable Standards or Authorities when such are either mentioned herein, or have jurisdiction over such materials or items of equipment.

.8 Materials shall bear approval labels as required by Code and/or Inspection Authorities.

.9 Install materials in strict accordance with manufacturer's recommendations.

.10 Include items of material and equipment not specifically noted on Drawings or mentioned in Specification but which are necessary to make a complete and operating installation.

.11 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.

.12 Unless otherwise noted, equipment and material specifications in Sections of the Specification governed by this Section are based on products of a manufacturer selected by the Consultant for the purpose of setting a standard of quality, size, performance, capacity, appearance and serviceability.

.13 In most instances the names of acceptable manufacturers are also stated for materials and equipment, and you may base your tender price on equipment and materials produced by either the specified manufacturer or a manufacturer listed as acceptable.

.14 For any items of equipment, material, or for any system where acceptable manufacturers are not stated, you must provide only the equipment, material or system specified.

.15 If materials or equipment manufactured and/or supplied by a manufacturer named as acceptable are used in lieu of products of the manufacturer specified, be responsible for ensuring that the substituted material or equipment is equivalent in size, performance and operating characteristics to the specified materials or equipment, and it shall be understood that all costs for larger starters, additional space, larger power feeders, and changes to associated or adjacent work required as a result of providing materials and equipment named as acceptable in lieu of the specified product will be borne by Contractor.

.16 In addition to the manufacturers specified or named as acceptable, the Contractor may propose alternative manufacturers of equipment and/or apparatus to the Consultant for acceptance, listing in each case a corresponding credit for each alternative proposed, however, the tender price must be based on apparatus or materials specified or named as acceptable. Certify in writing to the Consultant that the alternative meets all space, power, design, and all other required of the specified or equivalent material or apparatus. In addition, it shall be understood that all costs for larger starters, space, power feeders, and changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed alternatives, will be borne by the party making the proposal. Alternative equipment requiring greater than specified energy requirements or unduly limiting service space requirements will not be accepted.

.17 Where a manufacturer is not listed for a particular product, it will be deemed to mean that the contractor will provide the specified manufacturer's product.

1.19 EXAMINATION AND PREPARATION

.1 Examine the site and surrounding areas and be fully informed as to the conditions and limitations under which the work has to be executed. Claims for additional costs will not be entertained with respect to conditions which could reasonably have been ascertained by an inspection prior to Tender closing.

.2 Examine work upon which your work depends. Report in writing defects in such work. Application of your work shall be deemed acceptance of work upon which your work depends.

.3 Drawings are, in part, diagrammatic and are intended to convey scope of work and indicate general and approximate location, arrangement and sizes of equipment, piping, and similar items. Obtain more accurate information about locations, arrangement and sizes from study and coordination of drawings, including shop drawings and manufacturers' literature and become familiar with conditions and spaces affecting these matters before proceeding with work.

.4 Where job conditions require reasonable changes in indicated locations and arrangements, make such changes with approval of the Consultant at no additional cost to the Owner.

1.20 CUTTING AND PATCHING

.1 The Electrical Contractor will be responsible for all cutting and patching required for the electrical installation. Structural members are not to be cut without the consent of the Consultant.

.2 All cutting and patching required under Division 26, Division 27, and Division 28 shall be in accordance with Division 01. Layout such work for approval before undertaking same.

.3 Cutting shall be kept to an absolute minimum and performed in a neat and workmanlike manner using the proper tools and equipment. Caution shall be exercised in all cutting and procedures to ensure that concealed services are not affected. Do not cut if in doubt. Request Consultant's presence to determine if concealed services exist.

.4 Assume responsibility for prompt installation of Work in advance of concrete pouring or similar Work. Should any cutting or repairing of finished/unfinished Work be required because such installation was not done, employ the particular trade, whose Work is involved, to do such cutting and patching. Pay for any resulting costs. Layout such Work for approval before undertaking same.

1.21 CLEANING AND WASTE MANAGEMENT

.1 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this trade. At the completion of this work, the electrical installation is to be left in a clean and finished condition to the satisfaction of the Consultant.

.2 Assume responsibility for removing tools and waste materials on completion of Work, and leave Work in clean and perfect condition.

1.22 STARTING AND ADJUSTING

.1 Conduct acceptance tests to demonstrate that the equipment and systems actually meet the specified requirements. Tests may be conducted as soon as conditions permit, and consequently make all changes, adjustments, or replacements required as the preliminary tests may indicate prior to the final tests. Tests shall be as specified in various sections of this Division. Carry out tests in the presence of the Consultant. Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project. The Electrical Contractor shall be in charge of the plant during tests. He shall assume responsibility for damages in the event of injury to the personnel, building, equipment, and shall bear all costs for liability, repairs, and restoration in this connection. Submit test results.

.2 Make tests of equipment and wiring at times requested.

.3 Tests shall include meggered insulation values, voltage and current readings to determine balance of panels and feeders under full load, and operation of each piece of equipment for correct operation.

.4 Supply meters, materials and personnel as required to carry out these tests.

.5 Test electrical work to standards and function of Specification and applicable codes in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.

.6 Connect single phase loads so that there is the least possible unbalance of the supply phases.

.7 Submit all test results in report format.

.8 Trial Usage

.1 The Consultant reserves the right to use any system, piece of equipment, device, or material for such reasonable lengths of time and at such times as may be required to make a complete and thorough test of the same, or for the purpose of learning operational procedures, before the final completion and acceptance of the work. Such tests shall not be construed as evidence of acceptance of the work, and it is agreed and understood that no claim for damage will be made for injury or breakage to any part or parts

of the above due to the aforementioned tests, where such injuries or breakage are caused by a weakness or inaccuracy of parts, or by defective materials or workmanship of any kind. Supply all labour and equipment required for such tests.

.2 Perform and pay for all costs associated with any testing required on the system components where, in the opinion of the Consultant the equipment manufacturer's ratings or specified performance is not being achieved.

1.23 CLOSEOUT PROCEDURES

.1 The Consultant will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.

.2 Furnish a Certificate of Acceptance from Inspection Department on completion of work.

1.24 CLOSEOUT SUBMITTALS

.1 Project Record Documents

.1 Extra sets of white prints will be provided on which to make, as the job progresses, all approved changes and deviations from the original drawings. Complete Record Drawings accurately marked up in red ink must be submitted for approval before the contract is considered to be completed.

.2 Changes and deviations include those made by addenda, change orders, and supplemental instructions, and changes and deviations to be marked on the white print record drawings indicated on supplemental drawings issued with addenda, change orders, and supplemental instructions. Maintain the "as-built" white prints at the site for periodic inspection by the Consultant throughout the duration of the work.

.3 Upon substantial completion of the work, obtain a set of reproducible white prints of the drawings and neatly amend the print in accordance with the marked-up white prints to produce a true "as-built" set of drawings.

.4 As-built drawings are to indicate all circuiting as installed and all distribution junction box locations as well as conduit routes.

.5 As-Built AutoCAD Drawings

.1 Request CAD release form from Consultant, and submit back to Consultant.

.2 Transfer the information from the “as-built” white prints to the files, and submit to the Consultant for review.

.3 Employ a competent computer draftsperson to indicate changes on the electronic set of record drawings. Provide drawings in Adobe Acrobat 6.0, and AutoCAD release 2010.

.4 Submit three (3) CD’s of as-built drawings in AutoCAD format, one with each O&M manual.

.5 Provide three (3) sets of full size as-built drawings in hard copy format, one with each O&M manual.

.6 As-built Single Line Diagram:

.1 Provide in Main Electrical Room one wall mounted copy of as-built Single Line Diagram on 1/4 inch foam board.

.2 As-built Single Line Diagram to indicate manufacturer name and catalogue numbers of as-installed products.

.2 Operations and Maintenance (O&M) Data

.1 Submit two complete sets of Operation and Maintenance instruction manuals in hard copy, and one in electronic format. Include in each copy of the manual:

.1 Verification certificates for installation of life safety systems by the manufacturer’s representative.

.2 A copy of "reviewed" shop drawings.

.3 Complete explanation of operating principles and sequences.

.4 Recommended maintenance practices and precautions.

.5 Complete wiring and connection diagrams.

.6 Certificates of guarantees.

.2 Ensure that operating and maintenance instructions are specific and apply to the model and types of equipment provided.

.3 Warranties

.1 Submit a written guarantee to the Owner for one year from the date of acceptance. This guarantee shall bind the contractor to correct, replace or repair promptly any defective equipment workmanship without cost to the Owner.

.2 All equipment, materials and workmanship shall be unconditionally guaranteed for a minimum period of one year from the date of acceptance.

.3 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.

.4 Warranties for temperature controls and building automation systems will start on the date of verification of acceptance by the Consultant.

.5 Include these certificates with the maintenance and operating manuals in the appropriate sections.

1.25 DEMONSTRATION AND TRAINING

.1 In the presence of the Owner, demonstrate the proper operation of all systems.

.2 Instruct the Owner's designated representatives in all aspects of the operation and maintenance of systems and equipment listed in the trade sections governed by this Section. Obtain in writing from the Consultant a list of the Owner's representatives qualified to receive instructions.

.3 Arrange for and pay for the services of qualified service technicians and other manufacturer's representatives required for instruction of specialized portions of the installation.

2 Products – Not Used

3 Execution

3.1 CONCRETE WORK

.1 Refer to Division 03 – Concrete.

.2 Provide all concrete work required for the electrical work. Reinstall surfacing as per architectural requirements.

.3 Provide a 100 mm (4 inch) high concrete housekeeping pad for floor mounted electrical distribution equipment, such as the following:

.1 Transformers.

.2 Switchgear and switchboards.

.3 Distribution panelboards.

.4 Engine Generators.

.5 Uninterruptible Power Supplies and batteries.

.6 Transfer Switches.

3.2 LINTELS

.1 Refer to Division 04 – Masonry.

.2 Lintels for openings in masonry shall conform with requirements of by-laws, and as approved by the Structural Engineer.

.3 Pay all costs for lintels over openings, required solely by the electrical trades, not shown on architectural or structural drawings.

3.3 METALS

.1 Refer to Division 05 – Metals.

.2 Steel construction required solely for the work of this trade, and not shown on architectural or structural drawings shall be provided by this Division to the requirements of Division 05.

3.4 FLASHING AND SHEET METAL

.1 Flash all conduits and systems passing through roof or built into an outside wall, or a waterproof floor.

.2 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.

3.5 FIRESTOPPING

.1 Ensure that fire ratings of floors and walls are maintained.

.2 Provide ULC classified firestopping products by 3M or Hilti which have been tested in accordance with CAN4-S115.

.3 Pack clearance spaces, fill all spaces between openings, pipes and ducts passing through fire separations and install firestopping systems in accordance with the appropriate ULC system number for the products and type of penetration.

.4 Install firestopping systems using personnel trained or instructed by the product manufacturer.

3.6 ACCESS DOORS

.1 Group conduit work to ensure the minimum number of access doors is required.

.2 Access doors are to be installed by the trade responsible for the particular type of construction in which the doors are required.

3.7 PAINTING AND FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.2 Repair and finish factory finished equipment, damaged or scratched during installation, in an approved manner.

.3 All structural steel including hangers, brackets, supports and other ferrous metals shall be shop or factory prime painted wherever practicable. Wherever structural steel including hangers, brackets, supports, and other ferrous metals cannot be shop or factory prime painted, wire brush to remove all traces of rust, clean of all traces of dirt, oil, and grease, and apply one coat of an approved rust inhibiting primer in accordance with CGSB-GB-40d, and leave ready to receive finish paint.

.4 Primary and final painting for Work, other than items specified as factory primed or finished, will be performed as described in Division 09 – Finishes.

.5 All electrical fittings, supports, hanger rods, pull boxes, channel frames, conduit racks, outlet boxes, brackets, clamps etc., to have galvanized finish or paint finish over corrosion-resistant primer.

.6 All panelboards, motor starters etc., to be factory finished with baked on enamel. All enamel to be baked on gloss over corrosion resistant primer.

.7 Touch up minor damage to finish on factory finished equipment. Items suffering major damage to finish shall be replaced at the direction of the Consultant.

.8 Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.

.9 Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on job. Clean up or wire brush all equipment, etc., before painting.

.10 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.8 LOCATION OF OUTLETS

.1 Refer to Architectural drawings for dimensions denoting exact locations.

.2 The Consultant reserves the right to change the location of outlets to within 3 m from the point indicated on the plans without extra charge providing the Contractor is advised before installation is made.

.3 Location of lighting, convenience, telephone, power and communication outlets shall be subject to change, without extra cost to Owners, provided information is given prior to installation. No extra amount will be paid for extra labour and materials for relocating outlets up to 3000 mm from their original location nor will credits be anticipated where relocation up to 3000 mm reduces materials and labour. Other cases will be considered on their individual merits.

.4 Coordinate location of boxes with latest architectural drawings and instructions to suit door swings, millwork etc. prior to rough-in.

3.9 MOUNTING HEIGHTS AND DEVICE LOCATIONS

.1 Refer to architectural drawings for exact location of electrical equipment and devices.

.2 Architectural elevations take precedence over electrical elevations. If there are conflicts between architectural and electrical, adjust locations of electrical equipment at no additional cost to the owner.

.3 Prior to roughing-in, the contractor is to mark locations of electrical equipment and devices for conflicts with architectural, studs, etc. If conflicts are noted, inform the consultant for a decision prior to commencing the rough-in.

.4 Mounting heights of equipment and devices listed below is from finished floor to centreline of equipment, unless specified or indicated otherwise.

.5 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.6 Install electrical equipment at following heights above finished floor (AFF). Dimensions are to centre of device unless indicated otherwise.

.1 Power door operator push buttons: 1000 mm.

.2 HVAC thermostats and manual HVAC controls: 1200 mm.

.3 Local switches, and manual lighting control devices:

.1 1100 mm.

.2 Locate on lock side of door.

.4 System furniture service fittings: to suit furniture layout.

.5 Wall receptacles:

.1 General: min. 400 mm AFF.

.2 Above top of counters: 175 mm.

.3 Above top of continuous baseboard heater, or mechanical heating/radiation units: 75 mm to bottom of device.

.4 In fan rooms, mechanical rooms, and electrical rooms: 1100 mm.

.6 Outlets in raceways or millwork to be located as per Architectural details.

.7 Door bell pushbuttons: 1100 mm.

.8 Panelboards: as indicated in Section 26 24 16.

.9 Emergency lighting remote heads: 300 mm below finished ceiling, or 2400 mm AFF for exposed areas or areas with ceiling height above 2750 mm (9 feet).

.10 Communications:

.1 Typical communication outlets (voice and data): 400 mm.

.2 Communications outlets for wall mounted telephones, intercom, or similar: 1100 mm.

.3 Television outlets: 200 mm below finished ceiling.

.4 Wall mounted public address speakers: 2100 mm.

.5 Clocks: 2100 mm.

.11 Access control card readers and keypads: 900 mm.

.12 Fire alarm manual pull stations: 1200 mm.

.13 Wall mounted fire alarm audible devices, including bells or horns:

.1 2300 mm to the top of the device in areas of ceiling height 2450 mm or greater.

.2 150 mm below the finished ceiling for ceiling heights less than 2450 mm, measured to the top of the device.

.14 Wall mounted fire alarm visible signal devices, including strobes: 2300 mm.

.15 Fire Alarm emergency telephones: 1400 mm.

3.10 MANUFACTURER'S INSTRUCTIONS

.1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.

.2 Follow manufacturer's instructions where they cover points now specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

3.11 TESTS AND ACCEPTANCE

.1 The operation of the equipment and electrical system does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.

.2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.

.3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that work is complete and in perfect operating condition, with raceway and conduit systems properly grounded, wiring free from grounds, shorts, and that the entire installation is free for any physical defects.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Building wire and cable.

.1 Armoured cable.

.2 Metal clad cable.

.3 Wiring connectors and connections.

.2 Permitted voltage drop for feeder and branch circuits.

1.2 REFERENCES

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code.

.3 CSA C22.2 No. 0.3 - Test Methods for Electrical Wires and Cables.

.4 CSA C22.2 No. 48-M90 (R2000) - Non-metallic Sheathed Cable.

.5 CSA C22.2 No. 51 Armoured Cables.

.6 CSA C22.2 No. 52-96 (R2000) - Underground Service-Entrance Cables.

.7 CAN/CSA C22.2 No. 65-03 (CSA/UL/ANCE) – Wire Connectors.

.8 CSA C22.2 No. 75-03 (CSA/UL/ANCE) - Thermoplastic-Insulated Wires and Cables.

.9 CSA C22.2 No. 123 Aluminum Sheathed Cables.

.10 CSA C22.2 No. 131 Type TECK 90 Cable.

.11 NECA (National Electrical Contractors Association) - Standard of Installation.

.12 NETA (International Electrical Testing Association) - ATS-2003 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

.13 CAN/ULC-S139-12 – Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data and Optical Fibre Cables.

1.3 COORDINATION

.1 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

1.4 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.5 REGULATORY REQUIREMENTS

.1 Conform to CSA C22.1.

.2 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

1.6 SITE CONDITIONS

.1 Verify that field measurements are as indicated.

.2 Conductor sizes are based on copper unless indicated as aluminum or "AL".

.3 Wire and cable routing indicated is approximate unless dimensioned.

2 Products

2.1 MANUFACTURERS

.1 BICC Phillips.

.2 General Cable.

.3 Nexans.

.4 Prysmian.

.5 Southwire.

2.2 BUILDING WIRE

.1 RW90:

.1 Single copper conductor.

.2 Minimum #12 AWG for branch circuit wiring.

.3 Minimum #14 AWG for 120V control wiring.

.4 Chemically cross-linked polyethylene insulation.

.5 Rated for 90 degrees C, 600V

.6 Suitable for handling to minus 40 degrees C.

.7 For interior installations in conduit.

.2 RWU90:

.1 Single copper conductor.

.2 Minimum 12 AWG for branch circuit wiring.

.3 Minimum 14 AWG for 120 V control wiring.

.4 Chemically cross-linked polyethylene insulation.

.5 Rated for 90 degrees C, 600 V

.6 Suitable for handling to minus 4 degrees C.

.7 For exterior installations in conduit.

.3 T90 Nylon:

.1 Single copper conductor.

.2 Thin wall PVC insulation with nylon covering.

.3 Rated for 90 degrees C, 600V.

.4 May be used up to size 10 AWG for interior installations.

.5 Base conduit fill on RW90 cable diameters.

2.3 ARMOURED CABLE

.1 Description: Type AC.

.2 Two, three or four copper conductors rated RW90, 1000 V.

.3 Bare copper ground wire.

.4 Insulation Voltage Rating: 600 volts.

.5 Insulation Temperature Rating: 90 degrees C (194 degrees F).

.6 Insulation Material: Thermoplastic.

.7 Runs to be limited to fixture drops and in walls, maximum exposed run 1.5 m.

.8 Do not daisy chain (leap frog) luminaires with armoured cable.

2.4 FIRE RATED CABLES

.1 General:

.1 2 hour fire rating to ULC S139 and to meet 2020 Ontario Building Code Rule 3.2.7.10.

.2 Alternative means of compliance:

.1 Conduits encased in a minimum of 50 mm (2 in) of concrete.

.2 Be protected by a fire rated assembly listed to achieve the minimum fire rating as indicated.

.2 Manufacturers:

.1 Basis of Design: nVent Pyrotenax 1850 series.

.2 Alternates such as “Lifeline” installed in conduit may only be considered if listed by ULC under ULC Category Code ‘FHJRC’ after October 2014.

.3 Acceptable alternate: VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code ‘FHJRC’, dated 19 May 2015).

.1 Request quotation from Bhavik Jain at Cerco Cable (905.670.3777) for field certification of installed Vitalink cables prior to requesting Engineer’s construction field review.

.2 2-Hour rated Vitalink RC90 power cable must be installed according to UL protocol FHIT7.120 – Electrical circuit integrity systems certified in Canada.

2.5 TECK90 CABLE

.1 Single, three, or four conductors as indicated on drawings.

.2 Cable to CAN/CSA-C22.2 No. 131.

.3 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Aluminum alloy conductors (NUAL) permitted for feeders above 400 amps where indicated.

.4 Insulation: Cross-linked polyethylene (XLPE), type RW90, rating: 600 V.

.5 Inner jacket: polyvinyl chloride.

.6 Armour: interlocking aluminum.

.7 Overall covering: thermoplastic.

.8 Fastenings:

.1 One-hole steel straps to secure surface cables 50 mm diameter and smaller. Two-hole steel straps for cables larger than 50 mm diameter.

.2 Channel type supports for two or more cables at 1500 mm centres.

.3 Threaded rods: 6 mm diameter to support suspended channels.

.9 Connectors: Watertight, approved for TECK cable.

2.6 WIRING TERMINATION

.1 Lugs, terminals, or screws used for termination of wiring to be suitable for copper conductors. Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring. Maintain phase sequence and colour coding throughout.

.2 Splice wire, up to and including No. 6 gauge, with nylon insulated expandable spring type connectors.

.1 Thomas & Betts – Marr Max Series

.3 Splice large conductors using compression type connections insulated with heat shrink sleeves.

.1 Thomas & Betts – 5400 Series lugs & heat shrink type #s series

2.7 CONDUCTORS, WIRES, AND CABLES

.1 Indoor wiring installed in conduit, unless otherwise noted: 600 volt "RW90 XLPE".

.2 Wiring in channel back of fluorescent lighting fixtures: 600 volt type GTF or TEW.

.3 Lighting and power branch circuit wiring:

.1 Copper, minimum No. 12 gauge.

.2 Home runs to lighting and receptacle panels, which exceed 22 m (75 feet) in length: minimum No. 10 gauge.

.4 Size wires for 2 per cent maximum voltage drop to farthest outlet on a maximum 80 per cent loaded circuit.

.5 Outdoor wiring: “RWU90 XLPE”.

.6 Conductors shall be colour coded. Conductors No. 10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No. 8 gauge and larger may be colour coded with adhesive colour coding tape but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.

.7 Colour coding as follows:

.1 Phase "A" - Red

.2 Phase "B" - Black

.3 Phase "C" - Blue

.4 Control - Orange

.5 Ground - Green

.6 Neutral - White

.8 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

3 Execution

3.1 EXAMINATION

.1 Voltage Drop

.1 Ensure voltage drop in power and control conductors is in accordance with the requirements of the Electrical Code.

.2 Size conductors accordingly when sizes are not identified.

.1 Feeder conductors: maximum voltage drop of 2 per cent.

.2 Branch circuit conductors: maximum voltage drop of 3 per cent.

.2 Verify that mechanical work likely to damage wire and cable has been completed.

.3 Verify that raceway installation is complete and supported.

3.2 PREPARATION

.1 Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

.1 Route wire and cable as required to meet project conditions.

.2 Install cable to CSA C22.1.

.3 Conduit and cable supports

.1 All wiring to be installed in EMT at all exposed areas and in partitions unless otherwise specified.

.2 All mechanical equipment to be connected with liquid tight flexible conduit.

.3 Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.

.4 Conductors

.1 Provide separate neutral for each circuit. Common neutrals not permitted.

.2 Use solid conductor for feeders and branch circuits 10 AWG and smaller.

.3 Use stranded conductors for control circuits.

.4 Use conductor not smaller than 12 AWG for power and lighting circuits.

.5 Use conductor not smaller than 16 AWG for control circuits.

.6 Armoured cable (commonly referred to as BX) is only to be used for light fixture connections and limited to maximum 1830 mm in length.

.7 Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 25 m.

.5 Pulling conductors

.1 Pull all conductors into raceway at same time.

.2 Use suitable wire pulling lubricant for building wire 4 AWG and larger.

.3 Neatly train and lace wiring inside boxes, equipment, and panelboards.

.4 Protect exposed cable from damage.

.6 Connectors

.1 Use suitable cable fittings and connectors.

.2 Clean conductor surfaces before installing lugs and connectors.

.3 Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

.4 Use split bolt connectors for copper conductor splices and taps 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 per cent of insulation rating of conductor.

.5 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

.6 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.4 IDENTIFICATION

.1 Identify and colour code wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

.2 Where colour-coded tape is utilized, apply a minimum of 50 mm (2 inches) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.

.3 Utilize colour coding on bussing in panels and, switchgear, disconnects, and metering cabinets to match conductor colour coding.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Low-voltage control cabling.

.2 Control-circuit conductors.

1.2 REFERENCES

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code.

.3 CSA C22.2 No. 0.3 - Test Methods for Electrical Wires and Cables.

.4 CSA C22.2 No. 48-M90 (R2000) - Non-metallic Sheathed Cable.

.5 CSA C22.2 No. 51 Armoured Cables.

.6 CAN/CSA C22.2 No. 65-03 (CSA/UL/ANCE) – Wire Connectors.

.7 CSA C22.2 No. 75-03 (CSA/UL/ANCE) - Thermoplastic-Insulated Wires and Cables.

.8 CSA C22.2 No. 208 - Fire Alarm and Signal Cable.

.9 NECA (National Electrical Contractors Association) - Standard of Installation.

1.3 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.4 REGULATORY REQUIREMENTS

.1 Conform to CSA C22.1.

.2 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

1.5 PROJECT CONDITIONS

.1 Verify that field measurements are as indicated.

.2 Wire and cable routing indicated is approximate unless dimensioned.

1.6 COORDINATION

.1 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

2 Products

2.1 LOW VOLTAGE WIRING

.1 LVT:

.1 Multi conductor PVC insulated.

.2 Bare copper ground conductor.

.3 Overall PVC jacket.

.4 Rated 30 V.

.5 CMP (FT6) rated if cable is exposed.

.6 CMR (FT4) rated if cable is installed in conduit.

.2 Category 6 Network Cabling.

.1 CMP (FT6) rated if cable is exposed.

.2 CMR (FT4) rated if cable is installed in conduit.

2.2 TERMINATIONS AND SPLICES

.1 All terminations and splices shall be of an approved type for the conductors being used.

.2 Where conductors are terminated or spliced, it shall be done in the following manner:

.1 Where a single solid conductor is terminated in a device under one screw or clamping mechanism, no additional terminating hardware is required.

.2 Where multiple or stranded conductors are terminated in a device under one screw or clamping mechanism, self insulated crimp-on cable ends or approved equal shall be used up to and including No. 10 sized conductors. Approved compression lugs shall be used for larger conductor sizes.

.3 Where multiple conductors are spliced, properly sized Wing Nut connectors, or approved equal, shall be used for up to two No. 8 or three No. 10 AWG conductors. Pressure type sleeve cable connectors, splices, tee's, etc., shall be used for all larger size connections and terminations.

.4 Insulate all bare surfaces of splices with heat shrink sleeving or equivalent.

.5 Conductors connected to ground rods for service or equipment grounding or to building structural or architectural elements shall be terminated, connected and spliced using a thermoweld process or approved non-mechanical compression type connectors.

.3 Install all service and feeder conductors as continuous lengths without breaks, measured and cut based on site dimensions.

3 Execution

3.1 EXAMINATION

.1 Verify that mechanical work likely to damage wire and cable has been completed.

.2 Verify that raceway installation is complete and supported.

3.2 PREPARATION

.1 Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

.1 Route control cabling as required to meet project conditions.

.2 Install cable to the CSA C22.1.

.3 Conduit and supports

.1 All wiring to be installed in EMT at all exposed areas and in partitions unless otherwise specified.

.2 All mechanical equipment to be connected with liquid tight flexible conduit.

.3 Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.

.4 Conductors

.1 Use stranded conductors for control circuits.

.2 Use conductor not smaller than 16 AWG for control circuits.

.5 Pulling conductors

.1 Pull all conductors into raceway at same time.

.2 Neatly train and lace wiring inside boxes, equipment, and panelboards.

.3 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

.4 Protect exposed cable from damage.

.6 Connectors

.1 Use suitable cable fittings and connectors.

.2 Clean conductor surfaces before installing lugs and connectors.

.3 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

.4 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

.7 Identification

.1 Identify and colour code wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

.2 Where colour coded tape is utilized, apply a minimum of 50 mm (2 inches) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Grounding electrodes and conductors.

.2 Equipment grounding conductors.

.3 Bonding.

.4 The terms “connect” and “bond” are used interchangeably in this Specification and have the same meaning.

1.2 RELATED REQUIREMENTS

.1 Section 27 05 26 – Grounding and Bonding for Communications Systems.

1.3 REFERENCES

.1 Canadian Standards Association

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.2 CSA C22.2 No.0.4 - Bonding of Electrical Equipment.

.3 CSA C22.2 No. 41 - Grounding and Bonding Equipment.

.2 Ontario Electrical Safety Code.

.3 ANSI/TIA/EIA J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

.4 Institute of Electrical and Electronics Engineers, Inc.: IEEE 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.4 PERFORMANCE REQUIREMENTS

.1 Grounding System Resistance: 5 ohms.

.2 Provide all equipment grounding as required regardless of whether it has been shown on drawings or called for in this specification. Arrange grounds so that under normal operating conditions no injurious amount of current will flow in any grounding conductor.

1.5 ACTION SUBMITTALS

.1 Product Data: Provide for grounding electrodes and connections.

1.6 INFORMATIONAL SUBMITTALS

.1 Test Reports: Indicate overall resistance to ground and resistance of each electrode.

.2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.7 CLOSEOUT SUBMITTALS

.1 Project Record Documents: Record actual locations of components and grounding electrodes.

.2 Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.8 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years’ experience.

1.9 REGULATORY REQUIREMENTS

.1 Products: Listed and classified testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2 Products

2.1 MANUFACTURERS

.1 B-Line by Eaton.

.2 Hubbell (Burndy).

.3 Panduit.

.4 Thomas & Betts.

2.2 GROUNDING AND BONDING CONDUCTORS

.1 Electrical grounding conductors shall be UL 83 insulated stranded copper, except that sizes #10 AWG and smaller shall be solid copper. Insulation colour shall be continuous green for all equipment grounding conductors.

.2 Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes #10 AWG and smaller shall be ASTM B1 solid bare copper wire.

2.3 ROD ELECTRODES

.1 Material: Copper-clad steel.

.2 Diameter: 19 mm.

.3 Length: 3000 mm.

2.4 GROUND RODS

.1 Copper clad steel, 19 mm (3/4 inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.

.2 Quantity of rods shall be as required to obtain the specified ground resistance.

2.5 SPLICES AND TERMINATION COMPONENTS

.1 Components shall meet or exceed CSA C22.2 No 41, and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.6 GROUND CONNECTIONS

.1 Below Grade: Exothermic-welded type connectors.

.2 Above Grade:

.1 Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.

.2 Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

2.7 GROUND TERMINAL BLOCKS

.1 At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.8 SPLICE CASE GROUND ACCESSORIES

.1 Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 6 AWG insulated ground wire with shield bonding connectors.

2.9 MECHANICAL CONNECTORS

.1 Material: Bronze.

2.10 WIRE

.1 Material: Stranded copper.

.2 Foundation Electrodes: 2/0 AWG.

.3 Grounding Electrode Conductor: Size to meet Ontario Electrical Safety Code requirements.

2.11 GROUNDING WELL COMPONENTS

.1 Well Pipe: 200 mm by 600 mm long concrete pipe with belled end.

.2 Well Cover: Cast iron with legend "GROUND" embossed on cover.

3 Execution

3.1 EXAMINATION

.1 Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

.1 General

.1 Ground in accordance with the Ontario Electrical Safety Code, as shown on drawings, and as hereinafter specified.

.2 System Grounding:

.1 Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.

.2 Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

.3 Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

.4 Ground electrical equipment and wiring in accordance with Ontario Electrical Safety Code and Local Inspection Authority's Rules and Regulations.

.5 Install grounding conductors, outside Electric Rooms and Electrical Closets in conduit and conceal where possible. Make connections to water mains, all metallic piping systems, neutral and equipment with brass, copper or bronze bolts and connectors or weld using Cadweld or Thermoweld processes.

.6 Provide grounding conductors, sized as per Code, and connect to grounding bus or water main wherever non-raceways are installed.

.2 Provide grounding electrode conductor and connect to reinforcing steel in foundation footing. Bond steel together.

.3 Provide bonding to meet Regulatory Requirements.

.4 Bond together metal siding not attached to grounded structure; bond to ground.

.5 Install ground grid under access floors indicated.

.6 Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use #6 AWG bare copper conductor.

.7 Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

.8 Ground Resistance

.1 Grounding system resistance to ground not to exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Owner. Final tests shall assure that this requirement is met.

.2 Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before

the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

.3 Services at power company interface points shall comply with the power company ground resistance requirements.

.9 Ground Rod Installation

.1 Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.

.2 Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

.3 Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

.10 Inaccessible Grounding Connections

.1 Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

.11 Secondary Equipment and Circuits

.1 Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

.2 Metallic Piping, Building Steel, and Supplemental Electrode(s):

.1 Provide a grounding electrode conductor sized per code between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to CSA C22.2 No 41.

.2 Provide a supplemental ground electrode and bond to the grounding electrode system.

.3 Conduit Systems:

.1 Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.

.2 Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.

.3 Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.

.4 Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

.5 Boxes, Cabinets, Enclosures, and Panelboards:

.1 Bond the equipment grounding conductor to each pull box, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).

.2 Provide lugs in each box and enclosure for equipment grounding conductor termination.

.3 Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

.6 Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

.12 Corrosion Inhibitors

.1 When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

.13 Conductive Piping

.1 Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.3 FIELD QUALITY CONTROL

.1 Perform inspections and tests listed in NETA ATS, Section 7.13.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Conduit and equipment supports.

.2 Anchors and fasteners.

1.2 REFERENCES

.1 CSA C22.1 - Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code.

.3 CECA - Canadian Electrical Contractors Association.

1.3 CLOSEOUT SUBMITTALS

.1 Submit the following in the Operation and Maintenance Manual for products used over the course of the project:

.1 Product Data: Provide manufacturer's catalogue data for fastening systems.

.2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.4 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by Canadian Standards as suitable for purpose specified and shown.

2 Products

2.1 MANUFACTURERS

.1 B-line by Eaton.

.2 Burndy Canada Ltd. (Hubbell).

.3 Erico Caddy.

.4 E. Myatt & Co. Inc.

.5 Hilti Canada.

.6 Thomas & Betts.

.7 Unistrut.

.8 Alternates as considered by the Consultant.

2.2 GENERAL

.1 All supporting devices, strut channel, threaded rod, anchors, etc. to be used shall be of the “hot dipped” galvanized type. Electrogalvanized components will not be accepted.

.2 Materials and Finishes: Provide adequate corrosion resistance.

.3 Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

.4 Anchors and Fasteners:

.1 Concrete Structural Elements: Use expansion anchor sand preset inserts.

.2 Steel Structural Elements: Use beam clamps and welded fasteners.

.3 Concrete Surfaces: Use self-drilling anchors and expansion anchors.

.4 Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.

.5 Solid Masonry Walls: Use expansion anchors and preset inserts.

.6 Sheet Metal: Use sheet metal screws.

.7 Wood Elements: Use wood screws.

2.3 ANCHORS AND HANGERS

.1 Hangers for electrical conduit shall be galvanized after fabrication.

.2 Perforated strapping: not permitted.

2.4 INSERTS

.1 Use only factory-made threaded or toggle type.

.2 Where inserts cannot be placed, use factory-made expansion shields for light weights, where approved by the Consultant.

.3 Do not use powder-activated tools except with the written permission of the Consultant.

2.5 SLEEVES

.1 Through interior walls, use standard weight steel pipes, conduit, or 18 gauge galvanized steel. Cut flush with finished surfaces. Check room finish schedules.

.2 Through exterior walls above grade, floors, and roof use standard weight steel pipes, machine cut, flush with finished surface inside and to suit flashing outside.

.3 Through exterior walls below grade, water-proofed floors, and other water-proof walls, use heavy weight cast iron pipes, machine cut. Extend sleeves 100 mm (4 inches) above finished floors, and cut flush with underside of floor.

2.6 STEEL CHANNEL

.1 Description: Painted steel.

2.7 SUPPORTS

.1 Steel supports in wet or dry locations to be galvanized after fabrication.

.2 Where galvanized members are bolted together use cadmium plated bolts.

.3 For hanger rods use minimum 10 mm (3/8 inch) diameter steel threaded rod. Use clevis type attachment.

.4 Provide minimum 100 mm (4 inch) high concrete bases for all floor mounted equipment.

2.8 SUPPORTS AND BASES

.1 Submit proposed method of attachment of hangers and beam clamps, to cellular steel deck for approval before proceeding with Work.

.2 Supply and erect special structural Work required for the installation of electrical equipment. Provide anchor bolts and other fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.

.3 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets.

.4 Provide channel or other metal supports where necessary, to adequately support lighting fixtures. Do not use wood unless wood forms part of the building structure.

.5 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members, required between beams for supporting conduits and cables.

.6 Provide any additional supports required from concrete construction for any piping or equipment, by drilling same and installing expansion bolt cinch anchors.

.7 Do not use explosive drive pins in any section of Work without obtaining prior approval.

2.9 THREADED ROD COVERS

.1 Protect cable from abrasion caused by contact with threaded rod.

.2 To meet UL 94V-0 specifications.

.3 Colour: Black.

.4 Example product: Panduit TRC18FR-X20Y.

3 Execution

3.1 INSTALLATION

.1 Obtain permission from Consultant before drilling or cutting structural members.

.2 Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

.3 Install surface-mounted cabinets and panelboards with minimum of four anchors.

.4 In wet and damp locations use steel channel supports to stand cabinets and panelboards 25 mm (1 inch) off wall.

.5 Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

.6 Where threaded rod is exposed in data centre, provide threaded rod cover.

.7 Provide inserts, sleeves, equipment supports and hangers, sealing of sleeves and openings, as required for all electrical work. Ensure that the load onto structures does not exceed the maximum loading per square metre as shown on Structural Drawings or as directed by the Consultant.

.8 Provide insets, holes, anchor bolts and sleeves in time when walls, floors, and roof are erected.

.9 Provide sleeves at each place where electrical devices pass through a wall, floor or roof.

.10 Size sleeves to provide 13 mm (1/2 inches) clearance all round.

.11 Sleeves are not required in interior walls and dry area floors where conduit is installed ahead of floor construction.

.12 Seal all openings and sleeves after installation of equipment:

.1 With an approved material to maintain fire rating where sleeves and openings pass through fire separations and floors.

.2 With an approved material to maintain fire rating for sleeves and openings provided for future equipment.

.13 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 07.

.14 Place insets only in structural members and not in the finishing material.

.15 Secure all supports and hangers to the structure unless noted otherwise.

.16 Suspend hanger rods from approved concrete inserts and from beam clamps. Obtain Consultant's approval before welding to steel structural members.

.17 Secure supports to precast concrete members to inserts originally cast into the members or by rods passing between the members and connected to a steel plate bearing.

.18 Sealing of Sleeves and Openings to Maintain Fire Rating

.1 Use Dow-Corning #3-6548 'Silicone RTV' foam, Thomas & Betts "Flamesafe' firestopsystem, Electrovert 'Flameseal" firestop putty, or approved equal materials installed in accordance with the manufacturer's specifications and recommendations.

.2 Submit data sheets for review prior to installation.

.19 Supports

.1 All conduits, panels, etc. to be securely and adequately supported.

.2 Where more than three conduits run together, conduit racks to be used.

.3 Single runs of conduit to be supported by galvanized conduit straps or ring bolt type hangers. Tie wire or perforated metal strap hangers will NOT be accepted.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Metal conduit.

.2 Flexible metal conduit.

.3 Liquid tight flexible metal conduit.

.4 Electrical metallic tubing.

.5 Fittings and conduit bodies.

1.2 REFERENCES

.1 Canadian Standards Association

.1 CSA C22.1 – Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code.

.3 CAN/CSA-C22.2 No. 18 – Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.4 CSA C22.2 No. 45 – Rigid Metal Conduit.

.5 CSA C22.2 No. 45.1 – Rigid Metal Conduit - Steel.

.6 CSA C22.2 No. 56 – Flexible Metal Conduit and Liquid - Tight Flexible Metal Conduit.

.7 CSA C22.2 No. 83.1 – Electrical Metallic Tubing - Steel.

.8 CSA C22.2 No. 211.1 – Rigid Types EB1 and DB2/ES2 PVC Conduit.

.9 CSA C22.2 No.211.2 – Rigid PVC (Unplasticized) Conduit.

.10 CSA C22.2 No. 211.3 – Reinforced Thermosetting Resin Conduit (RTRC) on Fittings.

.11 CSA C22.2 No. 227.1 – Electrical Nonmetallic Tubing.

.12 CSA C22.2 No. 227.2.1 – Liquid-Tight Flexible Nonmetallic Conduit.

1.3 PROJECT RECORD DOCUMENTS

.1 Accurately record actual routing of conduits larger than 51 mm.

.2 Accurately record actual routing of all conduits installed below grade, regardless of size, including whether direct buried or installed in concrete duct bank.

1.4 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for purpose specified and shown.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Accept conduit on site. Inspect for damage.

.2 Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.6 PROJECT CONDITIONS

.1 Verify that field measurements are as shown on drawings.

.2 Verify routing and termination locations of conduit prior to rough-in.

.3 Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

2 Products

2.1 MANUFACTURERS

.1 Where products are listed in this section based on a single manufacturer, the equivalent product from the following manufacturers is acceptable:

.1 Appleton.

.2 Columbia-MBF.

.3 Crouse-Hinds by Eaton.

.4 Hubbell.

.5 Thomas & Betts Ltd.

2.2 CONDUIT REQUIREMENTS

.1 Minimum size: 21 mm (3/4 inch) unless otherwise specified.

.2 Outdoor locations, above grade: use rigid steel.

.3 Wet and damp locations: use rigid and non-metallic tubing.

.4 Dry locations:

.1 Concealed: Use electrical metallic tubing

.2 Exposed: Use electrical metallic tubing.

2.3 METAL CONDUIT

.1 Rigid Steel Conduit: C22.2 No. 45.1.

.2 Rigid Aluminum Conduit: C22.2 No. 45.

.3 Intermediate Metal Conduit (IMC): Rigid steel.

.4 Fittings and Conduit Bodies: Material to match conduit.

2.4 FLEXIBLE METAL CONDUIT

.1 Description: Interlocked steel construction.

.2 Fittings: CSA C22.2 No. 56.

2.5 LIQUID TIGHT FLEXIBLE METAL CONDUIT

.1 Description: Interlocked steel aluminum construction with PVC jacket.

.2 Fittings: CSA C22.2 No. 56.

2.6 ELECTRICAL METALLIC TUBING (EMT)

.1 Description: CSA C22.2 No. 83.1; galvanized tubing.

.2 Fittings and Conduit Bodies: CSA C22.2 No. 83.1; steel type.

2.7 ELECTRICAL NONMETALLIC TUBING (ENT)

.1 Not permitted.

2.8 CONDUIT, FITTINGS, AND ACCESSORIES

.1 Conduit accessories, conduits and fittings conforming to CSA Standard C22.2 No. 18-1972.

.2 Rigid conduit bushings:

.1 Thomas & Betts Ltd. - Series 5031.

.3 EMT Connectors:

.1 Thomas & Betts Ltd. - Steel City TC 121E Series.

.4 Ground Bushings:

.1 Thomas & Betts – Blackjack or 1220 Series.

.5 Flexible conduit connectors:

.1 Thomas & Betts Ltd. - Series 3110.

.2 EMT couplings: steel concrete tight to match connectors.

.6 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.

.1 Thomas & Betts – 8125 Series.

.7 Terminate EMT entering boxes or enclosures with nylon insulated steel concrete tight connectors.

.8 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.

.1 Thomas & Betts – 5332 Series.

3 Execution

3.1 INSTALLATION

.1 Install conduit to CSA C22.1.

.2 Arrangement and supports

.1 Arrange supports to prevent misalignment during wiring installation.

.2 Arrange conduit to maintain headroom and present neat appearance.

.3 Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

.4 Group related conduits; support using conduit rack.

.5 Construct rack using steel channel; provide space on each for 25 per cent additional conduits.

.6 Fasten conduit supports to building structure and surfaces to Section 26 05 29.

.7 Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports

.8 Do not attach conduit to ceiling support wires.

.9 Route exposed conduit parallel and perpendicular to walls.

.10 Route conduit installed above accessible ceilings parallel and perpendicular to walls.

.11 Route conduit in and under slab from point-to-point.

.12 Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

.13 Provide suitable fittings to accommodate expansion and deflection where conduit crosses expansion joints.

.3 Clearances

.1 Maintain adequate clearance between conduit and piping.

.2 Maintain 300 mm (12 inch) clearance between conduit and surfaces with temperatures exceeding 40 degrees C.

.4 Conduit bends

.1 Install no more than equivalent of three 90 degree bends between boxes.

.1 Use conduit bodies to make sharp changes in direction, as around beams.

.2 Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 50 mm size.

.5 Install wall entrance seals where conduits pass through exterior walls below grade.

.6 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.

.7 Cut conduit square using saw or pipe cutter; de-burr cut ends.

.8 Bring conduit to shoulder of fittings; fasten securely.

.9 Use suitable caps to protect installed conduit against entrance of dirt and moisture.

.10 Use conduit hubs or sealing locknuts to fasten conduit and to cast boxes.

.11 Provide suitable pull string in each empty conduit except sleeves and nipples.

.12 Ground and bond conduit to Section 26 05 26.

.13 Identify conduit to Section 26 05 53.

.14 Wiring Methods

.1 Install wiring in conduit unless otherwise specified.

.2 Install wiring and conduit work in a concealed manner. Surface conduit work is not permitted unless specifically noted.

.3 Use thin wall conduit, up to and including 53 mm (2 inch) conduit size, for branch circuit and feeder wiring in ceilings, furred spaces, and in hollow walls and partitions. Use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 65 mm or larger. Use rigid PVC conduit for wiring in slabs on grade and wiring below grade.

.4 Aluminium conduit may be used, in lieu of rigid steel conduit, in clean and dry locations, but shall not be used in poured concrete, or for signal and intercommunication systems wiring.

.5 Flexible conduit and armoured cable will be accepted for a maximum length of 1500 mm for final connection to lighting fixtures. Do not connect from fixture to fixture.

.6 Conduit manufacturer's touch-up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Wall and ceiling outlet boxes.

.2 Pull and junction boxes.

1.2 RELATED REQUIREMENTS

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 27 26 – Wiring Devices: Wall plates in finished areas and fire-rated poke-through fittings.

1.3 REFERENCES

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code.

.3 CAN/CSA-C22.2 No. 18 - Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.4 CSA C22.2 No. 18.1 (CSA/UL/ANCE) - Metallic Outlet Boxes.

.5 CSA C22.2 No. 40 - Cutout, Junction and Pull Boxes.

.6 CAN/CSA-C22.2 No. 85 - Rigid PVC Boxes and Fittings.

1.4 CLOSEOUT SUBMITTALS

.1 Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.5 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.1 OUTLET BOXES

.1 Sheet Metal Outlet Boxes: CSA C22.2 No. 18, galvanized steel.

.1 Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 13 mm male fixture studs where required.

.2 Concrete Ceiling Boxes: Concrete type.

.2 Non-metallic Outlet Boxes: CSA C22.2 No. 18.

.3 Cast Boxes: CSA C22.2 No. 18, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.

.4 Wall Plates for Finished Areas: As specified in Section 26 27 26.

2.2 PULL BOXES AND JUNCTION BOXES

.1 Sheet Metal Boxes: CSA C22.2 No. 18, galvanized steel.

.2 Hinged Enclosures: As specified in Section 26 27 16.

.3 Surface Mounted Cast Metal Box: CSA C22.2 No. 18, Type 4; flat-flanged, surface mounted junction box:

.1 Material: Cast aluminum.

.2 Cover: Provide with ground flange, neoprene gasket, and stainless steel cover screws.

2.3 OUTLET BOXES

.1 Conform to CSA C22.2 No. 18.

.2 Where 103 mm (4 inch) square outlet boxes are installed in exposed concrete or cinder block finished areas, blocks will be cut as described in Division 04 as instructed under this Section. Cut openings to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Use of mortar to patch up openings that are cut too large or to patch ragged edges is not permitted.

.3 Ceiling boxes: 103 mm (4 inch) octagon or square, complete with fittings, where required to support fixtures.

.4 Switch and receptacle boxes:

.1 103 mm (4 inch) square with plaster ring, where flush mounted in plaster walls.

.2 Iberville 1104 series box, or equal, where flush mounted in wood or drywall, with stud fasteners as required.

.3 Masonry boxes in masonry walls.

.5 Where boxes are surface mounted in unfinished areas they shall be FS conduits.

.6 Standard outlet boxes manufactured from code gauge galvanized steel.

.7 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area it is to be installed.

.8 Support outlet boxes independently of conduit and cable.

.9 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.

.10 Offset outlet boxes, shown back to back in partitions, horizontally a minimum 150 mm (6 inch) to minimize noise transmission between adjacent rooms.

.11 Use gang boxes at locations where more than one device, of the same system only, is to be mounted. Utilize separate boxes for each system.

.12 Use tile wall covers where 103 mm (4 inch) square outlet boxes are installed in exposed concrete or cinder block in finished areas.

.13 Provide flush mount boxes, panels, cabinets and electrical devices, which are installed in finished areas, with suitable flush trims and doors or covers, unless specifically noted otherwise.

.14 Provide pre-formed polyethylene vapour barriers for all boxes located in walls with internal vapour barriers.

3 Execution

3.1 INSTALLATION

.1 Install boxes to CSA C22.1.

.2 Install in locations as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

.3 Set wall mounted boxes at elevations to accommodate mounting heights indicated.

.4 Electrical boxes are shown on drawings in approximate locations unless dimensioned. Adjust box location up to 3 m (10 feet) if required to accommodate intended purpose.

.5 Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

.6 Maintain headroom and present neat mechanical appearance.

.7 Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

.8 Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 150 mm (6 inch) from ceiling access panel or from removable recessed luminaire.

.9 Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods.

.10 Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

.11 Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

.12 Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

.13 Use flush mounting outlet box in finished areas.

.14 Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

.15 Do not install flush mounting box back-to-back in walls; provide minimum 150 mm separation. Provide minimum 600 mm separation in acoustic rated walls.

.16 Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

.17 Use stamped steel bridges to fasten flush mounting outlet box between studs.

.18 Install flush mounting box without damaging wall insulation or reducing its effectiveness.

.19 Use adjustable steel channel fasteners for hung ceiling outlet box.

.20 Do not fasten boxes to ceiling support wires.

.21 Support boxes independently of conduit.

.22 Use gang box where more than one device is mounted together. Do not use sectional box.

.23 Use gang box with plaster ring for single device outlets.

.24 Use cast outlet box in exterior locations exposed to the weather.

.25 Use cast outlet box in wet locations.

.26 Large pull boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.2 ADJUSTING

.1 Adjust flush-mounting outlets to make front flush with finished wall material.

.2 Install knockout closures in unused box openings.

3.3 CLEANING

.1 Clean interior of boxes to remove dust, debris, and other material.

.2 Clean exposed surfaces and restore finish.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Cables installed in ducts.

.2 Direct buried cables.

1.2 RELATED REQUIREMENTS

.1 Section 31 23 00 – Excavation and Fill.

1.3 REFERENCES

.1 Canadian Standards Association, (CSA International).

.2 Insulated Cable Engineers Association, Inc. (ICEA).

1.4 SUBMITTALS

.1 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.

1.5 CLOSEOUT SUBMITTALS

.1 Record documentation:

.1 Records of underground utility locates.

.2 Record as-constructed location of all underground conduits and feeders on as-built drawings regardless of conduit size.

2 Products

2.1 FILL MATERIALS

.1 Sand fill: clean, natural sand and gravel material, free from silt, clay, loam, friable or soluble materials and vegetable matter.

.2 Backfill material: Selected material from excavation or other sources, reviewed by Consultant, unfrozen and free from rocks larger than 75 mm (3 inch), rock with sharp angular surfaces, cinders, ashes, sods, refuse, or other deleterious materials.

3 Execution

3.1 EXCAVATION AND FILL

.1 In accordance with Section 31 23 00.

.2 Trenching:

.1 Excavate to dimensions indicated. Ensure trench width is sufficient to accommodate mechanical vibratory compactor.

.2 Do not leave open trench at end of day's operation.

.3 Backfilling

.1 Do not proceed with backfilling operations until Electrical Inspection Authority has inspected and approved installation.

.4 Restoration

.1 Restore surface of work area to conditions exiting prior to execution of work.

.2 After backfilling trench, provide new topsoil as required to follow minimum depths after settlement of 100 mm (4 inches) for grass seeded areas.

.3 Restore surface of paved areas to match existing.

3.2 CABLE INSTALLATION IN DUCTS

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

3.3 DIRECT BURIAL OF CABLE

.1 Provide sand bed as indicated.

.2 Lay cables maintaining 75 mm (3 inch) clearance from each side of trench to nearest cable. Do not pull cable into trench.

.3 Provide offsets for thermal action and minor earth movements. Offset cable 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.4 Install treated planks on cables for mechanical protection. Install above cables and below markers.

.5 Cable separation:

.1 Maintain 75 mm (3 inch) minimum separation between cables of different circuits.

.2 Maintain 300 mm (12 inch) horizontal separation between low and high voltage cables.

.3 When low voltage cables cross high voltage cables maintain 300 mm (12 inch) vertical separation with low voltage cables in upper position.

.4 At crossover, maintain 75 mm (3 inch) minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

3.4 MARKERS

.1 Mark cable every 150 m along duct runs and changes in direction.

.2 Mark underground splices.

.3 Where markers are removed to permit installation of additional cables, reinstall existing markers.

.4 Install cedar post type markers.

.5 Lay concrete markers flat and centred over cable with top flush with finish grade.

.1 Where warning tape is used to comply with OESC Rule 12-012(11), bury the tape approximately halfway between the installation and grade level, covering the width of the raceways or cables installed, in accordance with OESC Bulletin 12-2-(latest version).

3.5 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance tests:

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests:

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.3 High Potential (Hipot) Testing.

.1 Conduct hipot testing in accordance with [manufacturer's] [ICEA] recommendations.

.7 Provide Owner with list of test results showing location at which each test was made, circuit tested and result of each test.

.8 Non-Conforming Work: Remove and replace entire length of cable if cable fails to meet any of test criteria.

3.6 WASTE MANAGEMENT

.1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.2 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.

.3 Do not dispose of unused [sealant] material into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

.5 Do not dispose of preservative treated wood through incineration.

.6 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.

.7 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Departmental Representative.

.8 Fold up metal banding, flatten and place in designated area for recycling.

End of Section

1 General

1.1 SECTION INCLUDES

.1 This section provides minimum acceptance requirements for vibration isolation and seismic restraints for all electrical equipment, conduit as required by codes.

1.2 RELATED REQUIREMENTS

.1 Division 03 – Concrete.

.2 Provide design, selection and provision of materials, installation instructions, installation and inspection of vibration isolation equipment and systems.

.3 Select vibration isolation equipment to maintain noise levels below the NC levels in the following schedule.

AREA	NOISE CRITERIA (NC level)
Offices - private	32 to 34
-open plan	36 to 38
-business machine areas	40 to 42
-conference/boardrooms	30 to 32
Dorms	26 to 28
Public Areas	38 to 40

The requirements under this Section are in addition to the requirements for supports and vibration isolation specified in other Sections.

1.3 REFERENCE STANDARDS

.1 Unless otherwise directed by the local authority having jurisdiction, the following codes and standards will apply:

.1 Ontario Building Code – Latest Edition.

.2 The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.

.1 Federal Emergency Management Agency (FEMA) manual 413, Installing Seismic Restraints for Electrical Equipment, January 2014.

1.4 COORDINATION

.1 Trades shall supply necessary information to the Vibration Isolation Manufacturer regarding equipment to be isolated.

.2 Provide shop drawings to other trades for setting anchor bolts and other appurtenances necessary for the proper installation of this equipment.

1.5 MANUFACTURER RESPONSIBILITIES

.1 Manufacturer of vibration isolation components to:

.1 Determine vibration isolation sizes and locations.

.2 Supply suitable vibration isolation as required.

.3 Supply installation instructions and drawings.

.4 Provide trained field supervision personnel on site to insure proper installation.

.5 Conduct site inspections of the Work in progress.

.6 Conduct a final inspection of the Work.

.7 Prepare a final inspection report of the installation.

1.6 SUBMITTALS

.1 Submit shop drawings for all devices specified herein and as indicated and scheduled on the drawings. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, attachment and anchorage requirements.

.2 Submit drawings for review showing complete details of foundations including necessary concrete and steel work, vibration isolation devices and reinforcing steel.

.3 Provide data sheets for isolation components

.4 Provide calculations for selection of seismic/wind restraints, certified by a qualified professional engineer, licensed in the province of Ontario.

.5 Provide Finite Element Analysis (FEA) of all customized restraints, snubbers, and support structures such as equipment concrete housekeeping pad bases. A summary report from the analyses shall be made available to the Consultant and shall indicate compliance with the design forces for the project – including all gravity, wind and seismic loads. The report shall show locations of maximum stress and explain any allowances given for localized yielding along with safety factors.

2 Products

2.1 MANUFACTURERS

.1 Vibration and sound control materials shall be manufactured by:

.1 Vibro-Acoustics.

.2 Kinetics Noise Control.

.3 Mason Industries.

.4 Tecoustics.

.2 All vibration isolation and seismic/wind restraint systems shall be by one manufacturer.

2.2 VIBRATION ISOLATION

.1 Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have kx/ky ratios of at least 0.9. All springs shall be fully color-coded to indicate capacity – color striping is not considered adequate.

.2 Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule.

.3 Steel Equipment Base: Bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.

.1 Bases for exterior use shall be painted or hot-dipped galvanized for complete corrosion resistance.

.2 Minimum clearance under steel equipment bases shall be 25 mm (1”).

.4 Concrete Inertia Base: Inertia bases shall be of welded steel construction with concrete in-fill supplied by the installing contractor on site and shall incorporate 15M (No.4) reinforcing bars, welded 300 mm (12”) maximum on centers each way.

.1 The weight of each inertia base shall be at least equal to the weight of the equipment mounted thereon or sufficient to lower the center of gravity to or below the isolator support plane.

.2 Inertia bases shall be a minimum of 100 mm (4”) thick. (See Isolation Schedule).

.3 Height-saving brackets or welded steel pockets shall be incorporated to ensure a 50 mm (2”) minimum clearance under each inertia base.

.5 Isolators:

.1 Free Spring Floor Mounted Isolators: Type FS – Free-standing, laterally stable, unhoused spring isolators with components for leveling and securing equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Type FST – same as Type FS with the addition of an equipment support top plate.

.2 Restrained Spring Floor Mounted Isolators: Type CSR – Laterally stable, vertically restrained spring isolators with welded steel housings and heavy top plates for supporting equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Housings shall include vertically restraining limit stops. Minimum clearance around the restraining bolts and between the housing and the spring shall be 13 mm (0.5"). Top plate and restraining bolts shall be out of contact with the housing during normal operation and neoprene grommets shall be incorporated to minimize short-circuiting of restraining bolts.

.3 Closed Mount Spring Isolators: Type CM – Floor mounted spring isolators with telescoping housings and bolts for leveling and securing equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a neoprene noise isolation pad, minimum 6 mm (0.25") thick, bonded to the base plate. Housings shall be fabricated or welded steel telescoping housings that incorporate neoprene stabilizers to minimize short circuiting and provide vertical damping.

.4 Rubber-in-Shear Floor Mounts: Type RD – “Double-deflection” neoprene isolators, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.

.5 Spring Hangers: Vibration isolator hanger supports with steel springs and welded steel housings. Hangers shall be designed for a minimum of 15 degree angular misalignment from vertical before support rod contacts housing; hangers serving lightweight loads 0.90 kN (200 lbs) and less may be exempt from this requirement. Provide a vertical uplift stopwasher on spring hangers for seismically restrained equipment, duct or piping.

.1 Type SH – spring hanger isolators complete with spring, compression cup, and neoprene acoustic washer.

.2 Type SHR – spring hanger with neoprene isolators complete with spring, compression cup, and neoprene “double-deflection” element at top of hanger.

.3 Type SHB – spring hanger with bottom cup isolators complete with spring, compression cup, and neoprene cup under spring.

.4 Type SHRB – spring hanger with neoprene and bottom cup isolators complete with spring, compression cup, neoprene “double-deflection” element at top of hanger, and neoprene cup under the spring.

.5 Type PSH – precompressed spring hanger isolators complete with spring, compression cup, neoprene acoustic washer, and hardware to compress spring. Springs shall be precompressed to 2/3 rated load.

.6 Type PSHR – precompressed spring hanger with neoprene isolators complete with spring, compression cup, neoprene “double-deflection” element at top of hanger, and hardware to compress spring. Springs shall be precompressed to 2/3 rated load.

.7 Type PSHB – precompressed spring hanger with bottom cup isolators complete with spring, compression cup, neoprene cup under spring, and hardware to compress spring. Springs shall be precompressed to 2/3 rated load.

.8 Type PSHRB – precompressed spring hanger with neoprene and bottom cup isolators complete with spring, compression cup, neoprene "double-deflection" element at top of hanger, neoprene cup under the spring, and hardware to compress spring. Springs shall be precompressed to 2/3 rated load.

.6 Neoprene Hangers: Type NH – "Double-deflection" neoprene hanger isolators, each with an integral neoprene sleeve between hanger rod and housing. The neoprene element shall include an internal metal washer as a fail safe to prevent pull-out failure. Provide vertical uplift stopwasher on neoprene hangers for seismically restrained equipment, duct or piping.

.7 Vibration Isolation Pads: Type N – Neoprene pad type isolators, 10 mm (0.375") minimum thick, ribbed on both sides. Type NSN – Sandwich neoprene pad type isolators, with 10 mm (0.375") minimum thick ribbed neoprene pads bonded to each side of a 3.5 mm (10 ga) minimum galvanized metal plate. Isolator pads shall be selected to ensure that deflection does not exceed 20% of isolator free height.

.8 Curb-mounted Spring Rail: Type RTR – Full-perimeter rail type isolator, minimum 1.6 mm (16ga) formed galvanized steel construction with integral spring isolators designed to fit over a roof curb and under the isolated equipment. Wind resistance shall be provided by means of resilient snubbers with a minimum clearance of 6 mm (0.25") so as not to interfere with the spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof, flexible EPDM connection joining the outside perimeter of the upper and lower members. The rail shall be manufactured, shipped and installed as a single piece unless its size exceeds standard shipping dimensions. Shipping splits and lifting points shall be coordinated with the installing contractor. An optional acoustic barrier system shall be provided as scheduled.

2.3 SEISMIC AND WIND RESTRAINTS

.1 General:

.1 Provide positive seismic and wind restraints on those systems and components required by the applicable building code and by the local authority having jurisdiction.

.2 Provide restraint devices as required, specified, and as scheduled for isolated and non-isolated systems and equipment. Provide calculations to determine restraint loadings for all restrained systems and equipment resulting from seismic forces.

.3 See the vibration isolation and seismic restraint schedule on the drawings for equipment specific values to be used in calculating the seismic restraint forces, including component importance factor, Ip.

.2 Vibration isolators with integral seismic restraint: Isolator housings shall be capable of withstanding the applicable design forces for the specific installation.

.1 Seismic Spring Floor Mounts: Type SFS – Laterally stable, restrained spring type with support for bolting to the equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a neoprene noise isolation pad, minimum 6 mm (0.25") thick, bonded to the base plate. Mount shall include integral all-directional limit stops with elastomeric grommets preventing metal-to-metal contact and with minimum 1/4" clearance under normal operation.

.2 Seismic Restrained Spring Isolator: Type SCSR – Laterally stable, restrained spring type with housings and heavy top plates for supporting the equipment and resisting seismic and wind loading. Housings shall be of welded steel construction and include vertically restraining limit stops. Maximum clearance around the restraining bolts shall be 6 mm (0.25"). Top plate and restraining bolts shall be out of contact with the housing during normal operation and neoprene grommets shall be incorporated to minimize short-circuiting of restraining bolts.

.3 Seismic Restrained Curb-mounted Spring Rail: Type RTR w/ seismic restraint – Full-perimeter rail type, minimum 16 ga formed galvanized steel construction with integral spring isolators designed to fit over a roof curb and under the isolated equipment. Seismic and wind resistance shall be provided by means of wire rope assemblies and resilient snubbers with a minimum clearance of 3 mm (0.125") so as not to interfere with the spring action under normal operation. The weather seal shall consist of continuous

closed cell sponge materials both above and below the base and a waterproof, flexible neoprene connection joining the outside perimeter of the upper and lower members. The rail shall be manufactured, shipped and installed as a single piece unless its size exceeds standard shipping dimensions. Shipping splits and lifting points shall be coordinated with the installing contractor. An optional acoustic barrier package shall be provided as required and scheduled.

.4 Seismic Cable Restraints: Type SRK – Seismic cable sway bracing restraints shall consist of 7x19 galvanized steel aircraft cable sized to resist seismic loads with a safety factor of five (5). Cable end connections shall use heavy brackets, thimbles, and wire rope clips or compression sleeves.

.5 Hanger Rod Stiffener: Structural steel angle attached with a formed steel clamp (Type VAC) to threaded rod support. Steel angle to be provided by contractor; steel clamp to be provided by seismic restraint manufacturer.

.6 Seismic Restraint Brackets: Type SRB – Formed steel brackets for securing floor-mounted equipment complete with pre-drilled holes. Brackets shall be galvanized or powder coated enamel for corrosion protection.

.7 Seismic Snubber: Structural steel angle(s) with surfaces covered with ribbed neoprene pads to cushion contact with snubber. Customized snubber designs may use other structural shapes and configurations as required. Snubbers shall be designed to limit equipment motion to no more than 6 mm (¼") in any direction.

.8 Concrete Anchor Bolts: Post-installed anchors in concrete shall be qualified for seismic restraint application in accordance with ACI 355.2.

.1 Mechanical anchor bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications.

.2 Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications.

.9 Grommet Washers: Type GW neoprene grommet washers, 70 durometer, of sufficient size to accommodate USS standard washers, long enough to sleeve through 6 mm (¼") plate material, and with at least 3 mm (1/8") thick material around the bolt hole.

3 Execution

3.1 INSTALLATION

.1 Install all vibration isolation equipment in accordance with the manufacturer's instruction. Where conflict occurs between the requirements of this Section and the manufacturer's instructions, apply the most stringent requirements.

.2 Coordinate size, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.

.3 Coordinate locations and sizes of structural supports with locations of vibration isolators and seismic/wind restraints (e.g., roof curbs, cooling towers, air-cooled chillers, etc.).

.4 Isolated and restrained equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.

3.2 VIBRATION ISOLATION

.1 Block and shim all bases level so that all electrical connections can be made to a rigid system at the proper operating level, before isolators are adjusted. Ensure that there are no rigid connections or incidental physical contacts between isolated equipment and the building structure or nearby systems.

.2 Ensure housekeeping pads have adequate space to mount equipment and isolator housings and shall also be large enough to ensure adequate edge distance for isolator anchors.

.3 Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.

.4 Extent of Conduit Isolation:

.1 Isolate all conduits larger than 25 mm (1") dia. rigidly connected to vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with the following:

Conduit Diameter	Distance from Vibrating Equipment
2 inches to 4 inches	50 feet
Pipe Diameter	Distance from Vibrating Equipment
50 mm to 100 mm	15 m

3.3 SEISMIC RESTRAINTS

.1 General

.1 All lighting, equipment and conduits shall be restrained to resist seismic forces per the applicable building code(s) as a minimum. Additional requirements specified herein are included specifically for this project.

.2 Install seismic restraint devices per the manufacturer's submittals. Any deviation from the manufacturer's instructions shall be reviewed and approved by the manufacturer.

.3 Attachment to structure for suspended equipment, pipe and duct: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

.4 Wall penetrations may be used as bracing locations provided the wall can provide adequate resistance without significant damage.

.5 Coordinate sizes and locations of cast-in-place inserts for post-tensioned slabs with seismic restraint manufacturer.

.6 Provide hanger rod stiffeners where indicated or as required to prevent buckling of rods due to seismic forces.

.7 Where rigid restraints are used on equipment, conduits, support rods for the equipment and conduits at restraint locations must be supported by anchors rated for seismic use. Post-installed concrete anchors must be in accordance with ACI 355.2.

.8 Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices and shall also be large enough to ensure adequate edge distance for restraint anchor bolts to avoid housekeeping pad breakout failure.

.2 Concrete Anchor Bolts:

.1 Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre- or post-tensioned tendons, electrical and telecommunications conduits

.2 Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

.3 Mechanical Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

.4 Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

.5 Set anchors to manufacturer's recommended torque, using a torque wrench.

.3 Equipment Restraints:

.1 Install fasteners, straps and brackets as required to secure all electrical equipment.

.2 Install neoprene grommet washers on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 3.2 mm (0.125 inch).

.3 Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

3.4 CONDUIT SYSTEMS

.1 Unless otherwise indicated on the drawings, the component importance factor for conduit systems shall be assigned as follows:

.1 Electrical conduits: Ip=1.5.

.2 For projects with a Seismic Design Category of C, provide seismic cable restraints on the following:

.1 All conduit systems assigned a component importance factor, Ip, of 1.5 with a nominal pipe diameter greater than 50 mm (2”) or trapeze-supported piping with combined operating weight over 15 kg/m (10 lb/ft).

.3 For projects with a Seismic Design Category of D, E or F, provide seismic cable restraints on the following:

.1 All conduit greater than 75 mm (3”) nominal diameter.

.2 All conduit systems assigned a component importance factor, Ip, of 1.5 with a nominal pipe diameter greater than 25 mm (1”) or trapeze-supported conduits with combined operating weight over 15 kg/m (10 lb/ft).

.4 This specification does not allow the use of the “12-inch rule” where conduit may be exempted from seismic restraint based on the length of the support rods.

.5 Restraint spacing:

.1 For conduits, space lateral supports a maximum of 12 m (40 feet) o.c., and longitudinal supports a maximum of 24 m (80 feet) o.c.

.2 For conduit risers, restrain the piping at floor penetrations using the same spacing requirements as above.

.6 Brace a change of direction longer than 3.7 m (12 feet).

.7 Longitudinal restraints for single conduit supports shall be attached directly to the conduit, not to the conduit hanger.

.8 For supports with multiple conduits (trapezes), secure conduits to trapeze member with clamps approved for application.

.9 Install restraint cables so they do not bend across edges of adjacent equipment or building structure.

.10 Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.

.11 Install flexible connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

.12 Coordinate seismic restraints with thermal expansion compensators, guides and anchor points. Thermal expansion anchor points shall be designed to accommodate seismic forces.

3.5 PANELBOARDS, LIGHTING, EMERGENCY LIGHTING BATTERY UNITS, AND EMERGENCY REMOTE HEADS

.1 Wall mounted panelboards, lighting, emergency lighting battery units, and emergency remote heads can be directly mounted to the building structure with approved fasteners to suit. Minimum two or more anchors shall be provided on each side of all wall mounted equipment.

.2 For emergency battery units, pre-installed brackets must be used.

3.6 FIELD TESTS AND INSPECTIONS

.1 After installation, arrange and pay for the vibration isolation product manufacturer to visit the site to verify that the vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that isolators are adjusted, with springs installed perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.

.2 After installation, arrange and pay for the seismic restraint product manufacturer to visit the site to verify that the seismic restraint systems are installed properly, and shall submit a certificate so stating.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Nameplates and labels.

.2 Wire and cable markers.

.3 Conduit markers.

.4 Receptacle labels.

.5 Signage.

1.2 RELATED REQUIREMENTS

.1 Section 27 05 53 – Identification for Communications Systems.

1.3 SUBMITTALS

.1 Product Data: Provide catalogue data for nameplates, labels, and markers.

.2 Provide shop drawings of nameplates for Consultant's review prior to fabrication (scale 1:1)

.3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.4 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.1 NAMEPLATES AND LABELS

.1 Nameplates:

.1 Engraved three-layer laminated plastic, letters on contrasting background.

.2 Colours to match existing building system, where applicable. If no building system exists, use the following:

.1 347/600 Volt System: White text on Blue Background.

.2 120/208 Volt System: Black text on White Background.

.3 Fire Detection System: White text on Red Background.

.4 Emergency Lighting System: Red text on White Background.

.5 LV Systems: White text on Green Background.

.6 120/208 Volt Uninterruptable Power Supply (UPS): White text on Orange Background.

.3 Confirm colours with Engineer prior to ordering nameplates.

.2 Equipment Nameplates to indicate:

.1 Equipment/Panelboard ID

.2 Ampacity.

.3 Voltage

.4 Number of Phases

.5 Number of wires in system

.6 Interrupting Capacity

.7 Size, number of poles, Panelboard ID, and circuit number of upstream overcurrent protection device.

.1 Location of upstream device if not in the same room.

.3 Coordination Study Labels to Section 26 05 73.16.

.4 Arc Flash Study Labels to Section 26 05 73.19.

.5 Locations:

.1 Distribution panelboards, and individual distribution panelboard branch breakers.

.2 Receptacle panelboards.

.3 Each electrical distribution and control equipment enclosure.

.4 Uninterruptible Power Supply.

.5 Mechanical Equipment.

.6 UPS Receptacles.

.7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.8 Terminal cabinets, junction boxes, and pull boxes: indicate system and voltage.

.9 Transformers: indicate capacity, primary and secondary voltages.

.6 Letter Size:

.1 Use 3 mm letters for identifying individual equipment and loads.

.2 Use 6 mm letters for identifying grouped equipment and loads.

.7 Labels:

.1 Mechanically fastened with sheet metal screws, with 5 mm white letters on black background.

.2 White letters on red background for UPS and equipment, and devices downstream of UPS.

.3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.

.4 Wording on nameplates and labels to be approved by the Engineer prior to manufacture.

.5 Allow for minimum of twenty-five (25) letters per nameplate and label.

.6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

2.2 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

2.3 WIRE MARKERS

.1 Description: tape, split sleeve, or tubing type wire markers.

.2 Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.

.3 Legend:

.1 Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

.2 Control Circuits: Control wire number indicated on shop drawings.

2.4 CONDUIT MARKERS

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Location: Provide markers for each conduit longer than 2 m.

.3 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.4 Colours to match equipment nameplate background colour:

.1 347/600 Volt System: Blue.

.2 120/208 Volt System: Black.

.3 Fire Alarm System: Red.

.4 Emergency Lighting System: Red/White.

.5 LV Systems (EPO, Remote Monitoring, Generator Control, Communications): Green.

.6 120/208 Volt Uninterruptable Power Supply (UPS): Orange

.5 Confirm colours with Engineer prior to commencing rough-in.

2.5 BRANCH BREAKER LABELS

.1 General:

.1 Legibly identify every circuit and circuit modification as to its clear, evident, and specific purpose or use. Include sufficient detail to allow each circuit to be distinguished from all others.

.2 Label spare positions that contain unused overcurrent devices or switches.

.3 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

.2 Switchboards, distribution panelboards, enclosed breakers, and disconnect switches:

.1 Locate identification at each switch.

.2 Branch breaker nameplates on switchboards, distribution panelboards and switchboards, and generator load breakers to indicate:

.1 Locate identification at each switch on a switchboard.

.2 Identification of downstream equipment fed from the breaker.

.1 Location of downstream device if not in the same room.

.3 Breaker size and number of poles.

.4 Interrupting Capacity.

.5 Circuit number (where applicable).

.6 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

.3 Lighting and Receptacle Panelboards:

.1 Provide a circuit directory that is located on the face or inside of the panel door.

.2 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

2.6 RECEPTACLE LABELS

.1 Label all receptacles with the panelboard ID and circuit number.

.2 Use receptacle labels by electronic labeller Brother P-Touch, model PT-20/25, Dymo-Tape or approved equal.

.3 Location: On receptacle wall plate.

3 Execution

3.1 EQUIPMENT NAMEPLATES FROM MANUFACTURERS

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

.2 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.

.3 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

3.2 CONDUIT IDENTIFICATION

.1 Locate labels as follows:

.1 At every end of every conduit, duct or cable run, adjacent to item of equipment serviced.

.2 On each exposed conduit, duct or cable passing through a wall, partition or floor (one on each side of such wall partition or floor).

.3 At intervals of 50'-0" along every exposed conduit, duct or cable run exceeding 50'-0" in length.

.4 At every access point on concealed conduit duct or cable.

.2 Place labels so as to be visible from 5'-0" above adjacent floor platform.

3.3 PREPARATION

.1 Degrease and clean surfaces to receive nameplates and labels.

3.4 APPLICATION

.1 Confirm colours prior to start of work.

.2 Install nameplate and label parallel to equipment lines.

.3 Secure nameplate to equipment front using adhesive.

.4 Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

.5 Identify conduit using field painting.

.6 Paint coloured band on each conduit longer than 2 m.

.7 Paint bands 6 m on centre.

3.5 LABELLING

.1 Colour code wiring consistently throughout the installation and generally match colour coding of internal wiring of pre-wired components.

.2 Label wiring with point name using Thomas & Betts 12 character polestar metalized labels with 3 rows of characters per label, or equal by Brady. Label to occur as a minimum at both ends and at pull boxes of the wiring run.

.3 Identify all pull boxes, junction boxes, etc. (installed as part of this project or used by this project) with the exact use of the box. Indelible felt pen marker is acceptable.

.4 Label light control items with point name using Thomas & Betts 12 character label, or equal by Brady. Label to be black lettering on clear backing.

.5 Label relays and controllers inside panels using Thomas & Betts 12 character label, or equal by Brady.

.6 Provide red, 13 mm (1/2 inch) diameter, sticker on emergency light fixture frame. Include circuit number on sticker with thin permanent black mark pen.

3.6 LABELS AND SIGNS

.1 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.

.2 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Provide a coordination study for the new portions of electrical distribution system. The basic analysis shall include a protective device evaluation, and a protective device coordination study.

.2 The project shall begin at the point of utility service for the facility and continue down through the system to all downstream distribution and branch panelboards, motor control centres and significant motor locations.

.3 The project shall include any new generators and any associated emergency power distribution equipment, including automatic transfer switches and generator ground fault protection.

1.2 RELATED REQUIREMENTS

.1 Section 26 05 73.19 – Arc-Flash Hazard Analysis.

.2 Single Line Diagram.

1.3 REFERENCE STANDARDS

.1 Perform all studies in accordance with the latest applicable IEEE and ANSI standards.

1.4 SUBMITTALS

.1 Submit the following in accordance with Section 26 05 00:

.1 Submit for review three copies of the protection coordination study.

.2 Shop drawings for equipment affected by the coordination study will not be reviewed until the coordination study has been submitted and reviewed.

.3 Include a one-line diagram of the system.

.4 Bind the final report in a three-ring binder, as well as a soft copy.

.2 Projection System Coordination

.1 Prepare a graph or coordination curves, prior to manufacture of service entrance and distribution equipment on K & E No. 336E Time-Current characteristic graph paper. Time-current characteristics shall be plotted of the following:

.1 Supply Authorities relays or fuses protecting incoming service (Contractor under this section shall obtain this information).

.2 Main and feeder protective devices at every voltage level used in distribution system.

.3 Protective devices associated with largest motor and/or refrigeration compressor.

.2 Preliminary submission of graph for comment will be accepted. Submit graph to Supply Authority for approval by them as providing satisfactory co-ordination. When curves have been approved by Supply Authority, they shall be submitted for approval. After approval has been obtained, order protective devices and calibrate to conform with these curves.

.3 Each time-current characteristic curve sheet shall include:

.1 A single line diagram for the portion of the system involved.

.2 Transformer damage curves (where applicable).

.3 Cable damage curves (where applicable).

.4 Available fault levels for the portion of the system involved.

.4 Consult manufacturer of the refrigeration compressors and obtain recommendations for settings on starters. Incorporate information in co-ordination curves and submit the associated curves to Compressor Manufacturer and obtain approval from the manufacturer.

.5 Compressor manufacturer and mechanical trade contractor will determine and calibrate proper protection on motor starters and will ensure that it co-ordinates with protective devices on switchboard.

.6 Co-ordination curves, mentioned above, shall be prepared by distribution equipment manufacturers as soon as possible after award of contract.

.7 At the option of this contractor under this section, these co-ordination curves may also be prepared by an independent testing organization. In this case, the independent testing organization shall determine the proper settings of all protective relays and devices and pass them on to the Switchboard manufacturer for incorporation into the switchboards. Include all associated costs in the tender.

.8 Distribution Equipment manufacturers shall examine drawings and specifications prior to award of contract to ensure that relays and devices being supplied by them will co-ordinate satisfactorily to Supply Authority requirements. Payment will not be allowed, after award of contract, for extra charges due to device changes to comply with recommended practices, due to oversight or negligence by distribution equipment manufacturers.

1.5 QUALITY ASSURANCE

.1 Preparer Qualifications: Firm experienced in the analysis, evaluation, and coordination of electrical distribution systems and similar to the system for this project.

.2 The study shall be prepared in accordance with the latest edition of NETA ATS, the Canadian Electrical Code, as well as manufacturer's recommendations.

.3 Short-Circuit Analysis and Coordination Study shall be performed by a registered Professional Engineer in Ontario. Study shall be signed and sealed by the Engineer. The Engineer shall have a minimum of eight years experience in the analysis, evaluation, and coordination of electrical distribution systems.

.4 The firm conducting the study shall have one million worth of Professional Liability Insurance in addition to standard general insurance.

2 Products

2.1 ACCEPTABLE TESTING ORGANIZATIONS

.1 Independent Testing Organizations

.1 AC Tesla.

.2 Brosz and Associates.

.3 C-INTECH.

.4 Eastenghouse.

.5 Enkompass.

.6 G.T. Wood.

.2 Electrical distribution manufacturers:

.1 Eaton.

.2 Schneider Electric.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

.1 Prepare coordination time-current characteristic curves to determine the required settings/sizes of the protective devices to maximize selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves shall be created through the use of the study software package, but must reflect actual protective devices to be installed. Adequate time-current curves shall be generated to depict coordination. In addition, protective device characteristics shall be suitably determined to reflect calculated short-circuit levels at the location.

.2 A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. All curve sheets shall be multi-color for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide solution to resolve situation. System coordination, recommended ratings, and setting of protective devices shall be accomplished by a registered professional electrical engineer with a minimum of eight years of current experience in the coordination of electrical power systems.

.3 The following information shall be provided on all curve sheets.

.1 Device identification and associated settings/size.

.2 Voltage at which curves are plotted.

.3 Current multiplier.

.4 ANSI frequent fault damage curve.

.5 Cable insulation damage curves.

.6 Transformer inrush point.

.7 Single-line for the portion of the system.

.8 Motor starting profiles (where applicable).

2.3 SINGLE LINE DIAGRAM

.1 The final report shall include a multi-color single-line diagram of the electrical distribution system within the scope of the project. The single-line shall include:

.2 Transformer rating, voltage ratio, impedance, and winding connection.

.3 Feeder cable phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.

.4 Switchboards, panelboards, fuses, circuit breakers, ATS's and switches continuous current ratings.

.5 Protective relays with appropriate device numbers and CT's and PT's with associated ratios.

.6 Detailed legend indicating device type identification and other significant details.

3 Execution

3.1 SUMMARY

.1 The results of the system studies shall be summarized in a final report.

.2 Where required, copies of the final report shall be submitted to the Supply Authority for their review and approval. Approved copies or the report shall be submitted to the Consultant.

3.2 ADJUSTING

.1 The contractor shall engage the manufacturer's service group or alternately a qualified independent testing firm to perform field adjustments of the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation / coordination study.

.2 Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved protective device coordination study, shall be carried out by manufacturer's service group.

.3 Submit a final service report confirming that settings have been completed.

End of Section

1 General

1.1 SECTION INCLUDES

.1 The contractor shall provide an Arc Flash Hazard Analysis Study per the requirements described in CSA-Z462 Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are obtained in CSA-Z462-08, Annex D.

.2 The scope of the studies shall include all existing distribution equipment and all new distribution equipment supplied by the equipment Manufacturer under this contract.

1.2 RELATED REQUIREMENTS

.1 Section 26 05 73.16 – Coordination Studies.

.2 Single Line Diagram.

1.3 REFERENCES

.1 References

.1 Institute of Electrical and Electronics Engineers, Inc. (IEEE):

.1 IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems

.2 IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

.3 IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis

.4 IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings

.5 IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

.6 IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations

.2 American National Standards Institute (ANSI):

.1 ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

.2 ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures

.3 ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

.4 ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

.3 The National Fire Protection Association (NFPA)

.4 OESC – Ontario Electrical safety Code

.5 CSA-Z462 – Workplace Electrical Safety

1.4 ACTION SUBMITTALS

.1 Submit the protective device coordination study to the Consultant prior to receiving final review of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

.1 The results of the protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Three (3) bound copies of the complete final report shall be submitted. Additional copies of the complete report with input and output data shall be provided on CD in PDF format.

.2 The report shall include the following sections:

.1 Executive Summary

.2 Descriptions, purpose, basis and scope of the study

.3 Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties

.4 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection

.5 Fault current calculations including a definition of terms and guide for interpretation of the computer printout

.6 Details of the incident energy and flash protection boundary calculations

.7 Recommendations for system improvements, where needed

.8 Single Line Diagram

.3 Arc flash labels (refer to CSA 2462-08 Annex Q) shall be provided in hard copy only.

1.6 QUALIFICATIONS

.1 Arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

.2 The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.

.3 The Registered Professional Electrical Engineer shall have a minimum of eight (8) years of experience in performing power system studies.

.4 The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year

1.7 COMPUTER ANALYSIS SOFTWARE

.1 The studies shall be performed using the latest revision of the SKM or equivalent.

2 Products

2.1 ACCEPTABLE TESTING ORGANIZATIONS

.1 Independent Testing Organizations

.1 AC Tesla.

.2 Brosz and Associates.

.3 C-INTECH.

.4 Eastenghouse.

.5 Enkompass.

.6 G.T. Wood.

.2 Electrical distribution manufacturers:

.1 Eaton.

.2 Schneider Electric.

2.2 STUDIES

.1 The contractor shall furnish an Arc Flash Hazard Analysis Study per CSA 2462-08 Standard for Electrical Safety in the Workplace, reference Section 4.1.8.2.2, 4.3.3

2.3 DATA COLLECTION

.1 Contractor shall furnish all data as required by the power system studies. The Engineer performing arc flash hazard analysis studies 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 studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

.2 Source combination may include present and future motors and generators.

.3 If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.4 ARC FLASH HAZARD ANALYSIS

.1 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in CSA Z462-08 Annex D.

.2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, panelboards and splitters) where work could be performed on energized parts.

.3 The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 112.5 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 calories per square centimetre.

.5 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the 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:

.1 Fault contribution from induction motors should not be considered beyond 3-5 cycles.

.8 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).

.9 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.

.10 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.

.11 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.

.12 Arc Flash calculations shall be based on actual overcurrent protective device clearing time.

.13 Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

.14 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.

2.5 REPORT SECTIONS

.1 Incident energy and flash protection boundary calculations

.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

3 Execution

3.1 FIELD ADJUSTMENT

.1 Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

.2 Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

.3 Notify Owner in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

.1 The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 inch by x 5 inch 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 firm and issue date.

.8 Labels shall be machine printed, with no field markings.

.4 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 volt, and applicable 208 volt panelboard, one arc flash label shall be provided.

.2 For each low voltage switchboard, one arc flash label shall be provided.

.5 Arc Flash Warning Label General Instruction

.1 Only qualified electricians who recognize and avoid the electrical and Arc Flash hazards are allowed to place the arc flash warning labels.

.2 Electricians should wear suitable PPE, such as electrical safety boots, Safety Glasses, etc. while performing labeling.

.3 Generally, arc flash label shall be put on a prominent pre-cleaned place on the front of the electrical equipment (such as panel, disconnect switch, generator output breaker). Label should be visible and readable, displayed horizontally, attached flatly and securely, and not allowed to cover other signs or labels on the equipment.

.4 Under the special request of the client, labels could be put on the back of the panel door when the panel is located in clean and finished spaces such as an office area.

.5 When putting a label on small equipment with no space labeling on the wall just beside the equipment is allowed.

.6 Special request may be attached to this General Instruction. For examples, more than one identical label is applied for large equipment; different labels could be applied for different sections of one equipment; for a splitter with several disconnect switches only one label is placed on the splitter for this group.

.7 Take the pictures for each label to indicate both names of the label and equipment and labeling area of the equipment. Email these pictures to the Consultant for quality control and record.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Electrical connections to equipment specified in other sections.

1.2 RELATED REQUIREMENTS

.1 Division 08 – Openings.

.2 Division 11 – Equipment.

.3 Division 21 – Fire Suppression.

.4 Division 22 – Plumbing.

.5 Division 23 – Heating, Ventilating, and Air Conditioning.

1.3 REFERENCES

.1 NEMA WD 1 - General Colour Requirements for Wiring Devices.

.2 NEMA WD 6 - Wiring Devices - Dimensional Requirements.

1.4 COORDINATION

.1 Coordinate work to Section 26 05 00.

.2 Obtain and review shop drawings, product data, and manufacturer's instructions for equipment provided under other sections.

.3 Determine connection locations and requirements.

.4 Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

.5 Sequence electrical connections to coordinate with start-up schedule for equipment.

1.5 SUBMITTALS

.1 Submit to Section 26 05 00.

.2 Product Data: Provide wiring device manufacturer's catalogue information showing dimensions, configurations, and construction.

.3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.6 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

2 Products

2.1 COMMON MOTOR REQUIREMENTS

.1 Motors up to and including 1/3 HP, shall be 1 phase, 60 Hz, 120 volts.

.2 Motors 1/2 HP and above shall be 3 phase, 60 Hz, 575 volts or 208 volts.

2.2 CORDS AND CAPS

.1 Attachment Plug Construction: Conform to NEMA WD 1.

.2 Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

.3 Cord Construction: NFPA 70, Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

.4 Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

3 Execution

3.1 WIRING OF EQUIPMENT PROVIDED UNDER OTHER DIVISIONS

.1 Use the following procedure with regard to wiring of motors and equipment provided under other Divisions.

.2 The following equipment shall be responsibility of the trade supplying the equipment unless otherwise noted, in accordance with the requirements laid out in the individual section, or this division:

.1 Motors.

.2 Starters.

.3 Variable Frequency Drives.

.4 Control wiring.

.3 In every instance, install starter, variable frequency drivers (VFD), etc. and wire to line side of the starter or VFD. Extend wiring from starter or VFD to motor as indicated.

.4 Provide all wiring for starters and VFD's from supply to starter to VFD and to motor. Coordinate requirements with the appropriate trade.

.5 Provide 500 mm of liquid tight flexible metal conduit for final connection to motor. Provide disconnect switches where required by code, and as indicated on the drawings.

.6 Where individual starters and controls are grouped together provide a panel for mounting this equipment. Provide a feeder, main fused disconnect and a splitter of adequate size and capacity and wire to line side of the starters on this panel and from starters to motors.

.7 Equipment, General

.1 Ascertain exact locations of starters, motors, etc. from drawings and coordinate exact locations with the supplying trade.

.2 Control wiring shall be the responsibility of the supplying trade.

.1 Control wiring shall be in accordance with Section 26 05 19, and Section 26 05 23.

.2 Control wiring shall be installed in conduit in accordance with Section 26 05 33.13.

.8 Plumbing Equipment

.1 Ascertain exact locations of starters, motors, infra-red plumbing fixture controls from Mechanical Drawings and coordinate exact locations with plumbing trade.

.2 Provide branch circuit wiring and an outlet for each infra-red plumbing fixture control.

.3 Control wiring shall be the responsibility of the plumbing trade, as described above.

.9 HVAC Equipment

.1 Ascertain exact locations of starters, motors, motorized dampers, VAV boxes, and heating control valves from HVAC drawings and coordinate exact locations with HVAC Division.

.2 In the case of unit heaters, reheat coils and cabinet unit heaters, terminate wiring on terminals provided. Control wiring, thermostats, or other control devices shall be the responsibility of the HVAC trade, as described above.

.3 Provide branch circuit wiring and an outlet for each motorized damper, variable air volume (VAV) box, or heating control valve. Control wiring shall be the responsibility of the HVAC trade, as described above.

3.2 EXAMINATION

.1 Verify that equipment is ready for electrical connection, wiring, and energization.

3.3 ELECTRICAL CONNECTIONS

.1 Make electrical connections to equipment manufacturer's instructions.

.2 Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

.3 Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

.4 Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

.5 Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

.6 Install disconnect switches, controllers, control stations, and control devices as indicated.

.7 Modify equipment control wiring with terminal block jumpers as indicated.

.8 Provide interconnecting conduit and wiring between devices and equipment where indicated.

.9 Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Commissioning of all building electrical systems and component including:

.1 Testing and adjustment.

.2 Demonstration and training.

.3 Instructions of all procedures for Owner's personnel.

.4 Updating as-built data.

.5 Co-ordination of Operation and Maintenance material.

.2 Provide labour and material to conduct the commissioning process as outlined in this specification section, including the hiring of an Independent Testing Contractor (ITC) as detailed below.

.3 Provisions of this section shall apply to all sections of Division 26, Division 27, Division 28, and sections related to electrical utilities in Division 33.

1.2 RELATED REQUIREMENTS

.1 Testing and commissioning are called for throughout the individual specifications. This does not relieve this trade from providing all testing and commissioning necessary to ensure that systems and equipment operate as required and that they interface with other systems and equipment as required.

.2 Section 26 08 50 – Commissioning of Lighting: additional commissioning requirements for commissioning of lighting and lighting controls.

1.3 COMMISSIONING PROCESS ALLOCATION

.1 The commissioning process shall be allocated a value equal to 5 per cent of the contract. The Electrical Contractor may draw from this allocation as the commissioning process is completed.

.2 The Electrical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.

.3 The Electrical Contractor may claim up to 3 per cent of the contract from this allocation leading up to performance testing. The remaining 2 per cent shall not be paid out until the performance testing, O&M manuals, and training have been completed satisfactorily.

1.4 DEFINITIONS

.1 Cx – Commissioning.

.2 Commissioning Authority

.1 The Commissioning Authority (CxA), also referred to as the Commissioning Consultant, shall be hired by The Owner.

.2 The CxA responsibilities shall include:

.1 preparing the commissioning plan

.2 co-ordinating with the contractor to schedule tests

.3 preparing a test form manual

.4 witnessing selected tests

.5 receiving all test forms

.6 co-ordinating the contractors training

.7 chair the commissioning meetings

.3 The Electrical Contractor shall co-operate with the CxA.

.4 The Electrical Contractor shall provide assistance to the CxA and have personnel available during the performance testing procedure. Each electrical system shall be tested in the operational mode.

1.5 SUBMITTALS

.1 Conform to Section 26 05 00 for requirements for shop drawings and record drawings.

.2 A commissioning document shall be prepared by the CxA prior to conducting these activities for use by the Commissioning Team.

.3 The electrical sub-contractor shall be responsible for ensuring all activities are properly documented in this manual and co-ordinated through the General Contractor.

.4 As-built drawings and data books must be available two weeks prior to commissioning for review and use by the consultant and Commissioning Team prior to the start of the commissioning activities.

1.6 QUALITY ASSURANCE

.1 Provide qualified trades persons, certified testing agencies, factory trained and approved by the Commissioning Team Leader.

.2 Submit the names of all personnel to be used during the Commissioning activities.

1.7 WARRANTY

.1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the Owner.

.2 The Electrical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.

.3 Refer to Division 01 and Section 26 05 00 for the requirements during the warranty period.

2 Products

2.1 EQUIPMENT

.1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Contractor shall advise the Consultant of instrumentation to be used and the dates the instruments were calibrated.

3 Execution

3.1 THE COMMISSIONING PROCESS

.1 The purpose of the commissioning process is to fully test all building systems including architectural, mechanical and electrical components and operating procedures by challenging these systems to realistic operation conditions.

.2 The commissioning process consists of:

.1 Shop Drawings and Record Drawings

.2 Installation inspection and equipment verification

.3 Independent testing contractor

.4 Testing of equipment and systems

.5 Commissioning meetings

.6 Operating and maintenance manuals

.7 Operating training

.8 Commissioning Agent testing

.9 Systems Demonstration and turnover

.10 Testing forms

.11 Warranties

3.2 PREPARATION

.1 Provide test instruments required for all activities as defined in the commissioning documents.

.2 Verify all systems are in compliance with the requirements of the commissioning documents prior to the pre-commissioning check out operation.

.3 Confirm all scheduled activities have identified personnel available.

.4 Where systems or equipment do not operate as required, make the necessary corrections or modifications, re-test and re-commission.

3.3 SYSTEM DESCRIPTION

.1 Perform all start-up operations, control adjustment, trouble shooting, servicing and maintenance of each item of equipment as defined in the commissioning documentation.

.2 Owner will provide list of personnel to receive instructions and will co-ordinate their attendance at agreed upon times.

.3 Prepare and insert additional data in the operations and maintenance manuals and update as-built drawings when need for additional data becomes apparent during the commissioning exercise.

.4 Where instruction is specified in the commissioning manual, instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.

.5 Conduct presentation on Owner's premises. Owner will provide space.

3.4 COMMISSIONING

.1 Commission the components of the electrical system using the NETA Acceptance Testing Specifications.

.2 Refer to the project commissioning plan prepared by the CxA.

.3 Commissioning activities for the electrical systems must have available up to date as-built drawing information and accurate Operations and Maintenance Manuals. These documents shall be a major part of this activity.

.4 Contractor shall be responsible to update all documentation with information and any changes duly noted during the Commissioning exercise.

.5 Contractor shall arrange for all outside suppliers, equipment manufacturers, test agencies and others as identified in the commissioning sections of this specification. The cost associated with this requirement shall be included as part of the tender price.

3.5 FINAL REPORT

.1 This trade shall assemble all testing data and commissioning reports and submit them to the General Contractor for submission to the Owner.

.2 Each form shall bear signature of recorder, and that of supervisor of reporting organizer.

3.6 SCHEDULE OF ACTIVITIES

.1 Commissioning activities shall be conducted based on pre-established schedule with all members of the commissioning team.

.2 In addition, there will be two meetings held through the contract duration to introduce the parties of the commissioning team, establish the schedules and deadlines for the various activities and review the Commissioning Manual.

.3 Adhering to the established schedule is very important as the co-ordination and scheduling of the participants will be difficult to alter once this is established. Close co-ordination of this schedule is important.

.4 In the event project cannot be commissioned in the allotted time slot, the contractor shall pay for all costs associated with assembling the Commissioning Team at a later date. If the contractor has not performed his duties to reach commissioning stage as outlined earlier, he will incur all expenses of other trades and the Commissioning Team due to his non-compliance.

3.7 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION

.1 The Electrical Contractor shall co-ordinate with the Electrical Consultant who will inspect the electrical installation.

.2 The Electrical Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:

.1 Manufacturers name, address and telephone number

.2 Distributors name, address and telephone number

.3 Make, model number and serial number

.4 Voltage and current ratings

3.8 INDEPENDENT TESTING CONTRACTOR

.1 The Independent Testing Contractor (ITC) shall be hired by the contractor and shall issue reports to the Electrical Consultant.

.2 The ITC shall conduct load balancing measurements to verify load balancing performed in accordance with Section 26 05 00.

3.9 TESTING OF EQUIPMENT AND SYSTEMS

.1 The Electrical Contractor shall be responsible for all tests detailed in this Section, and those tests required by a manufacturer as part of their installation requirements.

.2 The Electrical Contractor shall schedule all tests which shall be witnessed by the Electrical Consultant or the Commissioning Consultant. The contractor shall complete and sign the testing forms.

.3 The Electrical Contractor shall conduct tests on the following equipment as a minimum. Refer to the individual specification sections for test procedures.

.1 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

.2 Section 26 05 73.16 – Coordination Studies.

.3 Section 26 24 16 – Panelboards.

.4 Section 27 51 16 – Public Address Systems.

.5 Section 28 46 21.11 – Addressable Fire Alarm Systems.

.4 When all testing has been completed and all mechanical and electrical systems are operational the contractor shall conduct system load balance measurements, infra-red test and harmonics tests.

3.10 COMMISSIONING MEETINGS AND REPORTING

.1 The Electrical Contractor shall include the schedule for all tests in the construction schedule.

.2 The Commissioning meetings shall occur during the regular construction meetings. The testing schedules and the results of all tests shall be reviewed.

.3 All testing forms and reports associated with the electrical systems shall be directed to the Electrical Consultant, with copies to the Architect, Commissioning Consultant, and the Owner.

.4 The forms and reports to be issued shall include:

.1 Shop drawings, issued and accepted

.2 Equipment verification forms

.3 Testing forms

.4 Reports resulting from tests

.5 Testing schedule

.6 Minutes of commissioning meetings

.7 Manufacturers' Certificates

3.11 OPERATING AND MAINTENANCE MANUAL

.1 Conform to the specification section for the requirements of the O&M manuals.

3.12 DEMONSTRATION AND TRAINING

.1 Conform to section for requirements for instructions to the Building Owner for each system and equipment.

.2 The training shall be provided by qualified technicians or electricians and shall be conducted in a classroom and at the equipment or system.

.3 The training sessions shall be scheduled, co-ordinated and video taped by the Commissioning Consultant.

.4 Each training session shall be structured to cover:

.1 The operating and maintenance manual.

.2 Operating procedures.

.3 Maintenance procedures.

.4 Troubleshooting procedures.

.5 Spare parts.

.5 Submit a course outline to the Electrical Consultant before training commences. Provide course documentation for up to eight people.

.6 The training session shall be scheduled and co-ordinated by the Commissioning Consultant. The Commissioning Consultant shall video tape the sessions.

.7 Training shall be provided for the following systems:

.1 Electrical Systems including distribution and lighting: 8 hour minimum

.2 Section 27 51 16 – Public Address Systems: 1 hour minimum

.3 Section 28 46 21.11 – Addressable Fire Alarm Systems: 2 hours minimum

.8 The Electrical Contractor shall conduct a walkthrough of the installation. During the walkthrough the Electrical Contractor shall:

.1 Identify equipment

.2 Identify electrical panels

.3 Identify starters and disconnects

.4 Review the electrical power distribution

.5 Review the light power distribution

.6 Review the switchgear

.7 Review the general maintenance procedures

3.13 THE ELECTRICAL SYSTEM DEMONSTRATION AND TURNOVER

.1 The system demonstration and turnover to The Owner shall occur when:

.1 The installation is complete.

.2 The acceptance test conducted by the Electrical Consultant has been completed successfully.

.3 Training has been completed.

.4 Equipment Operating and Maintenance Manuals have been accepted.

.5 System operating manuals have been accepted.

.6 Shop-drawings have been updated.

.7 As-built drawings have been completed.

.8 The commissioning process has been completed successfully and system operation accepted by the Electrical Consultant and Commissioning Consultant.

.2 The systems demonstration shall be conducted by the Electrical Contractor and manufacturers. The demonstration shall cover a physical demonstration of equipment installation and operation.

3.14 TESTING FORMS

.1 The Electrical Contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The forms must be approved by the Electrical Consultant and the Owner before they are used.

End of Section

Task	Contractor	Consultant	Commissioning
Manufacturer's Start-Up Checklist Completed			
Cooling System			
Inspect heat exchanger/radiator for leaks, damages and debris			
Check filter cap gasket and sealing surfaces			
Check ventilation louver operation			
Check coolant level, PH level, oil and rust contaminate			
Check hoses and connections for deterioration and tightness			
Check jacket water heater hoses for proper operation			
Check jacket water pump for leaks and unusual noises			
Check coolant conditioner concentration and temperature protection			
Check fan drive pulleys, belts and fan for proper lubrication, tension and wear, and clearance.			
Fuel System			
Verify tank has proper gauge and overfill protection device.			
Ensure the tank is installed plumb and level.			
Ensure tank is not leaking at bottom.			
Ensure proper piping of fill and vent pipe.			
Check fuel thanks for leaks and fuel level			
Test day tank pump for proper operation			
Drain off water and sediment from trap or separator			
Check fuel lines for leaks and tightness			
Check fuel line brackets for wear points			
Inspect governor oil level			
Check all governor control linkages for free movement			
Inspect primary and secondary fuel filters for leaks			
Air Induction and Exhaust System			
Inspect air filter restriction indicator for reading			
Inspect and clean air filter			
Inspect air filter housing and piping for leaks			
Inspect turbo chargers for oil/exhaust leaks			
Inspect exhaust manifolds for leaks, loose hardware and oil carry over.			
Inspect muffler and piping for leaks, loose hardware, rain cap and supports, drain muffler			
Inspect crankcase vent for restrictions or excessive blow by			
Lubrication System			
Check lube oil level and top up			
Check proper operation of oil pressure gauge			
Check hoses and piping for leaks			
Inspect unit for leaks			

Task	**Contractor**	**Consultant**	**Commissioning**
Starting System			
Check starting batteries for electrolyte level and specific gravity.			
Clean and check batteries for loose/corroded connections			
Load test batteries, measure voltage drop			
Inspect starter for loose connection and unusual noises			
Check battery charger output/float rate and equalize timer			
Inspect battery charger output'/float rate and equalize timer			
Inspect charging alternator belts, pulleys and voltage output.			
Engine Monitors and Safety Controls			
Check operation of LOP, HWT and over speed shutdown circuits			
Inspect and test all alarms for proper operation			
Inspect wiring harness for weak and loose connections			
Check operation of engine mounted control panel and do an ATS Transfer Test if Allowed.			
Check oil pressure, water temperature, and alternator gauges for readings			
Control Panel			
Check for proper manual operation			
Operational check for correct voltmeter reading (adjust if necessary)			
Operational check for correction ammeter reading			
Operational check for correct frequency reading			
Inspect electrical connections			
Training and Demonstration			
Manufacturer's Performance Verification Checklist submitted to Cx Manager for final PV.			

End of Section

AUTOMATIC TRANSFER SWITCH			
Task	**Contractor**	**Consultant**	**Commissioning**
Manufacturer's Start-Up Checklist Completed			
ATS Visual Inspections			
ATS is correct voltage, ampacity			
Check terminations.			
Check for no voltage on Normal terminals with Normal source locked out and engine start disabled			
Check for no voltage on Emergency terminals with Emergency source locked out and engine start disabled			
Check ATS free from debris			
Check buswork and supporting hardware for carbon tracking, cracks, corrosion, or any other types of deterioration.			
Check stationary and movable contacts.			
Check system hardware for loose connections.			
Check all control wiring and power cables (especially wiring between or near hinged door) for signs of wear or deterioration.			
Check all control wiring and power cables for loose connections.			
Check cabinet interior for loose hardware.			
Check phase rotation.			
Tighten buswork, control wiring, power cables, and system hardware, as necessary.			
ATS Operation			
Connect the set starting batteries. Connect the normal Bypass Operation			
Verify proper operation of the battery charger.			
Test system operation by enabling test function on transfer switch and verify transfer sequence and timers.			
Test system bypass isolation operation.			
Verify Bypass/Isolation interlocks			
Verify Bypass/Isolation indicator lights.			
Close and lock the cabinet door.			
Verify engine startup and transfer to generator on loss of normal source.			
Verify engine cooldown and shutdown after transfer back to normal power.			

Verify alarm contacts.			
Training and Demonstration			
Manufacturer's Performance Verification Checklist submitted to Cx Manager for final PV.			

End of Section

1 General

1.1 SECTION INCLUDES

.1 Common requirements for commissioning of all electric lighting, including interior, exterior, and emergency lighting.

.2 The party responsible for the functional testing shall not be directly involved in either the design or construction of the project.

1.2 RELATED REQUIREMENTS

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 51 19 – LED Interior Lighting.

.3 Section 26 52 13.13 – Emergency Lighting.

.4 Section 26 56 19 – LED Exterior Lighting.

1.3 REFERENCES

.1 ASHRAE

.1 ASHRAE Guideline 0-2005 – The Commissioning Process.

.2 ASHRAE 90.1-2013 – Energy Standard for Building Except Low-Rise Residential Buildings.

.2 Illumination Engineering Society (IES)

.1 IES DG-29-11 – Design Guide for the Commissioning Process Applied to Lighting and Control Systems.

.3 Ontario Building Code

.1 Supplementary Standard SB-10: Energy Efficiency Requirements, December 22, 2016 update.

1.4 ACTION SUBMITTALS

.1 Refer to Section 26 05 00.

.2 Submit sample commissioning forms.

1.5 CLOSEOUT SUBMITTALS

.1 Section 26 05 00: Submittals for project closeout.

.2 Submit commissioning reports.

.1 Submit a floor plan or spreadsheet table checklist that indicates each local lighting control device, occupancy sensors, daylighting controls, system component.

.2 Submit the system sequence of operation fully describing the equipment components and functionality, including set points and alarm functions.

.3 The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings.

.3 The functional testing party shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.

2 Products – Not Used

3 Execution

3.1 COMMISSIONING

.1 Sensor placement and orientation for all sensor types.

.2 Occupancy sensor function, sensitivity, and time delays.

.3 Daylight harvesting sensor calibration.

.4 Manual control placement and operation.

.5 Automated control operation, including scheduled on/off functions and dimming trims and presets.

.6 Override operation, access, and functionality.

.7 Centralized control interfaces and operation.

.8 Client education of operations.

.9 Documentation archived to client.

3.2 FUNCTIONAL TESTING

.1 Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.

.2 When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:

.1 Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.

.2 Confirm that time switches and programmable schedule controls are programmed to turn the lights off.

.3 Confirm that photosensor controls reduce electric lights levels based on the amount of usable daylight in the space as specified.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Materials and installation for contactors for system voltages up to 600 V.

1.2 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.2 No.14, Industrial Control Equipment.

2 Products

2.1 CONTACTORS

.1 Contactors shall be electrically held 60 Hz, 120 V coil; NEMA Type 1 general purpose enclosure.

.2 Acceptable Manufacturers:

.1 Allen Bradley "500L" series

.2 Equivalent by Eaton.

.3 Equivalent by Schneider Electric.

.4 Equivalent by Siemens.

2.2 CONTACTORS

.1 Contactors: to CSA C22.2 No.14.

.2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.

.3 Fused switch combination contactor as indicated.

.4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.5 Mount in CSA Enclosure 1 unless otherwise indicated.

.6 Include following options in cover:

.1 Red indicating lamp.

.2 Hand-Off-Auto selector switch.

.7 Provided complete with control transformer, in contactor enclosure.

3 Execution

3.1 INSTALLATION

.1 Install contactors and connect auxiliary control devices.

3.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 53.

.2 Size 4 nameplate indicating name of load controlled as indicated.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Occupancy and Vacancy sensors.

.2 Power packs, and auxiliary relays, momentary switches.

.3 Manual controls devices, including dimming switches and low voltage momentary switches.

.4 Timer switches.

.5 Daylight harvesting photo sensors.

.6 Emergency lighting control units.

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

.1 Line voltage manual control devices, as described in Section 26 27 26 – Wiring Devices.

1.3 RELATED REQUIREMENTS

.1 Section 26 08 50 – Commissioning of Lighting.

.2 Section 26 27 26 – Wiring Devices.

.3 Section 26 50 00 – Lighting.

1.4 REFERENCES

.1 Canadian Standards Association (CSA) (www.csa.ca).

.1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code.

.3 CSA C22.2 No. 14 Industrial Control Equipment

.4 CSA C22.2 No. 184 - Solid-State Lighting Controls

.5 CSA C22.2 No. 184.1 - Solid State Dimming Controls.

.6 CSA C22.2 No. 156 - Solid-State Speed Controls

.7 CSA C22.2 No. 42.1 - Cover Plates for Flush Mounted Wiring Devices

.8 CSA C22.2 No. 42 - General Use Receptacles

.2 National Electrical Manufacturers Association (NEMA)

.1 WD1 (R2005) –- General Color Requirements for Wiring Devices.

.2 WD6 – Dimensional Specifications

.3 Ontario Building Code.

.4 UL 924 - Standard for Safety of Emergency Lighting and Power Equipment.

1.5 SUBMITTALS

.1 In accordance with Section 26 05 00.

.2 Product Data:

.1 Submit manufacturer’s descriptive literature and product specifications for each product.

.2 Manufacturer’s product drawings.

.3 Manufacturer’s installation instructions

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Products free of defects in material and workmanship.

1.7 WARRANTY

.1 Product is warranted free of defects in material and workmanship.

.2 Product is warranted to perform the intended function within design limits.

2 Products

2.1 MANUFACTURERS

.1 Wattstopper (Basis of Design).

.2 Cooper Lighting Solutions.

.3 Hubbell.

.4 Leviton.

.5 Lutron.

.6 Sensorswitch.

2.2 GENERAL REQUIREMENTS OF ALL SENSORS AND POWER PACKS

.1 Manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1 per cent.

.2 Five year warranty and CUL listed.

.3 In the event of failure, provide a bypass manual “override on” feature on each sensor.

.4 When bypass utilized, lighting to remain on constantly, or control is to be diverted to a wall switch until sensor is replaced. The override feature is to be designed for use by building maintenance personnel and not be readily achieved by building occupants.

2.3 OCCUPANCY AND VACANCY SENSORS

.1 General:

.1 Sensors using passive infrared, ultrasonic, microphonic, and multi-technology adaptive technology.

.2 Sensor timeouts configurable by system software.

.3 Electrical: Rating: 24 VDC input voltage, up to 40 mA current draw.

.4 Mechanical: Mounting: Sensors for mounting on ceilings and walls, including corners, must be available.

.5 Environmental:

.1 Operating Temperature Range: 0 degrees C to 40 degrees C

.2 Relative Humidity: 0 per cent to 95 per cent non-condensing.

.2 Dual Technology Wall Switch Sensor, 24V

.1 Wattstopper DW-100-24-W series (Basis of Design).

.2 Sensor capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.

.3 Utilize a dual sensing verification principle for coordination between ultrasonic and Passive Infrared (PIR) Technologies to reduce likelihood of false triggering.

.4 For best results, sensor shall feature a trigger mode where the end-user can choose which technology will activate the sensor from Off mode (initial), the type of detection that will reset the time delay (maintain), and the type of detection that will cause the sensor to be turned back on immediately after the lights are

turned off due to lack of motion (re-trigger). Selection of technologies for initial, maintain, and re-trigger shall be done with DIP switches.

.5 Sensor shall have its trigger mode factory preset to allow for quick installation in most applications. In this default setting, both technologies must occur in order to initially activate lighting systems. Detection by either technology shall maintain the lighting on, and detection by either technology shall turn lights back on after lights were turned off for 5 seconds or less in automatic mode, and 30 seconds or less in manual mode.

.6 Robotic test method, as referred in the NEMA WD 7 Guide, shall be utilized for minor motion coverage verification.

.7 Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 kHz. It shall utilize Advanced Signal Processing which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.

.8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall filter short wavelength IR, such as those emitted by the sun and other visible light sources. Face lens grooves in to avoid dust and residue build up which affects IR reception.

.9 Utilize zero crossing circuitry to reduce stress on relay, and therefore increase sensor life.

.10 Operate at 24 VDC and halfwave rectified and utilize a power pack or lighting control system input module to supply power.

.11 To blend in aesthetically, sensor protrusion not more than 3/8” from the wall and utilize colour-matched lens.

.12 To assure detection at desktop level uniformly across the space, sensor shall have a 28 segment, 2 level, Fresnel injection molded lens.

.13 Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by DIP switch.

.14 To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.

.15 Coverage up to 1,000 sq. ft. for walking motion, with a field view of 180 degrees.

.16 Automatic-ON or manual-ON operation, adjustable with a DIP switch.

.17 Sensor shall have an adjustable time delay.

.18 Each sensing technology shall have an LED indicator that remains active at all times, in order to verify detection within the area to be controlled.

.19 Sensor shall have a service switch to allow end-users to operate the sensor in the unlikely event of a failure; set by a trim pot.

.20 Sensor shall have a built-in light level that features simple, one-step daylighting setup that works from 8 fc to 180 fc.

.21 The Dual Technology wall switch sensor shall be a completely self-contained control system that replaces a standard toggle switch

.3 Dual Technology Ceiling Mounted Sensor, 24V

.1 Wattstopper DT-300 series (Basis of Design).

.2 The Dual Technology sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.

.3 Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic or microphonic and Passive Infrared (PIR) Technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either technology shall keep the lighting on.

.4 Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.

.5 Sensors shall be ceiling mounted with a flat, unobtrusive appearance, and provide 360 degree coverage.

.6 Ultrasonic sensing shall be volumetric in coverage, with a frequency of 40 kHz. It shall utilize Advanced Signal Processing that automatically adjusts the detection threshold dynamically to compensate for changing levels of activity and airflow throughout a controlled space.

.7 To avoid false ON activations, and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, in order to respond only to those signals caused by human motion.

.8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.

.9 Sensors shall operate at 24 VDC, and halfwave rectified, and utilize a 24 V power pack.

.10 Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

.11 The sensor shall have a built-in light level sensor that works from 10 fc to 300 fc.

.12 The sensors shall feature terminal style wiring.

.13 Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.

2.4 POWER PACKS

.1 General:

.1 Self-contained transformer and relay module.

.2 Internal relay controlling up to 20A for 120, 230, 277VAC or 347VAC ballast loads and 120VAC incandescent loads.

.3 Provide a 24 VDC, 150 mA output.

.4 Capable of parallel wiring without regard to AC phases on primary.

.5 Power pack can be used as a standalone, low voltage switch, or can be wired to sensor for auto control.

.6 Construction: high impact, UL rated plastic case

.7 Power pack shall be UL/CUL Listed, FCC Certified, UL 2043 plenum rated and meets ASHRAE 90.1 requirements

.8 Shall at minimum meet the following environmental specifications:

.1 Operating Temperature Range: 0 degrees C to 40 degrees C

.2 Relative Humidity: 0 per cent to 95 per cent non-condensing

2.5 DECORATOR LOW VOLTAGE MOMENTARY SWITCHES

.1 Wattstopper DCC2 series (Basis of Design).

.2 Switch intended for use with power packs and sensors requiring a momentary contact switch that provides on/off signals.

.3 12 VAC/VDC, 24 V Rectified, 24 VAC/VDC

.4 50 mA Max. Internal Contact rating

.5 500 mΩ resistance when closed

.6 Single pole, double throw with center position rest.

2.6 DIMMING SWITCHES

.1 Direct control of dimming luminaires up to the luminaire manufacturer's specified rating.

.2 Coordinate dimming signal configuration (2-wire phase cut, 3-wire, 4-wire 0-10V, or 4-wire DALI) with the fixture ballast or driver per Section 26 50 00, lighting fixture schedule, and related sections.

.3 Compatible with related lighting control devices i.e. occupancy sensors.

.4 Submit luminaire manufacturer's dimmer compatibility documentation to demonstrate compatibility and limits of dimming level.

.5 Acceptable Manufacturers:

.1 Lutron NovaT* style dimmers.

.2 Equal by Cooper.

.3 Equal by Philips.

.4 Approved Equal.

2.7 TIMER SWITCHES

.1 Digital time switch programmable to turn loads off after a preset time.

.2 Capable of operating as an ON/OFF switch.

.3 Five terminal, completely self-contained control system that replaces a standard toggle switch. Switching mechanism 30 V @ 1 A air gap relay.

.4 24 VAC when used in conjunction with power packs. For small rooms, or small localized loads, line voltage is permitted.

.5 No minimum load requirement.

.6 Time scroll feature permitting manual overriding of the preset time-out period. Selecting time scroll UP shall allow time-out period to scroll up throughout the timer possibilities to the maximum. Time scroll DN (down) shall allow time-out period to scroll down to minimum.

.7 Options available for user to enable:

.1 One second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).

.2 Beep warning sounding every five seconds once the time switch countdown reaches one minute.

.8 Manual timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.

.9 Liquid crystal display (LCD) that shows the timer's countdown.

.10 Incorporates two pulsed, open collector NPN transistor outputs for external latching relay coil drives or lighting control panel inputs.

.11 Fit behind a decorator style faceplate. Concealed calibration switch for setting time-out, time scroll, one second light flash, and beep warning to prevent tampering of adjustments and hardware.

.12 Time-out period adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.

.13 Operate with power packs in order to control additional loads.

.14 Utilize terminal style wiring.

.15 For safety, in the event there is an open circuit in the low voltage line, automatically switch to OFF mode.

.16 Warranty: 5 year warranty.

.17 CUL listed.

.18 Wattstopper TS-400 and TS-400-24 series (Basis of Design).

2.8 DAYLIGHT HARVESTING PHOTO SENSORS

.1 General:

.1 Class 2, low voltage.

.2 Ambient light sensor designed to interface directly with the analog input of the Lighting Control System.

.3 Supply an analog signal to the Lighting Control System proportional to the light measured.

.4 Sensor output shall provide for zero or offset based signal.

.5 Capable of a fully adjustable response in the range between 0 and 10,000 foot candles with a +/- 1 per cent accuracy at 21 degrees C.

.6 Input: 10 VDC.

.7 Output: 0 VDC to 10 VDC.

.8 Flame retardant housing and meet UL 94 HB standards.

.9 Operating temperature: -10 degrees C to 60 degrees C.

.2 Interior sensors: Fresnel lens, with a 60 degree cone of response. Range between 0 fc and 750 fc.

.3 Exterior sensors: Complete with hood over the aperture to shield the sensor from direct sunlight. Outdoor sensor circuitry completely encased in an optically clear epoxy resin. Sensor range between 0 fc and 750 fc.

2.9 SEQUENCES OF OPERATION

.1 Vacancy Sensor Operation: Manual On, Manual/Auto Off.

3 Execution

3.1 INSTALLATION

.1 In accordance with manufacturer’s instructions.

.2 Minimum 14 AWG from the circuit control hardware relays.

.3 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.

.4 It is the contractor’s responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at Owner's facility, to verify placement of sensors and installation criteria.

.5 Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

.6 Install manual control devices and sensors in accordance with manufacturer’s instructions for Vacancy Operation.

3.2 TRAINING

.1 Provide training in accordance with Section 26 05 00.

3.3 COMMISSIONING

.1 In accordance with Section 26 08 50.

.2 Upon completion of the installation, the system shall be completely commissioned to verify all adjustments and sensor placement to ensure a trouble-free lighting control system.

.3 Submit commissioning report to the Consultant and the commissioning authority for review.

.4 Provide the Consultant and Commissioning Authority with ten working days written notice of the scheduled commissioning date.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Metering transformer cabinets.

.2 Meter bases.

.3 Utility Requirements.

.4 A new service will be provided from a new padmount transformer, built to the requirements of the Local Hydro Authority as per the Standard Details.

1.2 REFERENCES

.1 Ontario Electrical Safety Code c/w Bulletins and Amendments.

.2 Ontario Building Code and its referenced standards.

.3 CSA C22.2 No. 52 - Underground Service-Entrance Cables

1.3 PRE-INSTALLATION MEETING

.1 Convene one week prior to commencing work of this section.

.2 Review service entrance requirements and details with utility company's representatives.

1.4 ACTION SUBMITTALS

.1 Product Data: Provide ratings and dimensions of transformer cabinets and meter bases.

1.5 INFORMATIONAL SUBMITTALS

.1 Submit utility company's prepared drawings.

1.6 QUALITY ASSURANCE

.1 Perform Work to utility company's written requirements.

.2 Obtain approval from Supply Authority and Inspection Authority on complete service. Coordinate work with Utility.

.3 Maintain one copy of each document on site.

1.7 REGULATORY REQUIREMENTS

.1 Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2 Products

2.1 SYSTEM DESCRIPTION

.1 Electric Utility Company: Alectra Utilities

.2 System Characteristics: 600Y volts, 3-phase, 3-wire.

.3 Available Fault Current: Confirm with Alectra Utilities.

2.2 METERING TRANSFORMER CABINET

.1 Manufacturers: As per Utility Requirements

.2 Description: Sheet metal cabinet with hinged door, conforming to utility company requirements, with provisions for locking and sealing.

.3 Dimensions: 48 inch wide by 48 inch high (depth to suit Hydro requirements).

2.3 METER BASES

.1 Meter Base: Provided by utility company.

2.4 PT'S AND CT'S

.1 Supplied by the utility for inclusion in main switchboard.

3 Execution

3.1 VERIFICATION OF CONDITIONS

.1 Verify that field measurements are as indicated on utility company's drawings.

3.2 PREPARATION

.1 Arrange with utility company to obtain permanent electric service to the project.

3.3 INSTALLATION

.1 Local Hydro Authority will provide high voltage cable and transformer. Primary duct bank, transformer vault and pad, secondary duct, secondary cable, grounding etc., to be provided by this Division.

.2 Utility Metering (Supplied by Local Hydro Utility - Alectra)

.1 Current and potential transformers for utility metering shall be in accordance with requirements of Supply Authority.

.2 Equipment manufacturer shall submit complete metering details for approval to utility and obtain their approval prior to manufacture.

.3 Compartment housing utility metering transformers shall be suitable for utility padlocking.

.3 Metering Instruments

.1 A flush mounted voltmeter and a flush mounted ammeter, along with three phase selector switches and associated metering transformers shall be provided.

.4 Work of this and related requirements

.1 Provision of concrete encased primary and secondary ducts, transformer vault to Local Hydro Authority requirements. Provision of fish wire in primary ducts.

.2 Provision of feeder from transformer to main switch.

.3 Grounding installation.

.5 Work by the Local Hydro Authority

.1 Provision of high voltage cable.

.2 Provision of transformer.

.3 Provision of all equipment at property line.

.4 Termination of medium voltage cables at both ends with stress cones.

.5 Termination of secondary cables and ground cable(s) at transformer.

.6 Service Entrance

.1 Connect to service entrance breaker as shown and as specified.

.2 Provide incoming and outgoing cable connections, torque same as required.

.3 Ground equipment as required by Code.

.7 Provide complete shop drawings for all distribution equipment. Local Hydro Authority will provide high voltage cable and transformer. Primary duct, transformer vault, secondary duct, secondary cable, grounding etc., to be provided by this Contractor.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

1.2 REFERENCES

.1 ANSI/ASHRAE/IES Standard 90.1-2013 -- Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 Canadian Standards Association (CSA):

.1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (25th Edition / 2012).

.3 CAN/CSA C22.2 No. 47 - Air-Cooled Transformers (Dry Type).

.4 CSA C802.2-18 Minimum Efficiency Values for Dry-Type Transformers.

.3 National Electrical Manufacturers Association (NEMA):

.1 NEMA ST-20 for Sound Level.

.4 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

.5 Ontario Building Code and its referenced standards.

1.3 ACTION SUBMITTALS

.1 Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, power, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

1.4 INFORMATIONAL SUBMITTALS

.1 Test Reports: Indicate loss data, efficiency at 25, 50, 75, and 100 per cent rated load, and sound level.

.2 Submit manufacturer's installation instructions.

.1 Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.

.2 Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 CLOSEOUT SUBMITTALS

.1 Record actual locations of transformers in project record documents.

1.6 REGULATORY REQUIREMENTS

.1 Products: Listed and classified by CSA (Canadian Standards Association).

.2 Efficiency ratings:

.1 Meet or exceed the efficiency levels indicated in CSA C802.2-12, and ASHRAE 90.1, Table 8.1.

1.7 DELIVERY, STORAGE, AND HANDLING

.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. Store in a clean, dry space. Maintain factory wrapping or

provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

.3 Handle to manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

.4 Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.

1.8 WARRANTY

.1 The transformer shall carry a 1 year warranty from the time of substantial performance.

2 Products

2.1 GENERAL

.1 Transformers shall be standard general purpose dry type unless otherwise indicated on drawings as K-Rated or Harmonic Mitigation type.

.2 Use transformers of one manufacturer throughout project and in accordance with CAN/CSA-C22.2 No.47 and CSA-C9.

.3 Manufacturers:

.1 STI.

.2 Delta Transformer.

.3 Eaton.

.4 Hammond.

.5 Powersmiths.

.6 Rex Power Magnetics.

.7 Siemens.

.8 Schneider Electric.

.9 Substitutions: permitted if approved by Consultant prior to Tender closing date.

2.2 GENERAL PURPOSE TRANSFORMERS

.1 NEMA ST-20, factory-assembled, air cooled low-inrush dry type transformer, ratings and voltages as indicated on drawings.

.2 Single or three phase as indicated on drawings.

.3 Type: AN/AA Ventilated self-cooled.

.4 Copper windings.

.5 Finish: Final coating to be ASA 61 Grey Epoxy Powder

.6 T-connected transformers are not acceptable.

.7 Isolate core and coil from enclosure using vibration-absorbing mounts.

.8 Impedance: Standard.

2.3 PRIMARY VOLTAGE

.1 600 volts delta, 3 phase;

2.4 SECONDARY VOLTAGE

.1 120/208 volts, 3 phase wye.

2.5 INSULATION SYSTEM AND AVERAGE WINDING TEMPERATURE RISE FOR RATED KVA AS FOLLOWS:

.1 1-15 kVA: Class 185 with 80 degrees C rise.

.2 16-500 kVA: Class 220 with 80 degrees C rise.

2.6 CASE TEMPERATURE

.1 Do not exceed 35 degrees C rise above ambient at warmest point at full load.

2.7 WINDING TAPS

.1 To NEMA ST-20.

.2 Four full capacity 5 per cent adjustment taps, 2 at 2.5 per cent FCBN (full capacity below nominal) and 2 at 2.5 per cent FCAN (full capacity above nominal).

2.8 BASIC IMPULSE LEVEL:

.1 10 kV BIL.

2.9 GROUNDING

.1 Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

2.10 MOUNTING

.1 1-15 kVA: suitable for wall mounting.

.2 16-75 kVA: suitable for wall or floor, as shown.

.3 Larger than 75 kVA: suitable for floor mounting.

2.11 COIL CONDUCTORS

.1 Continuous windings with terminations brazed or welded.

2.12 ENCLOSURE

.1 NEMA ST-20, CSA, Type 2 ventilated, Sprinkler-proof. Provide lifting eyes or brackets.

2.13 SOUND LEVELS

.1 To NEMA ST-20 for transformers up to 300 kVA:

.1 Up to 9 kVA: 40 dB.

.2 10 – 50 kVA: 45 dB.

.3 51 – 150 kVA: 50 dB.

.4 151 – 300 kVA: 55 dB.

2.14 NAMEPLATE

.1 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.

.8 Serial number.

2.15 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 53.

2.16 SOURCE QUALITY CONTROL

.1 Production test each unit according to NEMA ST-20.

3 Execution

3.1 INSTALLATION

.1 Set transformer plumb and level.

.2 Use flexible conduit, under the provisions of Section 26 05 33.13, 600 mm minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

.3 Mount wall-mounted transformers using integral flanges or accessory brackets provided by the manufacturer.

.4 Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

.5 Mount trapeze-mounted transformers as indicated.

.6 Provide seismic restraints.

.7 Provide grounding and bonding to Section 26 05 26.

.8 Mount dry type transformers up to 75 kVA, as indicated.

.9 Mount dry type transformers above 75 kVA on floor.

.10 Ensure adequate clearance around transformer for ventilation.

.11 Install transformers in level upright position.

.12 Remove shipping supports only after transformer is installed and just before putting into service.

.13 Loosen isolation pad bolts until no compression is visible.

.14 Make primary and secondary connections in accordance with wiring diagram.

.15 Energize transformers after installation is complete.

3.2 FIELD QUALITY CONTROL

.1 Section 26 05 00: Field Inspection, Testing, Adjusting.

.2 Perform inspections and tests listed in NETA ATS, Section 7.2.

3.3 ADJUSTING

.1 Measure primary and secondary voltages and make appropriate tap adjustments.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Power distribution panelboards – Circuit breaker type.

.2 Lighting and Appliance Branch Circuit Panelboards.

1.2 RELATED REQUIREMENTS

.1 Section 26 28 16.02 – Molded Case Circuit Breakers.

.2 Section 26 43 13 – Surge Protective Devices for Low-Voltage Electrical Power Circuits.

1.3 REFERENCES

.1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code (25th Edition / 2012)

.3 CSA C22.2 No.29 - Panelboards and Enclosed Panelboards.

.4 NEMA AB1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.

.5 NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

.6 NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

.7 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

.8 The panelboards and circuit breakers referenced herein are designed and manufactured according to the latest revision of the following specifications.

.1 NEMA PB 1 - Panelboards

.2 NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

.3 NEMA AB 1 - Molded Case Circuit Breakers

.4 CSA C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards

.5 CSA C22.2 No. 5-M91 - Molded Case Circuit Breakers

1.4 ACTION SUBMITTALS

.1 Submit in accordance with Section 26 05 00.

.2 Shop drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

.3 Shop drawings

.1 Indicate the following:

.1 Outline and support point dimensions

.2 Voltage

.3 Main bus ampacity

.4 Integrated short circuit ampere rating

.5 Circuit breaker arrangement, types and sizes.

.2 The following information shall be submitted to the Engineer:

.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

.6 Product data sheets

.3 Where applicable, the following additional information shall be submitted to the Engineer:

.1 Key interlock scheme drawing and sequence of operations

.4 Submittals for Construction

.1 The following information shall be submitted for record purposes:

.1 Installation information

1.5 CLOSEOUT SUBMITTALS

.1 Refer to Section 26 05 00.

.2 Record actual locations of panelboards and record actual circuiting arrangements in project record documents.

.3 Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

.4 Final as-built drawings and information shall incorporate all changes made during the manufacturing and installation process.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

.2 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

.3 Provide two of each panelboard key.

.4 Provide final panelboard schedules indicating panelboard data, phasing, breaker sizes, and loads served.

1.7 QUALITY ASSURANCE

.1 Regulatory Requirements

.1 Products: Listed and classified by CSA (Canadian Standards Association).

.2 Qualifications

.1 Company specializing in manufacturing of panelboard products with a minimum of 20 years' experience.

.2 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

.3 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

.4 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Inspect and report concealed damage to carrier within their required time period.

.2 Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

.3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

.4 Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

1.9 MANUFACTURER WARRANTY

.1 Warrant specified equipment to be free from defects in materials and workmanship for eighteen (18) months from the date of purchase.

2 Products

2.1 GENERAL

.1 Description: CSA C22.2 No.29, circuit breaker type.

2.2 DISTRIBUTION PANELBOARDS – CIRCUIT BREAKER TYPE

.1 Manufacturers:

.1 Square D by Schneider Electric, I-LINE Series.

.2 Eaton Cutler-Hammer, PRL 3 and PRL4 Series.

.3 Equal by Siemens.

.2 The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten days prior to bid date.

.3 Panelboard Bus:

.1 Copper, ratings as indicated.

.2 Provide copper neutral bus for panelboards indicated for 4-wire systems.

.3 Provide copper ground bus in each panelboard.

.4 Short Circuit Ratings:

.1 Panelboards rated 600 V shall have minimum integrated short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 65 000 amperes RMS symmetrical.

.2 Distribution panelboards with bolt-on devices contained therein shall have interrupting ratings as specified herein or indicated on the drawings.

.3 Panelboards shall be fully rated.

.4 Where indicated, provide circuit breakers ULC listed for application at 100 per cent of their continuous ampere rating in their intended enclosure.

.5 Minimum integrated short circuit rating: Panelboards rated 240 V shall have minimum integrated short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10 000 amperes RMS symmetrical.

.6 Molded Case Circuit Breakers: To Section 26 28 16.02.

.7 Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

.8 Cabinet Front: Surface type, fastened hinge and latch, metal directory frame, finished in manufacturer's standard gray enamel.

.9 Enclosures: CSA type 2 sprinklerproof complete with drip hood, or as noted.

.10 Trims shall be equipped with a flush lock

.11 Breaker positions labeled as “Spare” or “Space” shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.

.12 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.

2.3 BRANCH CIRCUIT PANELBOARDS

.1 Manufacturers:

.1 Square D by Schneider Electric, NQ or NQOD Series.

.2 Eaton Cutler-Hammer, POW-R-LINE 1, POW-R-LINE 2, POW-R-LINE 3 Series.

.3 Equal by Siemens.

.2 Description: CSA C22.2 No.29, circuit breaker type, lighting and appliance branch circuit panelboard.

.3 Panelboard Bus:

.1 Copper, ratings as indicated.

.2 Provide copper neutral bus in each panelboard.

.3 Provide copper ground bus in each panelboard.

.4 Provide insulated ground bus where scheduled.

.4 Minimum Integrated Short Circuit Rating: 10 000 amperes RMS symmetrical for 240 volt panelboards, or as indicated.

.5 Molded Case Circuit Breakers: NEMA AB 1, plug-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.

.6 Current Limiting Molded Case Circuit Breakers where indicated: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

.7 Cabinet Front: Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

.8 Enclosure shall be CSA type 2 sprinklerproof complete with drip hood, or as noted.

.9 Trims shall be equipped with a flush lock

.10 Breaker positions labeled as “Spare” or “Space” shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.

.11 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.12 Panelboards rated 240 Vac or less shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.

.13 Bus and breakers rated for symmetrical interrupting capacity, as indicated.

.14 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.15 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.16 Two keys for each panelboard and key panelboards alike.

.17 Copper bus with neutral of same ampere rating as mains.

.18 Mains: suitable for bolt-on breakers.

.19 Trim with concealed front bolts and hinges.

.20 Trim and door finish: baked grey enamel.

.21 The minimum short-circuit rating for branch circuit panelboards shall be as specified herein or as indicated on the drawings. Panelboards shall be fully rated.

.22 Bolt-on 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.

.23 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 ULC 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.

.24 Circuit breakers shall have a minimum interrupting rating of 10 000 amperes symmetrical at 240 volts, and 14 000 amperes symmetrical at 480 volts, unless otherwise noted on the drawings.

.25 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.

.26 Lighting and receptacle panels shall be surface or flush-mounting type, as shown.

.27 Panels shall be dead front type in code gauge steel enclosures. All panels shall be sprinkler proof c/w drip hoods as required.

.28 Panels shall have mains of voltage and capacity, and main and branch breakers, as shown on the drawings. Spaces shall include necessary bus work such that Owners, at a later date, need buy only the breakers.

.29 Where panels exceed 42 circuits, use multi-section panel with main cross-over solid bus bars. Main bus capacity of each section shall be full size to match cross-over bus.

.30 Breakers shall have bolted type connections. Multi-pole breakers shall be common trip type with a single handle, suitable for voltage applied and of same manufacture as single pole breakers.

.31 Panels for 120/208 volt, 3-phase, 4-wire systems shall be complete with full size breakers.

.32 Where shown on drawings or required by code, certain breakers shall include ground fault interrupter.

.33 Provide lighting and receptacle panels, surface or flush-mounting type, as shown.

.34 Provide locking bars on non-switched circuits where panels are used for switching lighting circuits.

.35 Panels for non-linear loads shall be complete with lugs for double neutrals.

.36 Panels shall be given a rust-resistant treatment to both tub and trim.

.37 Flush panels shall have concealed hinges and flush type combination lock latch. Locks shall be chrome plated. Doors shall open minimum 135 degrees. Trims shall have fasteners concealed and shall be prime coated to receive room finish paint.

.38 Surface mounted panels shall have manufacturer's standard surface door trim complete with lock and latch. Finish shall be grey.

.39 Recessed panels shall have standard flush trims.

.40 Co-ordinate panel finish with Room Finish Schedule.

2.4 MOLDED CASE CIRCUIT BREAKERS

.1 Breakers: to Section 26 28 16.02.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-on devices for 10 per cent of 15 A to 30 A breakers installed as indicated. Turn over unused lock-on devices to Owner.

.5 Lock-on devices for fire alarm, security, and sprinkler circuits.

.6 Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

.7 Provide breakers for externally mounted Surge Protective Devices in accordance with Section 26 43 13.

2.5 CONSTRUCTION

.1 General:

.1 Interiors shall be completely factory assembled. 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 Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.

.3 A temporary directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.

.4 All locks shall be keyed alike. Key same as existing.

.2 Branch Circuit Panelboards:

.1 Trims for branch circuit panelboards shall be supplied with a hinged door 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. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the owner's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.

.3 Distribution Panelboards:

.1 Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.

2.6 BUS

.1 Main bus bars shall be copper 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 A copper system ground bus shall be included in all panelboards.

.3 Full-size (100 per cent rated) insulated copper 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 busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200 per cent rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

2.7 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 53.

.2 Nameplate for each panelboard size 4 engraved.

.3 Nameplate for each branch circuit in distribution panelboards size 2 engraved.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

.5 Provide an engraved nameplate for each panelboard section.

.6 Provide copies of all circuit directories in Manuals.

3 Execution

3.1 INSTALLATION

.1 Install panelboards to CSA C22.1.

.2 Install panelboards plumb.

.3 Height: 1800 mm to top of panelboard; install panelboards taller than 1800 mm with bottom no more than 100 mm above floor.

.4 Provide filler plates for unused spaces in panelboards.

.5 Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

.6 Provide engraved plastic nameplates under the provisions of Section 26 05 53.

.7 Ground and bond panelboard enclosure according to Section 26 05 26.

.8 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.9 Install surface mounted panelboards on fire rated plywood backboards in accordance with Section 06 10 00. Where practical, group panelboards on common backboard.

.10 Connect loads to circuits.

.11 Connect neutral conductors to common neutral bus with respective neutral identified.

.12 Deliver five (5) duplicate keys for each panel lock to Owner.

.13 Mount electrical panels, where possible, with top of trim at uniform height of 2000 mm.

.14 Cap ends of conduits in accessible locations in ceiling spaces above panels, to allow for future wiring.

.15 The Contractors shall install all equipment per the manufacturer’s recommendations and the contract drawings.

.16 Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and Electrical Code requirements.

.17 After completion of wiring, type directory showing a clear description of each circuit being controlled from panel and place in metal frame inside door.

.18 Provide revised directories for existing panels if revised.

.19 Provide circuit breaker handle locks for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.

3.2 FIELD QUALITY CONTROL

.1 Perform inspections and tests listed in NETA ATS, Section 7.4 for switches, Section 7.5 for circuit breakers.

.2 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

.3 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20 per cent of each other. Maintain proper phasing for multi-wire branch circuits.

.4 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

3.3 ADJUSTING

.1 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other.

.2 Maintain proper phasing for multi-wire branch circuits.

3.4 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 NEMA and UL standards.

3.5 CLOSEOUTS

.1 Provide three 27 mm empty conduits from top of lighting, receptacle, telephone, signal and communication panels recessed in walls, to ceiling space.

.2 Include a copy of each panelboard schedule in the Operation and Maintenance manual.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 RELATED REQUIREMENTS

.1 Section 26 09 23 – Lighting Control Devices.

1.3 REFERENCES

.1 Canadian Standards Association

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code.

.3 CSA-C22.2 No.42-99(R2004), General Use Receptacles, Attachment Plugs and Similar Devices.

.4 CAN/CSA-C22.2 No.42.1-00(R2004), Cover Plates for Flush-Mounted Wiring Devices (Bi-National standard, with UL 514D).

.5 CSA-C22.2 No.55-M1986 (R2003), Special Use Switches.

.6 CSA-C22.2 No.111-00(R2005), General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

.2 International Electrotechnical Commission (IEC)

.1 IEC 60309 – Plugs, socket-outlets and couplers for industrial purposes.

1.4 ACTION SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 26 05 00.

.2 Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.

1.5 INFORMATIONAL SUBMITTALS

.1 Submit manufacturer's installation instructions.

1.6 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA (Canadian Standards Association).

2 Products

2.1 MANUFACTURERS

.1 Eaton.

.2 Hubbell Bryant.

.3 Molex.

.4 Pass & Seymour (Legrand).

2.2 WALL SWITCHES

.1 Single pole, double pole, three-way, four-way switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.

.2 Description: CSA-C22.2 No.111, Commercial Spec Grade, AC only general-use snap switch.

.3 Local switches shall be 20 ampere, silent, brown coloured, AC type and CSA certified, specification grade. Provide switches rated to suit system voltage 120 V or 347 V.

.4 Manually-operated general purpose AC switches with following features:

.1 Terminal holes approved for 10 AWG wire.

.2 Silver alloy contacts.

.3 Urea or melamine moulding for parts subject to carbon tracking.

.4 Suitable for back and side wiring.

.5 Voltage: 120 volt, AC as indicated.

.6 Current: 20 amperes.

.7 Body and Handle: white plastic with toggle handle. Confirm finish colour prior to ordering.

.8 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.9 Example Products (Decorator style):

.1 120 volt:

.1 Hubbell HBL2121 series.

.10 Example Products (Toggle style):

.1 120 volt:

.1 Hubbell HBL1221 (single pole).

.2 Hubbell HBL1222 (double pole).

.3 Hubbell HBL1223 (three-way).

.4 Hubbell HBL1224 (four-way).

.11 Local switches and receptacles shall be of the same manufacturer throughout except where a specified item is not made by that manufacturer.

2.3 RECEPTACLES

.1 General

.1 Description: CSA C22.2 No.42, Commercial Spec Grade general use receptacles.

.2 Device Body: white plastic.

.3 Configuration: Type as specified and indicated.

.4 Convenience Receptacle: Type 5-15, 5-20 where indicated.

.5 GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

.6 Data Room Receptacle Types: As indicated on drawings.

.7 Receptacles of one manufacturer throughout project.

.2 Receptacles shall be white coloured, specification grade, unless noted otherwise.

.3 Receptacles shall be as listed below:

.1 15 ampere, 120 volt, single phase grounded duplex receptacle shall be NEMA-U- ground type CSA Configuration 5-15R.

.2 20 ampere, 120 volt, single phase grounded duplex receptacle shall be NEMA-U-ground type CSA Configuration 5-20RA

.3 15 ampere, 120 volt, weatherproof receptacles shall be equal to those above but complete with gasketted cast plate and hinged covers.

.4 Other types of receptacles shall be provided as shown on Drawings.

.5 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No.42 with following features:

.1 White urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Break-off links for use as split receptacles.

.4 Eight back wired entrances, four side wiring screws.

.5 Triple wipe contacts and riveted grounding contacts.

.6 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:

.1 White urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Four back wired entrances, 2 side wiring screws.

.7 Other receptacles with ampacity and voltage as indicated.

.8 Example Products (Decorator style duplex 5-15R):

.1 Pass & Seymour 26252 Series.

.2 Hubbell HBL2152 Series.

.9 Ground Fault Circuit Interrupter (GFCI or GFI) Receptacles

.1 Protected by a ground fault circuit interrupter of the Class A type.

.2 Any receptacle within 1.5 m of a sink must be GFCI protected.

.3 Any receptacle located outdoor must be GFCI protected.

.10 Wet Location and weatherproof devices:

.1 Receptacles and cover plates suitable for wet locations, cover plates to provide shielding with and without a plug inserted into the receptacle in accordance with OESC rule 26-702. Cover plates to be marked “Extra Duty”.

.2 Receptacles shall be 20A rated, GFI.

2.4 COVER PLATES

.1 Cover plates for wiring devices to: CAN/CSA-C22.2 No.42.1.

.2 Cover plates from one manufacturer throughout project.

.3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.4 Stainless steel, vertically brushed, cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.

.5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

.7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

.8 Decorative Cover Plate: Polycarbonate.

.1 Pass & Seymour TP26W Series

.9 Switch, receptacle, telephone and other plates shall be stainless steel 18-8 chrome metal alloy, Type 302, non-metallic in finished areas and pressed steel in unfinished areas. Finish brush marks shall be run in a vertical direction.

.10 Wet Location and weatherproof devices: receptacles and cover plates shall be suitable for wet locations, and provide shielding with and without a plug inserted into the receptacle in accordance with OESC rule 26-702.

2.5 RECEPTACLE CORD REELS

.1 Retractable cable reel, mounted to structure above. 125 V, 5-15R or 5-20R (as indicated on drawings) C/W 40 feet of cabtire (or equal).

.2 Provide framing bracket to support reel at underside of structure above.

.3 Connect to GFCI breakers.

.4 Manufacturers:

.1 Hubbell HBL-C40-123TT

.2 Woodhead (Molex) 997 series.

.3 Approved equal.

3 Execution

3.1 MOUNTING HEIGHTS

.1 In accordance with Section 26 05 00.

3.2 EXAMINATION

.1 Verify that outlet boxes are installed at proper height.

.2 Verify that wall openings are neatly cut and will be completely covered by wall plates.

.3 Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.3 PREPARATION

.1 Provide extension rings to bring outlet boxes flush with finished surface.

.2 Clean debris from outlet boxes.

3.4 INSTALLATION

.1 Install to CSA C22.1.

.2 Install devices plumb and level.

.3 Install switches with OFF position down.

.4 Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.

.5 Do not share neutral conductor on load side of dimmers.

.6 Install receptacles with grounding pole on bottom.

.7 Connect wiring device grounding terminal to outlet box with bonding jumper.

.8 Install decorative plates on switch, receptacle, and blank outlets in finished areas.

.9 Connect wiring devices by wrapping conductor around screw terminal.

.10 Use jumbo size plates for outlets installed in masonry walls.

.11 Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

.12 Switches:

.1 Install single throw switches with handle in "UP" position when switch closed.

.2 Install switches in gang type outlet box when more than one switch is required in one location.

.13 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Where split receptacle has one portion switched, mount vertically and switch upper portion.

.3 Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.

.4 Receptacles for maintenance of HVAC and similar equipment located on rooftops

.1 Provide weatherproof GFI 5-20R receptacles on roof, installed at 750 mm (30 inches) above finished roof level, complete with wet location cover plate.

.2 Locate within 7500 mm (25 feet) of new HVAC equipment, and at least 1800 mm (6 feet) away from roof line.

.3 Refer to 2018 OESC rules 2-316, 26-708, and 26-710, and OESC bulletin 26-27-0, or latest edition.

.14 Cover plates:

.1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

.4 Do not install plates until final painting of room or area is completed. Remove protective covering.

.15 Circuit identification: in accordance with Section 26 05 53.

3.5 FIELD QUALITY CONTROL

.1 Inspect each wiring device for defects.

.2 Operate each wall switch with circuit energized and verify proper operation.

.3 Verify that each receptacle device is energized.

.4 Test each receptacle device for proper polarity.

.5 Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

.1 Adjust devices and wall plates to be flush and level.

3.7 CLEANING

.1 Clean exposed surfaces to remove splatters and restore finish.

End of Section

1 General

1.1 SUBMITTALS

.1 Provide submittals in accordance with Section 26 05 00.

.2 Product Data:

.1 Provide fuse performance data characteristics for each fuse type and size above 200 amps. Performance data to include: average melting time-current characteristics.

.3 Shop Drawings:

.1 Provide shop drawings in accordance with Section 26 05 00.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Ship fuses in original containers.

.2 Do not ship fuses installed in switchboard.

.3 Store fuses in original containers in storage cabinet.

.4 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 26 05 00.

1.3 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with Section 26 05 00.

.2 6 spare fuses of each type and size installed up to and including 600 A.

2 Products

2.1 MANUFACTURERS

.1 Bussman by Eaton.

.2 GEC.

.3 Littelfuse.

.4 Mersen.

.5 Substitutions are not permitted.

2.2 FUSES - GENERAL

.1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

.2 Fuses: product of one manufacturer.

.3 Fuses shall be sized as shown, time delay type, and of the same type throughout.

.4 Fuses shall be CSA certified Class-J for 1-600A or Class-L for 650 Amps and above.

2.3 FUSE TYPES

.1 Class J fuses.

.1 Type J1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.

.2 Type J2, fast acting.

.2 Class L fuses.

.1 Type L1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.

.2 Type L2, fast acting.

.3 Class R fuses.

.1 Type R1, (UL Class RK1), time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum, to meet UL Class RK1 maximum let-through limits.

.2 Type R2, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.

.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

2.4 FUSE REQUIREMENTS

.1 Dimensions and Performance: CSA C22.2 No. 248 Series, Class as specified or indicated.

.2 Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

.3 Power Load Feeder Switches: HRC-1 Class J time delay type.

.4 Other Feeder Switches: HRC-1 Class J time delay type.

3 Execution

3.1 INSTALLATION

.1 Install fuses to manufacturer's instructions.

.2 Install fuse with label oriented such that manufacturer, type, and size are easily read.

.3 Provide a complete set of fuses in each fusible device supplied under this Division and provide 3 spare fuses for each size used.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Materials for Molded-Case Circuit Breakers (MCCB).

.2 Accessories

1.2 RELATED REQUIREMENTS

.1 Section 26 24 16 – Panelboards.

1.3 REFERENCES

.1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code 25th Edition / 2012.

.3 CSA-C22.2 No. 5-02, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

.4 NEMA AB1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.

.5 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

1.4 SUBMITTALS

.1 Submit product data in accordance with Section 26 05 00.

.2 Include time-current characteristic curves for breakers with ampacity of 400 A and above, or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

.3 Include termination temperature rating in degrees C.

.4 Certificate of Origin

.1 Prior to any installation of circuit breakers in either a new or existing installation, Contractor must submit three (3) copies of a certificate of origin, from the manufacturer, duly signed by the factory and the local manufacturer's representative, certifying that all circuit breakers come from this manufacturer, they are new and they meet standards and regulations. These certificates must be submitted to the Engineer for approval.

.2 A delay in the production of the certificate of origin won't justify any extension of the contract and additional compensation.

.3 Any work of manufacturing, assembly or installation should begin only after acceptance of the certificate of origin by Engineer. Unless complying with this requirement, Engineer reserves the right to mandate the manufacturer listed on circuit breakers to authenticate all new circuit breakers under the contract, and that, to Contractor's expense.

.4 In general, the certificate of origin must contain:

.1 The name and address of the manufacturer, and the person responsible for authentication. The responsible person must sign and date the certificate;

.2 The name and address of the licensed dealer, and the person of the distributor responsible for the Contractor's account.

.3 The name and address of the Contractor, and the person responsible for the project.

.4 The name and address of the local manufacturer's representative. The local representative must sign and date the certificate.

.5 The name and address of the building where circuit breakers will be installed:

.1 Project title

.2 End user's reference number

.3 The list of circuit breakers

2 Products

2.1 GENERAL

.1 Molded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5

.2 Bolt-on Molded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Plug-in Molded case circuit breakers: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.4 Common-trip breakers: with single handle for multi-pole applications.

.5 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.6 Circuit breakers with interchangeable trips.

2.2 INTERRUPTING CAPACITY

.1 Protective devices shall be fully rated, for required available fault current. Series rated shall not be used on this installation.

.2 Refer to panelboard and switchboard Specification Sections.

2.3 MOLDED CASE CIRCUIT BREAKERS – GENERAL

.1 Molded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

.2 NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

.3 Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

.4 1-, 2-, or 3-pole bold on, single-handle common trip voltage as indicated on drawings.

.5 Overcentre toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.

.6 Calibrate for operation in 40 degree C ambient temperature.

2.4 MOLDED CASE CIRCUIT BREAKERS – UP TO 150 AMPERE

.1 Permanent trip unit containing individual thermal and magnetic trip elements in each pole, unless noted otherwise on drawings.

2.5 MOLDED CASE CIRCUIT BREAKERS – 151 TO 399 AMPERE

.1 Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.

2.6 MOLDED CASE CIRCUIT BREAKERS – 400 AMPERE AND ABOVE

.1 Electronic trip type with adjustments for long-time, instantaneous and short-time functions.

.2 Provide ground fault function for breakers greater than 400 Amps.

.3 1000 Amp and Above:

.1 Modbus Communications

.1 Breaker status.

.1 Open.

.2 Closed.

.3 Tripped.

.2 Cause of trip.

.3 Time of trip.

.4 Current at time of trip.

.5 RMS currents per phase and ground.

.6 Peak demand.

.7 Present demand.

.8 Energy consumption.

2.7 ADDITIONAL FEATURES

.1 Provide as indicated on drawings:

.1 Shunt trip

.2 Auxiliary switch

.3 Motor-operated mechanism.

.4 Under-voltage release

.5 On-off locking device

.6 Handle mechanism

3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as per related sections.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Fusible and non-fusible enclosed low-voltage disconnect switches from 30 to 800 amps.

1.2 RELATED REQUIREMENTS

.1 Section 26 28 13 – Fuses.

1.3 REFERENCES

.1 Canadian Standards Association

.1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (OESC) 27th Edition, 2018.

.3 CAN/CSA-C22.2 No. 4-16 – Enclosed and Dead-Front Switches.

.4 CSA C22.2 No. 248 series – Low-voltage fuses.

.2 NETA (International Electrical Testing Association) ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4 SUBMITTALS FOR REVIEW

.1 Product Data: Provide switch ratings, and enclosure dimensions.

1.5 SUBMITTALS FOR CLOSEOUT

.1 Record actual locations of enclosed switches in project record documents.

1.6 REGULATORY REQUIREMENTS

.1 Products: Listed and classified by CSA or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2 Products

2.1 MANUFACTURERS

.1 Eaton Cutler-Hammer

.2 Siemens.

.3 Square D by Schneider Electric.

2.2 DISCONNECT SWITCHES

.1 Provide dedicated disconnect switches at electrical equipment.

.2 Fused or un-fused disconnect or safety switches: Type "A", quick-make, quick-break construction with provision for padlocking switches in either "ON" or "OFF" position.

.1 Quick-make, quick-break.

.2 Heavy duty industrial type.

.3 Lockable with up to 3 padlocks.

.4 Cover interlocked with switch mechanism.

.5 Viewing window for viewing blades.

.3 Fused switches equipped with fuse clips designed for Class "J" fuses and designed to reject standard NEC fuses.

.4 Enclosure: CSA Type 1 sprinkler-proof, or as noted.

.5 Switches throughout project of same manufacturer.

3 Execution

3.1 INSTALLATION

.1 Provide fused or un-fused safety or disconnect switches as shown and as required by Code.

.2 Install disconnect switches complete with fuses, if applicable, to CSA C22.1.

.3 Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.

.4 Coordinate fuse ampere rating with installed equipment. Fuse ampere rating variance between original design information and installed equipment, size in accordance with Bussmann Fusetron 40 degree C recommendations. Do not provide fuses of lower ampere rating than motor starter thermal units.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Factory assembled packaged engine generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.

.2 Exhaust silencer and fittings.

.3 Fuel fittings and sub-base fuel tank.

.4 Battery and charger.

.5 Weatherproof skin-tight sound attenuating enclosure.

.6 Enclosure accessories.

.7 Remote annunciator panel.

1.2 RELATED REQUIREMENTS

.1 Section 26 36 23.13 – Bypass Isolation Automatic Transfer Switches.

.2 Section 26 52 13.13 – Emergency Lighting.

.3 Section 28 46 21.11 – Addressable Fire Alarm Systems.

1.3 ALTERNATIVES

.1 The generator set manufacturer shall supply an itemized listing of optional prices to provide additional service and maintenance as per semi–annual (Table 4) and annual inspections (Table 5) identified in CSA C282 and show as an alternative price with the quotation.

1.4 REFERENCES

.1 CSA Group:

.1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (27th edition/2018).

.3 CAN/CSA-C22.2 No. 5 – Molded-Case Circuit Breakers: Molded case switches and circuit breaker enclosures (Tri-National standard, with UL 489 and NMX-J-266-ANCE).

.4 CAN/CSA-C22.2 No. 94 – Special Purpose Enclosures.

.5 CSA C22.2 No. 100 – Motors and Generators.

.6 CSA C22.2 No. 141 – Emergency Lighting Equipment.

.7 CSA C282-15 – Emergency Electrical Power Supply for Buildings.

.8 CSA B139 Series-15 – Installation Code for Oil-Burning Equipment.

.9 CSA Z245.1-18, Steel pipe.

.2 CCME: Canadian Council of Ministers of the Environment – Environmental Code of Practice for Aboveground and Underground Storage Tank System Containing Petroleum and Allied Petroleum Products.

.1 Ontario Fire Code, latest edition.

.2 O.Reg. 524/98, Environmental Compliance Approvals – Exemptions for Section 9 of the Act.

.3 National Fire Code of Canada 2010.

.4 Underwriters' Laboratories of Canada:

.1 CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems.

.2 CAN/ULC-S601 – Standard for Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids.

.3 CAN/ULC-S661 – Standard for overfill protection devices for flammable and combustible liquid storage tanks.

.5 Technical Standards & Safety Authority (TSSA) of Ontario:

.1 FS-219-26 – Fuel Oil Code Adoption Document Amendment: Ontario amendments to CSA B139-15 series.

1.5 SUBMITTALS

.1 To Section 26 05 00.

.2 Shop Drawings:

.1 Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams, including schematic and interconnection diagrams.

.2 Outline drawings of assembly, including sound attenuated weatherproof enclosure and accessories.

.3 Weight of complete assembly, including fuel.

.4 One line diagrams and wiring diagrams for assembly and components.

.5 Interconnection wiring diagrams

.3 Product data:

.1 Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, fuel tank, and remote radiator.

.2 Technical data on all major components. Technical data must include an alternator thermal damage curve, description and operating characteristics of the alternator protection device, and an alternator reactive capability curve. Alternator data demonstrating compliance to section.

.3 Certification of the emissions performance of the generator set engine by the engine manufacturer.

.4 Seismic certification, as required.

.5 Acoustical information of enclosure.

.4 Test Reports: Indicate results of performance testing.

.5 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

.6 Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

.7 Manufacturer's Field Reports: Indicate procedures and findings.

.8 Provide four printed copies of submittals and one electronic copy.

.9 Data for Ministry of Environment Environmental Activity and Sector Registry (Certificate of Approval).

.1 The maximum electrical output rating of the generator set (kW),

.2 Manufacturer’s combustion contaminant emissions data or U.S. EPA emissions standard certification sheet.

.3 Layout drawing showing engine exhaust stack orientation, for generator sets installed in outdoor enclosures.

.4 Enclosure layout drawing,

.5 Manufacturer's enclosure noise emissions data.

.10 Colour samples for custom enclosure colour.

.11 Project information:

.1 Test reports and certifications.

.2 Factory test procedures.

.12 Contract closeout information: Operating and maintenance data.

1.6 CLOSEOUT SUBMITTALS

.1 AHJ inspection documentation:

.1 Fuelling compliance certificate.

.2 Variance approval correspondence, as applicable.

.2 Maintenance Contracts

.1 Manufacturer to maintain model and serial number records of each generator set provided for at least 20 years.

.2 The manufacturer shall itemize the complete offering of preventative and full-service maintenance contracts for the generator with submission, as described for each maintenance period described below.

.3 Maintenance service as part of base bid submission:

.1 Provide 7 x 24 x 365 service and maintenance of Generator for two years from Date of Substantial Completion. Price is to include two (2) full service maintenance program visits per each year.

.3 Operation and Maintenance Data

.1 Operation Data: Include instructions for normal operation.

.2 Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and fuel tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

.3 Provide electronic copies of all documents, test data, shop drawings, etc.

.4 Training records including attendance sheet, date, and training syllabus.

1.7 MAINTENANCE MATERIAL SUBMITTALS

.1 Provide three copies of maintenance materials.

.2 Spare Parts

.1 Provide two of each of the following:

.1 Fuel oil filter element.

.2 Lube oil filter element.

.3 Air filter element.

.4 Fuel water separator.

.3 Tools: provide one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal tool box.

1.8 MANUFACTURER'S QUALIFICATIONS

.1 The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

.2 The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

.3 The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

.4 The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

.5 The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten years. When requested by the Consultant, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

.6 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience, and with service facilities within 160 km of project.

.7 Supplier: Authorized or franchised distributor of specified manufacturer with minimum three years documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Store equipment in original, undamaged package.

.2 Deliver to the project site in manufacturer's original wrapping and containers, labelled with manufacturer's name, product information, etc.

.3 Coordinate delivery date and time with the Owner and equipment supplier.

.4 Installing contractor to accept unit on site, inspect for damage, provide craning c/w spreader bars, and install equipment.

1.10 WARRANTY

.1 Warrant the material and workmanship of the generator set and associated equipment for a minimum of [two] years from registered commissioning and start-up, or 30 months from date of arrival on site.

.2 The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

.3 Warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Service of the generators sets to be performed by technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier.

2 Products

2.1 MANUFACTURERS

.1 Manufacturer List:

.1 Cummins Power Generation, (Basis of Design).

.2 Caterpillar.

.3 Gal Power.

.4 Kohler Power Systems.

.5 LMR Power Systems.

.6 Sommers.

.7 Wajax Power Systems (MTU Onsite Energy).

.2 Substitution Limitations: Only approved bidders shall supply equipment provided under this contract. Proposals must include a line-by-line compliance statement based on this specification.

2.2 REGULATORY REQUIREMENTS

.1 Generator set to be listed and labelled by a certification organization accredited by the Standards Council of Canada.

.2 Comply with all applicable EPA emissions standards at the date of installation.

.3 Conform to requirements of CSA C22.1, the Ontario Electrical Safety Code, and other requirements of the Electrical Safety Authority (ESA).

.4 Conform to all requirements of CSA C282.

.5 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for purpose specified and indicated.

.6 Installation in accordance with the National Fire Code of Canada.

2.3 GENERATOR SET

.1 Ratings

.1 The generator set shall operate at 1800 rpm and at a voltage of: 600 Volts AC, three phase, 3-wire, 60 Hz.

.2 The generator set shall be rated per ISO 8528 at [200 kW] at 0.8 PF, standby rating, based on site conditions of:

.1 Altitude: 914 meters (3000 feet).

.2 Ambient temperatures up to 40 degrees C (104 degrees F)

.3 Emissions:

.1 25 kW to 300 kW – EPA Tier 3 certified.

.4 Standby rating, based on site conditions of: Altitude 400 meters above sea level, ambient temperatures of 40 degrees C, based on temperature measured at the control for indoor installations, and measured at the air inlet closest to the alternator for outdoor equipment.

.2 Performance

.1 Voltage regulation to not exceed one percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load to not exceed plus or minus 0.5 percent.

.2 Frequency regulation to be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.

.3 The engine-generator set to be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine generator set at operating temperature.

.4 Motor starting capability shall be a minimum of [920 kVA]. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

.5 Alternator: produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.

.6 The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.

.7 The time required to automatically start, accelerate to rated speed and voltage, synchronize and parallel all generator sets to the system bus on a normal power failure shall not exceed 15 seconds, assuming that the generator sets are in an ambient temperature of 15 degrees C or greater, and water jacket heaters are operating properly.

.8 The generator set, complete with sound attenuated enclosure, shall be tested by the generator set manufacturer per ANSI S1.13. Data documenting performance shall be provided with submittal documentation.

.3 Construction

.1 Engine generator set mounted on a heavy-duty steel base to maintain alignment between components. The base to incorporate a battery tray with hold-down clamps within the rails.

.2 All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

.4 Connections

.1 Load connections composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the quantity and size as shown on the drawings.

.2 Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.

.3 Generator set control interfaces to other system components made on a common, permanently labeled terminal block assembly.

2.4 ENGINE AND ENGINE EQUIPMENT

.1 Diesel engine, 4 cycle, radiator and fan cooled. Minimum displacement 23.1 litres, with 6 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:

.1 An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

.2 Skid-mounted radiator and cooling system rated for full load operation in 50 degrees C ambient as measured at the generator air inlet, based on 0.5 inches H2O external static head. Radiator sized based on a core temperature which is 10 degrees C higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.

.3 Electric starters capable of three complete cranking cycles without overheating.

.4 Positive displacement, mechanical, full pressure, lubrication oil pump.

.5 Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

.6 An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.

.7 Replaceable dry element air cleaner with restriction indicator.

.8 Flexible supply and return fuel lines.

.9 Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.

.2 Coolant heater

.1 Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.

.2 The coolant heater shall be installed on the engine with SAEJ20 compliant materials. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using isolation valves to isolate the heater for replacement of the heater element. The design shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

.3 The coolant heater shall be provided with a 24 V DC thermostat, installed at the engine thermostat housing. An AC power connection shall be provided for a single AC power connection to the coolant heater system.

.4 Coolant heater(s) sized as recommended by the engine manufacturer to warm the engine to a minimum of 40 degrees C in a 15 degree C ambient, in compliance with CSA C282 requirements, as a minimum, or the temperature required for starting and load pickup requirements of this section.

.3 Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location

.4 Starting and Control Batteries: lead acid type, 24 volt DC, sized as recommended by the engine manufacturer for compliance to CSA C282 starting requirements, complete with battery cables and connectors.

.5 Exhaust Silencer

.1 Provide exhaust silencer for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer.

.2 The silencer shall be selected by the manufacturer to suit the overall noise rating of the enclosed unit in Article 2.10.

.3 Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.

.4 Complete exhaust system to be installed within the enclosure, with vertical exhaust discharge.

.6 Provide fully regulated, constant voltage, current limited, multi-rate battery charger(s) for the generator set. The chargers shall be designed for heavy-duty industrial service, primarily to quickly recharge and maintain batteries that start internal combustion engines. Charger shall be rated a minimum of 12 amps, and be capable of operating in parallel with another like charger for reliability and added charging capacity.

.1 Charger shall provide 4 distinct charge states: “dead battery”, “bulk charge”, “absorption”, and “float”. Charge rate shall be temperature compensated to provide proper charging in ambient conditions from –20 degrees C to +55 degrees C.

.2 Provide LED indication of general charger condition, including charging, fault, and equalize. Provide a 2 line LCD display to indicate charge rate, battery voltage, faults, and provide for charger set up. Charger shall provide relay contacts for fault conditions as required by CSA C282.

.3 The charger shall operate properly during fault conditions, including battery disconnection while charging, reversed battery polarity connections, and shorted battery.

.4 The charger shall be compliant to the same RFI/EMI and voltage surge performance as are specified for the genset control.

2.5 LOW VOLTAGE AC ALTERNATOR

.1 The AC alternator shall be; synchronous, four pole, 2/3 pitch, brushless, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. The alternator design shall prevent shaft current from flowing and eliminate the need for insulated bearings. All insulation system components shall meet NEMA MG1 requirements for Class H insulation systems. Actual temperature rise measured by resistance method at full load shall not exceed 105 degree C in a 40 degree C ambient.

.2 The alternator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage up to 5 percent above or below rated voltage.

.3 A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

.4 The alternator shall be supplied with a dedicated, independent power source for the voltage regulation system, which provides sufficient excitation for the alternator to supply 300 per cent of rated output current for 10 seconds.

.5 The subtransient reactance of the alternator to not exceed 15 per cent, based on the standby rating of the generator set.

.6 Provide an anti-condensation heater for the alternator for generator sets installed outdoors or in unheated environments.

.7 Provide two embedded resistance temperature detectors per phase and temperature indication equipment. The control system shall annunciate high alternator temperature as a fault condition.

.8 The alternator shall be capable of operation with reverse kVAR of 0.15 per unit.

2.6 GENERATOR SET CONTROL

.1 The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, protection, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

.2 The control shall be mounted on the generator set in an accessible location. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

.3 The generator set mounted control shall include the following features and functions:

.1 Control Switches

.1 Mode Select Switch.

.1 The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

.2 EMERGENCY STOP switch.

.1 Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from

automatic restarting. The switch shall include a lockout provision for use in safely disabling the generator set for necessary service.

.2 Locate inside Generator Enclosure.

.3 RESET switch.

.1 The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

.4 PANEL LAMP switch.

.1 Operating the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is operated, or after the switch is operated a second time.

.5 Voltage and Frequency Adjustment. The genset mounted control shall include digital raise/lower switches for adjustment of voltage and frequency.

.2 Generator Set AC Output Metering

.1 Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output kW, kWh, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.

.2 Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (kW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output. Both analog and digital metering are required.

.3 The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.

.4 The control system shall log total number of operating hours, total kWh, and total control on hours, as well as total values since reset.

.5 Generator Set Alarm and Status Display.

.1 The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of all alarm, shutdown, and status conditions associated with the generator set, including all paralleling control functions and the engine ECM on an alphanumerical display on the genset. The following alarm, shutdown, and status conditions are required, as a minimum:

.1 low oil pressure (alarm)

.2 low oil pressure (shutdown)

.3 oil pressure sender failure (alarm)

.4 low coolant temperature (alarm)

.5 high coolant temperature (alarm)

.6 high coolant temperature (shutdown)

.7 engine temperature sender failure (alarm)

.8 low coolant level (alarm or shutdown--selectable)

.9 fail to crank (shutdown)

.10 fail to start/overcrank (shutdown)
.11 overspeed (shutdown)
.12 low DC voltage (alarm)
.13 high DC voltage (alarm)
.14 weak battery (alarm)
.15 low fuel day-tank (alarm)
.16 high AC voltage (shutdown)
.17 low AC voltage (shutdown)
.18 under frequency (shutdown)
.19 over current (warning)
.20 over current (shutdown)
.21 short circuit (shutdown)
.22 ground fault (alarm)
.23 over load (alarm)
.24 emergency stop (shutdown)

.2 Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

.3 Engine Status Monitoring

.1 The following information shall be available from a digital status panel on the generator set control:

.1 engine oil pressure (psi or kPa)
.2 engine coolant temperature (degrees F or C)
.3 engine oil temperature (degrees F or C)
.4 engine speed (rpm)
.5 number of hours of operation (hours)
.6 number of start attempts
.7 battery voltage (DC volts)

.2 The control system shall also incorporate a data logging and display provision to allow logging of a minimum of the last 20 warning or shutdown indications on the generator set, the time of the last fault of each type, and the number of faults of each type, and total time of operation at various loads as a percent of the standby rating of the generator set.

.4 Engine Control Functions:

.1 The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.

.2 The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

.3 The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

.4 The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

.5 Alternator Control Functions:

.1 The generator set shall include an automatic microprocessor-based voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The voltage regulation system shall be based on a full wave rectified input, pulse-width modulated output design. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

.2 Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown).

.3 Controls shall be provided to individually monitor all three phases of the output current for 1, 2, or 3-phase short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).

.4 Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

.5 An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

.6 A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC

.7 During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

.8 The control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.

.6 The generator set shall be provided with a network communication module to allow real time communication with the generator set control by remote devices. The control shall communicate all engine and alternator data; alarm, shutdown and status conditions; and allow starting and stopping of the generator set via the network in both test and emergency modes.

.4 Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the

audible and visual alarms called for by CSA 282; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. 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. 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.

.5 The generator set shall be provided with a utility grade protective relay, designed to provide thermal overload protection for the alternator, and performance certified for that purpose by a 3rd party testing organization. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided. Relay shall be installed to allow shutdown of the generator excitation system on an alternator overload condition, with the engine operating for a cool-down period before shutdown. The relay shall not include an instantaneous trip function.

2.7 CONTROL INTERFACES FOR REMOTE MONITORING

.1 No field connections for control devices shall be made in the AC power output enclosure. Provide the following features in the control system:

.1 Form "C" dry contact set rated 2 A @ 30 VDC to indicate existence of any alarm or shutdown condition on the generator set.

.1 Warning Alarms

.1 Common Alarm
.2 High Battery Voltage
.3 Low Battery Voltage
.4 Charger AC Failure
.5 Pre-High Engine Temperature
.6 Pre-Low Oil Pressure
.7 Low Engine Temperature
.8 High Engine Temperature
.9 Low Oil Pressure
.10 Low Coolant Level
.11 Low Fuel Level

.2 Critical Alarms

.1 Fail to Start
.2 Low Fuel
.3 Overspeed

.3 Information Contacts

.1 Genset Running
.2 Genset Not in Auto

.2 One set of contacts rated 2 A @ 30 VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.

.3 A fused 10 amp switched 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

.4 A fused 20 amp 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

2.8 CIRCUIT BREAKERS

.1 CAN/CSA-C22.2 No. 5, molded case circuit breakers on generator output with integral thermal and instantaneous magnetic trip in each pole, sized to CSA C22.1. Include battery-voltage operated shunt trip, connected to open circuit breakers on engine failure. Unit mount in enclosure to meet CSA C22.2 No. 100, Type 1 requirements.

.2 Bolt-on, molded case, temperature compensated for 40 deg. C ambient, dual thermal-magnetic trip. Electronic trip type with adjustments for long-time, instantaneous and short-time functions.

.3 Breaker status dry contacts for remote monitoring of the following functions:

.1 Breaker contact status (Open / Closed).

.2 Breaker trip status.

.4 Schedule of generator output circuit breakers:

.1 Generator Output Breaker to feed emergency side of Automatic Transfer Switches.

.1 Equipped with shunt trip capability.

.2 Load Bank Breaker

.1 Rating and ampacity of load bank breaker to match generator output breaker.

.2 Equipped with shunt trip capability to ensure that the breaker will be tripped during testing upon receiving engine start signal from Automatic Transfer Switch. Electrical contractor to provide cables from ATS to breaker to suit manufacturer's instructions.

.3 Provide lugs allowing ease of connection for load bank cables.

2.9 REMOTE ANNUNCIATION AND MONITORING

.1 Provide remote annunciator panel for field installation by installing Contractor.

.2 Provide NIC Card for SNMP Monitoring.

2.10 WEATHERPROOF SKIN-TIGHT ENCLOSURE

.1 Sound attenuating enclosure with sound attenuation to provide sound levels of no greater than 75 dB(A) at 7 m perimeter.

.2 To suit conduit entry from below grade.

.3 Access doors with key locks, welded hinges, and door lock port hole to keep door open during maintenance.

.4 Primed for corrosion protection and finish painted in a custom colour to be selected by the Owner and confirmed at submittal review.

.5 Interior of enclosure to consist of high reflectance materials to improve light levels when servicing or maintaining unit.

2.11 ACCESSORIES

.1 Factory provided accessories in the generator enclosure prewired to a panelboard in the generator enclosure:

.1 Heating:

.1 Battery thermal wrap, 120 volt, minimum 75 watts per battery to maintain battery temperature of 27 degrees C (80 degrees F), and complete with thermostat to eliminate batter damage caused by overheating or acid spill.

.1 Basis of design: HOTSTART, Inc., KBW series.

.2 Motorized intake dampers, 5 kW 208 volt 3-phase forced flow heater in enclosure complete with reverse acting thermostat for control to maintain 10 degrees C at all times.

.3 Engine block circulating coolant heater with thermostat sized to engine manufacturer's recommendations.

.2 Lighting:

.1 Emergency battery unit complete with 2 hours runtime on loss of utility power and complete with two MR16 LED heads, light output equivalent to two 20 W MR16 incandescent lamps, in accordance with CSA C282 clause 6.11.1.

.1 Minimum illumination: 50 lx (5 fc).

.2 Battery units shall include automatic self-diagnostic circuitry, and a surge protection device (SPD) on the supply site of power to the unit.

.3 Battery unit to be c/w CSA 5-15 plug and plugged into a dedicated emergency lighting receptacle installed immediately adjacent to the battery unit.

.3 Minimum one 5-15R GFI duplex receptacle on generator (in addition to the battery unit receptacle).

.4 If spring isolators are to be used, provide generator frame-bottom metal sealing plate to maintain heat inside enclosure, proper directionality of airflow, maintain noise rating, and prevent animal ingress.

.5 Other accessories as indicated on the generator enclosure layout drawing, and as required for a complete operating system, and as recommended by the generator manufacturer.

.6 Accessories to be fed from a panelboard pre-installed within the generator enclosure, rated 100 A 120/208V, 3-Ph, 4W, 10 kA IC, c/w main breaker, and c/w full size, bolt-on breakers, installed with vibration isolation from the generator enclosure.

.1 Single phase, or plug-on breaker panelboard, or panelboard installed outside the skin-tight enclosure will be rejected and field replaced at manufacturer's expense.

.2 Acceptable panelboard and circuit breaker manufacturers:

.1 Eaton PRL1 series.

.2 Schneider Electric NQ series.

.3 Siemens equal.

.2 Supplier to include an inspection for unit enclosure and generator accessories by the Electrical Authority Having Jurisdiction (ESA in Ontario) prior to shipment to site. Submit ESA inspection report to Consultant.

2.12 SUB-BASE FUEL TANK

.1 Fuel tank of sufficient capacity to enable minimum 48 hour runtime at full load.

.2 Approvals:

.1 CAN/ULC-S601.

.2 TSSA (Technical Standards and Safety Authority) certified.

.3 Construction:

.1 Sub-base type.

.2 Double walled steel tank.

.3 Complete with interstitial monitoring between the steel walls.

.4 To come complete with leak detection monitoring system.

.5 Where the height of the sub-base fuel tank equals or exceeds 914 mm (36 inches), provide an integrated platform complete with steps, and handrail for access to the generator for maintenance. Platform shall provide 1 metre clear working space on each side of the generator.

.4 Fill Pipe:

.1 Minimum 50 mm (2 inch) diameter pipe size.

.2 Terminated outside of the enclosure to current CSA B139 series and TSSA requirements.

.3 Designed and installed in such a manner as to ensure the transfer of fuel to the tank without flow restriction and to avoid spillage.

.4 Each fill opening and each entry to a fill pipe shall be provided with a weather-tight cover designed to discourage tampering.

.5 Tank shall be equipped with vent whistles or other applicable warning devices.

.6 Tank to be equipped with an overfill protection device in accordance with ULC-S661.

.7 Piping shall be of steel construction.

.8 Provide lockable stainless steel spill containment box outside the enclosure complete with drain.

.9 Sub-base tank finish colour: white.

.5 Vent Pipes:

.1 Fuel tank shall be vented in accordance with manufacturer's instructions or recommendations and the standard to which they are certified.

.2 Generator shall be complete with vent pipe not less than 50 mm (2 inch) diameter, and emergency vent pipe not less than 75 mm (3 inch) diameter.

.3 Vent pipes to be terminated outside of the enclosure to current CSA B139 code requirements.

.4 The vent pipes shall be provided with a weatherproof hood or vent cap having a free open area at least equal to the cross-sectional open area of the vent pipe. The vent hood or cap shall prevent ingress of foreign objects and blockage by ice build-up.

.5 Vent pipes shall be installed to drain towards the tank, and shall be installed without sags or traps in which liquid can collect.

.6 Pipes shall be of steel or galvanized construction.

.6 Fuel Level Gauge

.1 Fuel tank shall be complete with an approved glass sight fuel-level gauge.

.2 Gauging by means of a dipstick shall not be permitted.

.3 The gauge shall not be fitted in a location that can:

.1 Permit a discharge of fuel from the tank at the normal liquid level within the tank; or

.2 Interfere with the operation of the vent alarm if the gauge were broken.

2.13 SEQUENCE OF OPERATION

.1 Start generator set on receipt of a start signal from remote equipment (automatic transfer switch). The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.

.2 Start generator within 15 s of loss of normal power.

.3 The generator set shall complete a time delay start period as programmed into the control.

.4 The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:

.1 The control system shall verify that the engine is rotating when the starter is signalled to operate. If the engine does not rotate after three attempts, the control system shall shut down and lock out the generator set, and indicate "fail to crank" shutdown.

.2 The engine shall start and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the

engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.

.3 The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.

.5 On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.

.6 When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

.7 On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

.1 Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

2.14 SOURCE QUALITY CONTROL

.1 Provide factory test, start-up by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.

.2 The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided to the Consultant. All testing shall be performed with calibrated metering.

.3 Factory testing may be witnessed by the Owner and Consultant. Costs for travel expenses will be the responsibility of the Owner and Consultant. Supplier is responsible to provide two weeks notice for testing.

.4 Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include:

.1 Four (4) hour run at full load.

.2 Maximum power.

.3 Voltage regulation.

.4 Transient and steady-state governing.

.5 Single step load pickup:

.1 Zero to 100% to zero.

.2 Zero to 75% to zero.

.3 Zero to 50% to zero.

.4 Zero to 25% to zero.

.6 Function of safety shutdowns.

3 Execution

3.1 EXAMINATION

.1 All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.2 PREPARATION

.1 Location of generator with sub-base tank in accordance with the National Fire Code of Canada:

.1 Locate at a minimum distance of 3 metres to a building on the same property.

.2 Locate at a minimum distance of 3 metres to a property line.

.3 Locate at a minimum distance of 1 metre from an adjacent tank.

3.3 INSTALLATION

.1 Install equipment in accordance with final submittals and contract documents. Comply with applicable provincial and local codes as required by the Authority Having Jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of CSA listed products.

.2 Perform Work to CSA C22.1.

.3 Conform to CSA C282 and CSA B139.

.4 Concrete housekeeping pad:

.1 Install generator on concrete housekeeping pads designed by Structural Engineer.

.2 Cast-in-place concrete housekeeping pad to extend a minimum of 1 metre beyond footprint of generator.

.3 Coordinate exact conduit entry point with equipment submittals prior to fabricating pad.

.4 Permanently fasten equipment to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.

.5 Provide all interconnecting wiring between all major equipment provided for the on-site power system. Provide interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

.6 Install remote annunciator adjacent to the automatic transfer switch, or as noted on drawings.

.7 Systems Integration:

.1 Use stranded conductors to connect start-stop signal from Automatic Transfer Switch in Section 26 36 23.13.

.2 Fire Alarm System Supervision: Use stranded conductors to connect to Fire Alarm System per Section 28 46 21.11 for the following signals:

.1 Common generator fault condition (including main disconnect open) to provide a supervisory signal at the fire alarm system.

.2 Generator Running.

.3 Low Fuel.

.4 Not in auto.

3.4 GROUNDING AND BONDING (3-POLE ATS)

.1 Ground and bond to Electrical Code requirements, and Section 26 05 26.

.2 Remove bonding jumper from generator neutral to suit 3-pole ATS.

.3 For 3-pole transfer switches utilized on 4-wire systems with unswitched neutrals, provide warning sign at the generator to clearly indicate the use of a floating neutral and that the generator neutral is not separately grounded.

3.5 FIELD QUALITY CONTROL

.1 Inspect equipment for physical damage. Repair scratches and other installation damage prior to final system testing. Thoroughly clean equipment to remove all dirt and construction debris prior to initial operation and final testing of the system.

.2 Manufacturer Services:

.1 On completion of the installation, conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

.2 Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the Consultant.

.3 Inspections

.1 Complete all verifications, inspections, and reports prior to scheduling TSSA inspection.

.2 Carry for the cost of all inspections by authorities having jurisdiction, including, but not limited to, the Electrical Safety Authority (ESA), and Technical Standards Safety Authority (TSSA).

.3 Carry the cost of all TSSA variances, i.e. variance due to fuel tank larger than 2500 L, or as detailed in CSA B139.

.4 On Site Acceptance Test

.1 The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. Notify the Consultant in advance of the test for the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system.

.2 Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

.3 Installation acceptance tests to be conducted on-site shall include a "cold start" test, a four hour full load (resistive) test, and a one step rated load pickup test in accordance with CSA C282. Provide a resistive load bank and make temporary connections for full load test, if necessary.

.4 Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least two hours. Coordinate timing and obtain approval for start of test with site personnel.

.5 The generator set supplier shall issue a test report documenting the results of testing, and including a complete list of all settings in the control system.

.6 Upon completion of testing, provide fuel to fill generator fuel tank.

3.6 TRAINING

.1 The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the Owner.

.2 Familiarize the Owner's Representative in the testing and maintenance requirements prescribed by Ontario Regulations, O.Reg 524/98:

.1 The system shall be used and operated for the purpose of testing or performing maintenance for a maximum of 60 hours in any 12-month period.

.2 The system shall be used and operated for the purpose of testing or performing maintenance only between the hours of 7 a.m. and 7 p.m.

.3 When the system is used and operated for the purpose of testing or performing maintenance, the air intakes, doors and windows of any buildings or structures located on the same site as the system shall be closed, if doing so would reduce the likelihood of emissions from the system entering the building or structure.

.4 If more than one generator unit is part of the system, only one unit shall be used and operated at any time for the purpose of testing or performing maintenance.

.5 If the Ministry of the Environment issues a smog advisory that identifies an area in which the system is located, the system shall not be used or operated for the purpose of testing or performing maintenance until a termination notice with respect to the advisory has been issued for that area.

3.7 MAINTENANCE

.1 Perform equipment maintenance as described in PART 1 of this section.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.

.2 The Automatic Transfer Switch will transfer the load in delayed transition (break and delay-before-make) mode.

.3 The transfer switch shall feature a double-sided bypass isolation mechanism.

1.2 RELATED REQUIREMENTS

.1 Section 26 32 13.13 – Diesel-Engine-Driven Generator Sets.

.2 Section 28 46 21.11 – Addressable Fire Alarm Systems.

1.3 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.1-18, Canadian Electrical Code, Part I (24th Edition), Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code (OESC) 27th Edition, 2018.

.3 CSA C22.2 No.5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).

.4 CSA C22.2 No.178.1-12, Transfer Switch Equipment.

.5 CSA C282-09, Emergency Electrical Power Supply for Buildings.

.6 CAN/CSA C60044-1-07 (R2011), Instrument Transformers.

.2 IEEE

.1 IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

.3 National Electrical Manufacturers Association (NEMA)

.1 ANSI/NEMA ICS 2-1996(R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

.2 NEMA ICS 1 - General Standards for Industrial Control and Systems.

.3 NEMA ICS 2 -Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

.4 NEMA ICS 6 - Industrial Controls and Systems: Enclosures.

.5 NEMA ICS 10-1993, AC Automatic Transfer Switches.

1.4 ACTION SUBMITTALS

.1 Within ten days after award of contract, provide electronic copies of the following information for review:

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations, including voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, weights, and enclosure details.

.2 A copy of the markings that are to appear on the transfer switches when installed.

.3 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

.4 Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.

.5 Manufacturer’s certification of prototype testing.

.6 Manufacturer’s published warranty documents.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Make, model and type.

.2 Single line diagram showing controls and relays.

.3 Description of equipment operation including:

.1 Automatic starting and transfer to standby unit and back to normal power.

.2 Test control.

.3 Manual control.

.4 Automatic shutdown.

.2 Submit drawing of the engraved phenolic equipment nameplate.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 26 05 00. Make prints of electronic submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for transfer switches for incorporation into manual.

.3 Detailed instructions to permit effective operation, maintenance and repair.

.4 Technical data:

.1 Schematic diagram of components, controls and relays.

.2 Illustrated parts lists with parts catalogue numbers.

.3 Certified copy of factory test results.

.5 On-site commissioning and functional testing reports.

.6 Warranty card, specifying the warranties for all ATS’s.

1.6 OPERATIONS AND MAINTENANCE DATA

.1 Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions.

.2 Maintenance Materials:

.1 Include routine preventative maintenance and lubrication schedule.

.2 List special tools, maintenance materials, and replacement parts, or indicate if there are no special tools or user serviceable parts.

.3 Provide two of each special tool required for maintenance, if applicable.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities to respond in timely manner.

.2 Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.

.3 The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours/day, 365 days/year.

.4 The transfer switch shall be serviced by a local service organization that is trained and factory certified in transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours/day, 365 days/year.

.5 Manufacturer certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

.2 Regulatory Requirements

.1 Provide products listed and classified by CSA or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

.2 CSA listed and labeled.

.3 Meet all requirements as described in CSA C282.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect transfer switches from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

1.9 FIELD MEASUREMENTS

.1 Verify that field measurements are as indicated on shop drawings.

1.10 MAINTENANCE SERVICE

.1 Provide service and maintenance of transfer switch for one year from date of Substantial Completion.

1.11 WARRANTY

.1 Minimum one year from the date of commissioning, warranted against defects in materials and workmanship.

2 Products

2.1 MANUFACTURERS

.1 ASCO 7000 Series automatic transfer and bypass isolation switch (basis of design).

.2 Equal by Cummins Power Generation.

.3 Equal by Caterpillar.

.4 Equal by Eaton.

.5 Equal by Kohler Power Systems.

2.2 RATINGS

.1 As indicated on single line diagram.

.2 Minimum interrupting capacity per the following table, unless a higher value is indicated on the drawings:

Switch Rating (Amps)	AIC Rating (kA)
70 - 225	25
250	25
400	35
600, 800	65
1000, 1200	65
1600, 2000	100 Optional
2500, 3000	100
4000	100

2.3 SYSTEM DESCRIPTION

.1 Automatic load transfer equipment to:

.1 Monitor voltage on all phases of normal (utility) and emergency (generator) power sources.

.2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.

.3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.

.4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.

.5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

2.4 AUTOMATIC TRANSFER AND BYPASS/ISOLATION SWITCH

.1 Description: NEMA ICS 2, automatic transfer switch with manual bypass switch suitable for continuous operation.

.2 Configuration: Draw-out type electrically-operated, mechanically-held transfer switch with manually-operated CONNECTED, TEST, AND DISCONNECTED draw-out positions, and with mechanically-operated, mechanically-held transfer switch connected to bypass automatic switch in both NORMAL and EMERGENCY positions.

.3 The transfer switch shall feature a double sided bypass-isolation mechanism to allow power transfer switches to be inspected, tested, and maintained without any interruption of power to the load.

.4 The isolate and bypass procedure shall not exceed 15 seconds.

.5 Transfer switch shall permit bypass of the load to either source without load interruption.

.6 Bypass Switch Ratings: Match automatic transfer switch for electrical ratings.

.7 Transition: Delayed.

2.5 CONSTRUCTION

.1 Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.

.2 Transfer switches shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms.

.3 Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.

.4 Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plugs, to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.

.5 Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.

.6 Transfer switches shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

2.6 ENCLOSURE

.1 Enclosure: ICS 6, Type 1.

.2 Finish: Manufacturer's standard gray enamel.

.3 Maximum dimensions and space restrictions: refer to drawings.

.1 Ensure adequate space is available at sides and rear of the equipment as required to allow access during installation.

.4 Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of CSA standards. The cabinet door shall include permanently mounted key type latches.

.5 Transfer switch equipment shall be provided in a minimum NEMA 1 sprinklerproof enclosure.

.6 Enclosures shall be the NEMA type specified. The cabinet shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

.7 Enclosure shall be complete with wireway as required to accept top, side, or bottom cable entry.

2.7 CONNECTIONS

.1 Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

.2 Transfer switch shall be provided with mechanical lugs suitable for copper conductors and sized to accept the full output rating of the switch.

.3 Lugs suitable for multiple parallel runs of conductors.

.4 Contractor to field verify exact size and quantity of conductors.

2.8 SERVICE CONDITIONS

.1 Transfer switches rated to carry 100 per cent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 degrees C to +60 degrees C, relative humidity up to 95 per cent non-condensing, and altitudes up to 3000 m (10 000 feet).

2.9 MATERIALS

.1 Instrument transformers: to CAN/CSA C60044-1.

.2 Contactors: to NEMA ICS2.

2.10 CONTROLS AND INDICATORS

.1 Selector switches:

.1 2 position for system test with load “Test”, “Auto”

.2 3 position for generator control “Auto”, “Manual”, “Engine Start”

.3 Test position - normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.

.4 Auto position - normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.

.5 Manual position - transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.

.6 Engine start position - engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.

.2 Control transformers: dry type with 120 V secondary to isolate control circuits from:

.1 Normal power supply.

.2 Emergency power supply.

.3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:

.1 Voltage sensing: 3 phase for normal power and on three phases for emergency, solid state type, adjustable drop out and pick up, close differential, 2 V minimum undervoltage and over voltage protection.

.2 Time delays as indicated in the Sequence of Operation section

.3 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.

.4 Product Options and Features

.1 Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION, NORMAL BYPASS, ALTERNATE SOURCE BYPASS.

.2 Test Switch: Mount in cover of enclosure to simulate failure of normal source.

.3 Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

.4 Transfer Switch Auxiliary Contacts: two normally open; two normally closed.

.5 Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.

.6 Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.

.5 Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.

.1 High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which sources are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.

.2 High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.

.3 “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.

.4 “TEST” pushbutton to initiate a pre-programmed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.

.5 "LAMP TEST" pushbutton(s) to test all lamps on the panel by lighting them, either simultaneously from one control, or individually.

.6 The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool or an operator display panel.

.7 Security Key Switch or password on control panel to allow the user to inhibit adjustments.

.8 Key operated test operator switch to prevent manual operation or testing of the transfer switch unless key is in place and operated.

.9 Digital AC meter display panel, to display 3-phase AC Volts, Hz, kW load level, and load power factor. The display shall be colour-coded, with green scale indicating normal or acceptable operating level, yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.

.10 Vacuum LED alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:

.1 Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.

.2 Display source status, to indicate source is connected or not connected.

.3 Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, kW, kVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.

.4 The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:

.1 Adjust voltage and frequency sensor operation set points.

.2 Set up time clock functions.

.3 Set up load sequence functions.

.4 Enable or disable control functions in the transfer switch, including program transition.

.5 Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.

.5 Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.

.6 Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.

.7 Display fault history on the transfer switch, including condition, date/time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.

.6 Internal Controls

.1 Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.

.2 Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:

.1 Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).

.2 Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).

.3 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.

.4 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.

.5 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.

.6 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).

.7 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.

.8 Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.

.3 All transfer switch sensing shall be configurable from the Transfer Switch or a Remote PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. Designs utilizing DIP switches or other electromechanical devices are not acceptable. The transfer control shall incorporate a series of diagnostic LED lamps.

.4 The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not acceptable.

.5 The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cool-down) (adjustable in a range of 0-30 minutes).

.6 The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.

.7 The control system shall be designed and prototype tested for operation in ambient temperatures from -40 degrees C to +70 degrees C. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards

.8 The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

2.11 ACCESSORIES

.1 Ensure pilot lights indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.

.2 Plant exerciser.

.3 Auxiliary Relays:

.1 Auxiliary relays to provide normally open (NO) and normally closed (NC) contacts for remote alarms.

.2 The transfer switch will provide the following dry contact monitoring points to determine status of the ATS remotely:

.1 Normal power available
.2 Emergency power available
.3 ATS in “Normal” position
.4 ATS in “Emergency” position
.5 ATS “Not in Auto”
.6 Pre-Transfer
.7 Failure to Synchronize
.8 Extended Parallel Alarm

.4 Instruments:

.1 Digital true RMS, indicating type 2 per cent accuracy, flush panel mounting:

.1 Voltmeter: AC, scale 0 to nominal system voltage +10%.
.2 Ammeter: ac, scale 0 to 10% above continuous rating.
.3 Frequency meter: scale 55 Hz to 65 Hz.
.4 Voltmeter selector switch: rotary, maintained contacts, panel mounting type, round notched handle, four position, labelled "OFF-Phase A-Phase B-Phase C".

.5 Ammeter selector switch: rotary, maintained contacts, panel mounting type, designed to prevent opening of current circuits, round notched handle, four position labelled "OFF - Phase A - Phase B - Phase C".

.6 Bypass and Isolator

.1 A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.

.2 Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control interwiring shall be provided with disconnect plugs.

.3 Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.

.4 Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs that disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.

.5 The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

.6 When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

.7 Designs requiring operation of key interlocks for bypass isolation or ATSs which cannot be completely withdrawn when isolated are not acceptable.

.7 Communications Module

.1 The communications shall be capable of connecting to the Ethernet TCP/IP network with BacNet card for BAS communication. This module shall allow for the seamless integration of communication transfer devices.

.2 Allow remote viewing of transfer switch information from a PC, including transfer switch name, real time load in kW on the transfer switch, current source condition, and current operating mode.

2.12 EQUIPMENT IDENTIFICATION

.1 Identify equipment in accordance with Section 26 05 53.

.2 Control panel:

.1 For selector switch and manual switch: size 4 nameplates.

.2 For meters, indicating lights, minor controls: use size 3 nameplates.

.3 Warning labels:

.1 For 3-pole transfer switches utilized on 4-wire systems with unswitched neutrals, provide warning sign on transfer switch to clearly indicate the use of a floating neutral and that the generator neutral is not separately grounded.

.2 For 4-pole transfer switches utilized on a 4-wire system with a switch neutral, provide warning sign on transfer switch to clearly indicate that each source is separately grounded.

.4 Nameplates:

.1 Engraved phenolic nameplate, 3 mm (1/8 in) thick plastic engraved sheet.

.2 Red face, white core unless noted otherwise.

.3 To be mechanically attached with self-tapping screws.

.4 White letters, 12 mm (1/2 in.) high unless otherwise noted below.

.5 To include:

.1 Identity of equipment (i.e. ATS-1), 20 mm (3/4 in.) high letters.

.2 Voltage.

.3 Ampacity.

.4 Number of phases.

.5 Identity, switchboard section (if applicable), circuit number, and size of Normal Power source.

.6 Identity, switchboard section (if applicable), circuit number, and size of Emergency Power source.

.7 Identity of device or panelboard on the Load side of the transfer switch.

.8 Date of installation.

.9 If upstream or downstream device is located in a separate room from ATS, indicate the room name and number.

.6 Confirm exact colours and text with the engineer prior to fabrication.

.7 Example of nameplate:

AUTOMATIC TRANSFER AND BYPASS ISOLATION SWITCH

ATS-1

800A-4P, SWITCHED NEUTRAL, 347/600 V, 3PH, 4W

NORMAL FED FROM 800A-3P BREAKER IN MAIN SWITCHBOARD

EMERGENCY FED FROM 450 kW STANDBY GENERATOR OUTSIDE

CONTROLS 450 kW GENERATOR FOR DATA CENTRE

FEEDING PANEL DPSP6A

INSTALLED APRIL 2013

2.13 SOURCE QUALITY CONTROL

.1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Consultant.

.2 Notify Consultant 5 days minimum in advance of date of factory test.

.3 Tests:

.1 Operate equipment both mechanically and electrically to ensure proper performance.

.2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.

.3 Check voltage sensing and time delay relay settings.

.4 Check:

.1 Automatic starting and transfer of load on failure of normal power.

.2 Retransfer of load when normal power supply resumed.

.3 Automatic shutdown.

.5 Provide copy of test reports and include with Commissioning Manual.

2.14 SEQUENCE OF OPERATION

.1 The automatic and manual control of an emergency electrical power supply system, including the starting of a generator set or generator sets, and actuation of automatic transfer switches to connect a load to the emergency supply and reconnect it to the normal supply, shall be in the following sequence:

.1 Confirm initial set points with the Consultant prior to start up and commissioning.

.2 The generator sets shall be started when the normal supply at the transfer switch on one or more phase has been interrupted or is at a voltage that is less than 70 per cent of the nominal system voltage for 3 seconds.

.1 Initiate time delay to start alternate source engine generator: Upon initiation by normal source monitor.

.2 Time delay to start alternate source engine generator: 0 to 3 seconds, adjustable. Initial set point 3 seconds.

.3 Initiate transfer load to alternate source: Upon initiation by normal source monitor and permission by alternate source monitor.

.4 Time delay before transfer to alternate power source: 0 to 60 minutes, adjustable.

.1 Initial set point for “Life Safety” transfer switches: zero (immediate transfer).

.2 Initial set point for “Non-Life Safety” transfer switches: 30 seconds.

.5 The set points for the items above shall be configured such that the generator is connected to and powering life safety equipment within 15 seconds of the loss of normal power.

.3 Where delayed emergency loads are arranged to be connected to the emergency supply later than the emergency loads, all of the delayed emergency loads and any other loads that have been arranged for connection at the same time.

.4 On restoration of the normal supply, and after nominal voltage and frequency have been maintained at nominal levels on all phases of the transfer switch for a period of 1 to 30 minutes, the automatic transfer switches shall transfer the loads back to the normal supply, except that the transfer shall occur without delay when an emergency supply fails.

.1 Initiate retransfer load to normal source: upon permission by normal source monitor.

.2 Time delay before transfer to normal power: 0 to 60 minutes, adjustable; bypass time delay in event of alternate source failure. Initial set point 15 minutes.

.3 Delayed transition duration: 0.5 to 3 seconds. Initial set point 0.5 seconds.

.5 After the transfer of loads back to the normal supply, the automatic shutdown of the generator set shall be delayed for 5 minutes or a reasonable length of time to stabilize the operating temperature under no-load conditions.

.1 Time delay before engine shut down: 0 to 60 minutes, adjustable, of unloaded operation. Initial set point 5 minutes.

.2 Implementation of pre-transfer elevator control sequence should be coordinated with Division 14 to confirm if required:

.1 On a failure of normal power and a transfer to emergency power, the pre-transfer contacts shall be disabled and a transfer of the elevator load to the emergency power source shall take place without additional delay.

.2 On a retransfer from emergency power to normal power, the pre-transfer contacts shall inhibit a transfer to normal power for a minimum of 20 seconds.

.3 When the system is under test conditions in which both the normal and the emergency power sources are live, the pre-transfer contacts shall be enabled and shall inhibit a transfer to the emergency source for at least 20 seconds.

.3 Automatic engine exerciser:

.1 Engine Exerciser: Start engine every 7 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.

.2 Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

.3 Initial set point: turn off automatic engine exerciser.

.4 Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:

.1 Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.

.2 The transfer switch shall issue a compatible start command to the generator set, and cause the generator set to start and run at idle until it has reached normal operating temperature.

.3 When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.

.4 When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate

source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.

.5 The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.

.6 On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.

.7 The transfer switch shall operate the generator set unloaded for a cool-down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

.5 Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:

.1 Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.

.2 When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.

.3 At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3 Execution

3.1 FACTORY TESTING

.1 The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. Tests shall be conducted as per CSA standards. A certified test report shall be included in each copy of the Operations Manual. Test process shall include calibration of voltage sensors. The following factory tests shall be performed:

.1 Visual inspection to verify that each ATS is in accordance with the specifications.

.2 Mechanical test to verify that ATS sections are free of mechanical hindrances.

.3 Insulation resistance test to ensure integrity and continuity of entire system.

.4 Main switch contact resistance test.

.5 Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.

.2 Provide for the Owner and Consultant to witness factory testing.

3.2 EXECUTION

.1 Verify conditions, including restrictions for moving equipment into position and ensure equipment can suit these limitations.

.2 Coordinate disassembly and field assembly of equipment with the manufacturer.

3.3 INSTALLATION

.1 Install transfer switches to in accordance with codes, as shown on the drawings, and as recommended by manufacturer's instructions.

.2 Emergency Lighting at Life Safety Transfer Switches

.1 Provide Emergency Battery Units in rooms containing Life Safety automatic transfer switches in accordance with Section 26 52 13.13. Units require sufficient capacity to provide 2 hours duration in accordance with CSA C282 clause 6.11.1.

.2 Minimum illumination: 50 lx (5 fc).

.3 Battery units shall include automatic self-diagnostic circuitry, and a transient voltage surge suppressor on the supply site of power to the unit.

.3 Provide engraved plastic nameplates.

.4 Locate, install and connect transfer equipment as indicated.

.5 Check relays and solid state monitors and adjust as required to ensure correct operation.

.6 Install and connect remote alarms and IP based monitoring.

.1 For Life Safety transfer switches, provide signal cabling to connect “Automatic transfer switch in bypass mode” to Fire Alarm System per Section 28 46 21.11 to provide remove visual and audible indication per CSA C282-09 clause 9.5.3.

.7 Connect generator control wiring.

.8 Set field-adjustable intervals and delays, relays, and engine exerciser. Verify exact set points with the Consultant.

3.4 MANUFACTURER'S FIELD SERVICES

.1 The manufacturer shall provide disassembly, field assembly, and field certification services to suit restrictions of moving equipment into place.

.2 A factory-authorized service representative is to perform start-up and testing of the ATS in the presence of the commissioning authority.

3.5 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00, and Section 26 08 00.

.2 Energize transfer equipment from normal power supply.

.3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

.4 Set selector switch in "Manual" position and check to ensure proper performance.

.5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.

.6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown. Repeat, at 1 hour intervals, 4 times, complete test with selector switch in each position, for each test.

3.6 COMMISSIONING

.1 Submit commissioning reports to the Consultant.

.2 A factory-authorized service representative is required to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

.3 Following completion of automatic transfer switch installation and after making proper adjustments and settings, site tests shall be performed by the manufacturer’s representative in accordance with manufacturer's written instructions to demonstrate that each automatic transfer switch functions satisfactorily and as specified. Advise the Consultant of the site testing within five days prior to its scheduled date, and provide certified field test reports within 14 days following successful completion of the site tests. Test reports shall describe adjustments and settings made and site tests performed. Minimum operational tests shall include the following:

.1 Insulation resistance shall be tested, both phase-to-phase and phase-to-ground.

.2 Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

.3 Verify that manual transfer warnings are properly placed.

.4 Perform manual transfer operation.

.5 After energizing circuits, demonstrate the interlocking sequence and operational function.

.6 Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

.7 Simulate loss of phase-to-ground voltage for each phase of normal source.

.4 Verify time-delay settings.

.5 Verify pickup and dropout voltages by data readout or inspection of control settings.

.6 Verify proper sequence and correct timing of automatic engine starting, transfer time delay, re-transfer time delay on restoration of normal power, and engine cool-down and shut-down.

.7 Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

.8 Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.

.9 Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.

.10 Low phase-to-ground voltage shall be simulated for each phase of normal source.

.11 Operation and settings shall be verified for specified automatic transfer switch operational feature, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.

.12 Manual and automatic transfer and bypass isolation functions shall be verified.

3.7 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00. Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 26 05 00.

3.8 DEMONSTRATION

.1 At the final inspection in the presence of the Consultant, demonstrate that the complete auxiliary electrical power system operates properly in every respect

.2 Coordinate this demonstration with the demonstration of the engine-generator.

.3 Demonstrate operation of transfer switch in bypass, normal, and emergency modes.

.4 Demonstrate operation of IP based monitoring and configuration.

3.9 TRAINING

.1 The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided.

.2 The training program shall be not less than two hours in duration.

.3 Training date shall be coordinated with the Owner.

End of Section

1 General

1.1 SUMMARY

.1 Section Includes

.1 These specifications describe pertinent material requirements and installation practices for Low Voltage AC Power Panel Surge Protective Devices (SPDs). Furnish and install the SPDs equipment having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract drawings.

.2 The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy Surge Protective Devices. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments (as tested by ANSI/IEEE C62).

.2 Applicability

.1 SPDs shall be fully applicable for the purpose of protecting all facility AC electrical circuits from the hazardous effects of transient voltages. These transients may be generated externally by lightning induced energies, utility load factor corrections, and substation switching or they can be internally generated due to inductive and/or capacitive load switching.

.3 Suitability

.1 SPDs shall be suitable for all service entrance panelboards as indicated on the electrical layouts and single line diagrams. Products are to be configured for parallel installation - no series designs shall be considered acceptable. Design products to allow installation as a stand-alone device allowing mounting adjacent to panelboards. Installation is to be accomplished by a qualified electrical contractor.

1.2 RELATED REQUIREMENTS

.1 Section 26 24 16 – Panelboards.

.2 Section 26 28 16.02 – Molded Case Circuit Breakers.

1.3 REFERENCES

.1 Canadian Standards Association:

.1 CSA C22.1-18 – Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (27th Edition / 2018).

.3 CSA C22.2 No. 269.2-13 – Surge Protective Devices - Type 2 - Permanently Connected.

.2 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE C62.41.1-2002 - IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.

.2 IEEE C62.41.2-2002 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

.3 IEEE C62.45-2002, Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

.4 IEEE C62.62-2010, Standard Test Specifications for Surge Protective Devices.

.5 IEEE 142-2007, Recommended Practice for Grounding of Industrial and Commercial Power Systems - Green Book.

.6 IEEE 1100-2005, Recommended Practice for Powering and Grounding Electronic Equipment - Emerald Book.

.3 National Electrical Manufacturers Association (NEMA):

.1 NEMA LS-1. Document rescinded in entirety August 19, 2009. No replacement document has been issued.

.4 Ontario Building Code and its referenced standards.

.5 Underwriters Laboratories Inc. (UL):

.1 ANSI/UL 1449, (4th Edition), Standard for Safety, Surge Protective Devices.

.2 UL 1283 (Fourth Edition) - 2005, Standard for Electromagnetic Interference Filters.

.6 Other relevant standards:

.1 MIL-STD-220C, Method of Insertion-Loss Measurement.

1.4 DEFINITIONS

.1 Surge Protective Device: A device composed of at least one non-linear component and intended for limiting surge voltages on equipment by diverting or limiting surge current and is capable of repeating these functions as specified. SPDs were previously known as Transient Voltage Surge Suppressors (TVSS) or secondary surge arresters.

.2 L-G: measurements from phase to equipment grounding conductor as line terminals of utilization equipment.

.3 L-L: measurements from phase to phase in a polyphase system, or from one line to another line in a single phase system.

.4 L-N: measurement from phase(s) to neutral for both single and three phase systems.

.5 N-G: measurements from neutral to equipment grounding conductor at line terminal of utilization equipment.

.6 External mounted surge suppressor: Surge Protective Device (SPD) mounted outside of the power panel as a separate component.

1.5 SUBMITTALS FOR REVIEW

.1 Submit in accordance with Section 26 05 00.

.2 Shop Drawings:

.1 Line drawings or catalog sheets detailing dimensions and weight of enclosure, lifting and support points, and enclosure details.

.2 Internal wiring diagram illustrating all modes of protection in each type of SPD required.

.3 Wiring diagram showing all field connections and manufacturer's recommended wire size, recommended circuit breaker or fuse size, required overcurrent protection type, and maximum lead length.

.3 Provide the following product data:

.1 Voltage Protection Ratings (VPRs), I-nominal ratings, Short Circuit Current Ratings, SPD type designations, dimensions showing construction, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period, and replacement terms.

.2 List and detail all protection systems such as fuses, disconnecting means, and protective features.

.4 Submit product data for all components and accessories.

.5 Manufacturer's Installation Instructions:

.1 Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

.2 Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

.6 Test reports:

.1 Submit cover sheet of test report from a recognized independent testing laboratory certifying compliance with UL 1449.

.2 Provide verification that the SPD complies with the required UL 1449 latest edition, latest revision, and Canadian approvals.

.3 Provide spectrum analysis of each unit based on MIL-STD-220C test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds values indicated in this section.

.4 UL documentation verifying Short Circuit Current Rating (SCCR).

.5 Proof of UL 1283 listing for EMI filters.

.7 Upon request, present unencapsulated but complete SPD for visual inspection; proprietary technology included. MOV type and quantity shall reflect kA ratings on cut sheets, verification of monitoring, thermal, overcurrent protection, etc.

.8 Include the following information:

.1 Data for each suppressor type indicating conductor sizes, conductor types, and connection configuration and lead lengths.

.2 Manufacturer's certified test data indicating the ability of the product to meet or exceed requirements of this specification.

.3 Drawings, with dimensions, indicating SPD mounting arrangement and lead length configuration, and mounting arrangement of any optional remote diagnostic equipment and assemblies.

.4 List and detail all protection systems such as fuses, disconnecting means and protective materials.

.5 Indicate SPD wiring, bonding, and grounding connections on wiring diagrams for each system. Include installation details demonstrating mechanical and electrical connections to equipment to be protected.

.6 Wiring diagram of SPD diagnostic indicators.

1.6 CLOSEOUT SUBMITTALS

.1 Maintenance data: submit operation and maintenance data, and engineering data for incorporation into manual specified in Section 26 05 00.

.2 Warranty Document.

1.7 ENVIRONMENTAL REQUIREMENTS

.1 Operating temperature range: -40 degrees C to 70 degrees C (-40 degrees F to 160 degrees F).

.2 Elevation: Operation up to 3 658 m (12 000 feet) above sea level.

.3 Generate no appreciable magnetic fields.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle in accordance with Section 26 05 00.

.2 Store materials in dry, secure location and protect from weather.

.3 Protect from moisture and humidity.

.4 Store in accordance with manufacturer's written instructions.

.5 Waste management and disposal in accordance with Section 26 05 00.

1.9 MANUFACTURER WARRANTY

.1 Five-year warranty.

.2 Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPD shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section. This is, the warranty shall cover the effects of lightning, single phasing, and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.

1.10 MANUFACTURER QUALIFICATIONS

.1 Manufacturer regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than five years. Substitution of products supplied by a manufacturer not named as acceptable is not allowed during bid period.

1.11 QUALITY ASSURANCE

.1 All SPDs manufactured by a single ISO-9001 registered company normally engaged in the design, development and manufacture of such devices for electrical and electronic system equipment protection.

.2 Manufacturer regularly engaged in the manufacture of surge suppression products for the specified categories for minimum of ten years.

.3 Manufacturer shall offer repair or replacement service for all materials and components incorporated in the Surge Protective Devices.

.4 Technical assistance (no cost to customer) provided by manufacturer through a factory representative or a local distributor and a factory staffed toll-free technical hotline.

.5 Manufacturer shall provide a toll-free customer service phone number to facilitate all inquiries regarding product returns, warranty claims, purchasing requirements and payment or credit issues.

.6 Listed to most recent edition of UL 1449 and UL 1283. (UL 1449 Fourth Edition since August 2014).

.7 Products certified by a recognized testing agency accredited by the Standards Council of Canada, and bear a certification mark from that agency indicating acceptance to Canadian standards.

.1 Equipment certification by one of the following bodies:

.1 Listed by Underwriters Laboratories, Inc. and exhibit the cUL Listing Mark for the category "Surge Protective Devices" or SPD. Provide UL Listing Card under category VZCA7 (SPDs certified for Canada) to confirm compliance to UL 1449, and assigned Voltage Protection Ratings.

.2 Listed by ETL.

.3 Listed and classified by CSA (Canadian Standards Association).

.2 SPD to be cUL labeled with no less than a 100 kA Short Circuit Current Rating (SCCR).

2 Products

2.1 OUTDATED AND DEFUNCT SPECIFICATION CRITERIA

.1 Selection of SPD is not be made, solely, or in part, based upon any of the following ambiguous specifications, and obsolete terminology. These terms are no longer recognized by ANSI, NEMA, IEEE, or IEC standards as bonafide suppressor performance parameters. Submittals bearing reference to <u>any</u> of the following will be rejected.

.1 A1 ringwave: removed in 2002 revisions of IEEE C62 documents.

.2 Joule ratings: there is no recognized standard for SPD joule ratings.

.3 NEMA LS-1: document rescinded by NEMA.

.4 Response time: not endorsed by IEEE, NEMA, or UL as a valid SPD rating parameter.

.5 Suppressed Voltage Ratings (SVR): terminology deprecated with UL 1449 third and subsequent editions.

.6 UL 1449, second edition. Replaced by third edition in 2009.

.7 UL 1449, third edition. Replaced by fourth edition in 2014.

2.2 MANUFACTURERS

.1 The inclusion of a manufacturer in the following list does not indicate the manufacturer meets all the requirements in this specification. Likewise, the omission of a manufacturer is not indicative of any lack of qualification. The manufacturer and product must meet all the requirements of this specification.

.2 No unit will be accepted as an “approved equal” unless it meets the warranty, strength, safety features, performance ratings, and all other requirements of this specification.

.3 Manufacturers.

.1 Asco.

.2 Current Technology.

.3 Mersen.

.4 Raycap Electrical Protection Systems.

.5 Total Protection Solutions.

.4 The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Substitution of products supplied by a manufacturer not named as acceptable is not allowed during bid period.

2.3 SURGE PROTECTION DEVICES – GENERAL

.1 Obtain all surge suppression devices through one source from a single manufacturer.

.2 SPD separate from panelboards. Integral SPDs not acceptable.

.3 The SPD listed by recognized testing agency accredited by the Standards Council of Canada, and bear a certification mark from that agency indicating acceptance to Canadian standards, and to UL’s 1283 and UL’s 1449 standards (latest edition, latest revision), and not merely the components or modules. Label all SPDs as a Type 2 for use in Type 1 and Type 2 locations.

.4 Protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N, and N-G, and have bidirectional, positive, and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only four modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.

.5 If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a minimum 100 kA symmetrical fault current with 600 VAC applied.

.6 Suppression Components:

.1 Metal Oxide Varistors (MOVs).

.2 Gas tubes, silicon avalanche diodes, or selenium cells: not permitted.

.3 Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls, such as through the use of Thermally Protected MOVs (TPMOVs).

.4 Where SPD is not equipped with overtemperature controls, pack all surge components, current carrying paths and fusing in fuse grade silica sand or epoxy potting for arc quenching capability, minimization of smoke and contaminates in the event of failure.

.7 Internal Fusing - Overcurrent Protection

.1 Individually fuse each suppression component for safety and performance.

.2 Fusing shall be present in every mode, including Neutral-to-Ground.

.3 All overcurrent protection must be included within the device, and not require external overcurrent protection.

.8 Surge Current Rating

.1 Service Entrance: 200 kA per phase.

.2 Distribution: 100 kA to 200 kA per phase.

.3 Point of Use: 100 kA per phase.

.9 Short Circuit Current Rating (SCCR), sometimes referred to as fault current rating: minimum 100 kA.

.10 Nominal Discharge Current (In, or I-nominal):

.1 UL labelled with a minimum 10 kA I-nominal.

.11 Maximum Continuous Operating Voltage (MCOV): The maximum continuous operating voltage (MCOV) of all components not less than 125 per cent for a 120 V system, 120 per cent for 220 and 240 V systems, and 115 per cent for 347 and 600 V systems.

.1 277 V systems: 320 V MCOV.

.2 480 V systems: 552 V MCOV.

.12 UL 1449 Listed Voltage Protection Ratings (VPRs) to not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	800 V	800 V	800 V
480Y/277	1200 V	1200 V	1200 V
600Y/347	1500 V	1500 V	1500 V
Voltage	L-L	L-G	
480 Delta	1800 V	1800 V	
600 Delta	2500 V	2500 V	

.13 Minimum EMI/RFI filtering of -50 dB at 100 kHz.

.14 SPD enclosure:

.1 Minimum NEMA type 12 rating in indoor applications.

.2 Minimum NEMA type 4 in outdoor applications.

.15 Diagnostics and Monitoring:

.1 Visual LED diagnostics to indicate failure of a suppression component. Monitor every suppression component of every mode, including N-G.

.2 Form C dry contacts (NO or NC) for remote monitoring capability to indicate the failure of any MOV in the unit.

.3 Surge event counter with backup power source.

2.4 SERVICE ENTRANCE AND TRANSFER SWITCH SPDS:

.1 cUL 1449 listed and labeled as a Type 2 device.

.2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.

.3 cUL 1449 listed and labeled with a minimum I-nominal rating of 20 kA.

.4 A cUL approved disconnect switch provided as a means of service disconnect if a 60 A breaker is not available.

.5 Connect SPD using the manufacturer's breaker/wire recommendations. If recommendations are not available, use a 60 amp breaker and 6 AWG cable with full size ground.

.6 Minimum Surge Current Rating: 200 kA per phase (100 kA per mode).

2.5 DISTRIBUTION PANELBOARD SPDS:

.1 cUL 1449 listed and labeled as a Type 2 device.

.2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.

.3 cUL 1449 listed and labeled with a minimum I-nominal rating of 20 kA.

.4 SPD connected using the manufacturer's breaker/wire recommendations. If recommendations are not available a 60 A breaker and 6 AWG with full size ground will be used.

.5 Minimum Surge Current Rating: 100 kA per phase (50 kA per mode).

2.6 LIGHTING AND RECEPTACLE BRANCH CIRCUIT PANELBOARD SPDS:

.1 cUL 1449 listed and labeled as a Type 2 device.

.2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.

.3 cUL 1449 listed and labeled with a minimum I-nominal rating of 10 kA.

.4 SPD connected using the manufacturer's breaker/wire recommendations. If recommendations are not available a 60 A breaker and 6 AWG will be used.

.5 Minimum Surge Current Rating: 100 kA per phase (50 kA per mode).

3 Execution

3.1 PRE-INSTALLATION MEETINGS

.1 Pre-installation meetings: conduct pre-installation meeting one week prior to commencing work of this Section and on-site installations to verify project requirements, substrate conditions and co-ordination with other building sub-trades, to review manufacturer's installation instructions and warranty requirements.

3.2 FIELD QUALITY CONTROL

.1 Have manufacturer of products supplied under this Section review Work involved in the handling, installation, application, protection, and cleaning of its products. Submit written reports in acceptable format to verify compliance of Work with Contract in accordance with Section 01 33 00 and Section 01 78 00.

.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 at stages listed:

.1 After delivery and storage of products, and when preparatory work on which the work of this Section depends is complete, but before installation begins.

.2 Twice during progress of work at 66 per cent and 99 per cent complete.

.3 Upon completion of the work, after cleaning is carried out.

.4 Obtain reports within three (3) days of review and submit immediately to Consultant.

3.3 EXAMINATION

.1 Verify service and separately derived system Neutral to Ground bonding jumpers.

3.4 INSTALLATION

.1 Do complete installation in accordance with CSA-C22.1, CAN/CSA-C22.2 No. 0, ANSI/IEEE C62.41, and all other applicable codes.

.2 Manufacturer’s instructions

.1 Install SPD in accordance with manufacturer’s installation instructions with lead lengths as short and as straight as practically possible. Lead lengths no greater than 600 mm (24 inches). Gently twist conductors together.

.2 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions.

.3 Connect SPD to service panel being protected via a circuit breaker for each phase, based on the number of poles and the connecting wire size, with a 100 A maximum.

.4 Follow the SPD manufacturer’s recommended installation practice as outlined in the equipment installation manual. Ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.

.5 Installation position of SPD:

.1 Locate SPD adjacent to the panelboard, in a position as close as possible to the neutral and ground lugs. Rearrange breaker positions for SPDs to minimize the length of the phase, neutral, and ground conductors.

.2 Mount SPD as close as possible to panel being protected in a position that will minimize lead lengths between suppressor and control breaker(s) to which suppressor connects. Utilize conduit, preferably metallic, to accomplish these connections with a recommended minimum wire size of 10 AWG, a maximum wire size of 4 AWG (for ease of dressing), or as noted on the single line diagram. Do not extend suppressor leads beyond manufacturer's recommended maximum length without specific engineering approval. The rationale for this is the longer connecting leads between the SPD and the power panel, the higher the residual transient voltage.

.3 Locate surge suppressors as indicated and mount securely, plumb, true, and square to adjoining surfaces.

.4 Install surface mounted surge suppressors on fire-retardant plywood backboards as recommended in manufacturer's written instructions. Where practical, group SPDs on common backboard with other equipment.

.5 Mount housings and enclosures on fire-retardant plywood backboard with top not higher than 1.8 m (6 feet) above finished floor.

.6 Wiring:

.1 Install units on a breaker, sized, where indicated, that meets or exceeds the fault current rating of the panelboard.

.2 Connect SPD to service panel being protected via a circuit breaker for each phase, based on the number of poles and the connecting wire size. Connect SPD using the manufacturer’s breaker/wire recommendations.

.1 If recommendations are not available, a 60 A breaker and 6 AWG phase, neutral, and ground conductors will be used.

.2 If the SPD is supplied with lead wires, the match overcurrent protection to the 75 degree C ampacity of the wiring as described in Ontario Electrical Safety Code, Table 2; i.e. a 30 A breaker to suit 10 AWG lead wires.

.3 Install SPD in a neat, workmanlike manner. Lead dress as short and as straight as possible and be consistent with recommended industry practices for the application on which these units are installed.

Bind phase, neutral, and ground conductors tightly (one twist per 30 cm) over entire run, from suppressor to service panel, and always use the shortest length of connecting cable possible.

.4 If the SPD is supplied by the manufacturer with lead wires, cut excess lead length.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Common requirements for all electric lighting, including interior, exterior, and emergency lighting.

1.2 RELATED REQUIREMENTS

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 52 13.13 – Emergency Lighting.

.3 Section 26 52 13.16 – Exit Signs.

.4 Section 26 56 19 – LED Exterior Lighting.

1.3 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code, 25th Edition / 2012.

.3 CSA C22.2 No. 9.0 - General Requirements for Luminaires.

.4 CSA C22.2 No. 250.0 - Luminaires (Bi-National Standard, with UL 1598).

.2 Illumination Engineering Society (IES)

.1 IES HB-10-11 – The Lighting Handbook, 10th Edition.

.2 IES LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.

.3 IES LM-80-08 – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.

.3 NEMA WD 6 - Wiring Devices - Dimensional Requirements.

1.4 SUBMITTALS FOR REVIEW

.1 Refer to Section 01 33 00.

.2 General

.1 The Contractor shall be responsible for supplying equipment product data, and as indicated in the specification, partial or complete working samples of the specified equipment in a timely fashion for design team approval, prior to releasing orders on equipment. Contractor shall be responsible for coordinating all aspects of order placement, deposits, shop drawing procurement, order release, order follow-up, delivery tracking, etc. with Distributor in a timely fashion. Some luminaires may require at least 12 to 16 weeks of lead time or more- the Contractor is responsible for allowing sufficient time for the order-and-deposit process, shop drawing procurement, submittal, and review process. Substitutions will not be accepted on the basis of the contractor's obligation to make any deadlines, contractual or otherwise, agreed by the contractor toward the completion of this project. Lamp submittals are as important and necessary as luminaire submittals and must be supplied by the Contractor to assure correct lamp wattage, color and efficacy.

.2 All submittals shall be generated by respective factories with their seals or other authentication marks and each submittal sheet shall be clearly labeled with respective luminaire type, complete catalog number relevant to submitted luminaire, date of submittal generation and name, phone number, and email address of submittal author in order to track provenance of information. The Consultant may contact respective factory submittal source.

.3 The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous environment requirements of this project. Calculations were typically made to determine luminances, luminance ratios, and/or horizontal and vertical illuminances and uniformities. In some instances, virtual

reality "images" were generated with lighting calculation software to assist the Design Team and/or the Client in assessing the lighting quality of the spaces or areas. Equipment and/or manufacturers which have been shown to comply with the established criteria, including ASHRAE/IES 90.1 or California Title 24 or other such energy code as applicable by ordinance, code, Federal law, or mandate, and/or intended LEED or other green-building certification, is specified herein. Substitutions in all likelihood will be unable to meet all or some of the salient criteria as the specified equipment.

.4 Substitution of products supplied by a manufacturer not named as acceptable is not allowed during bid period.

.5 The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each luminaire, a recommended maintenance manual including:

.1 Vendor and local representative's contact information

.2 Tools required

.3 Instructions

.4 Types of cleaners to be used

.5 Replacement parts identification lists

.6 Equipment product data (high-quality reproducible copies)

.7 Warranty documentation

.3 Shop Drawings:

.1 Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

.2 Wiring diagrams for power, signal and control wiring.

.4 Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes and the following:

.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.2 The product literature shall provide an explanation of all options and descriptors in the catalog number as submitted.

.3 Include luminaire weight.

.4 Provide complete photometric data prepared by independent testing laboratory for each luminaire, for approval by Engineer.

.5 Physical description of lighting fixtures including dimensions.

.6 Ballast, including BF.

.7 Energy-efficiency data, including ballast input wattage.

.8 Life, output (lumens, CCT and CRI), and energy efficiency data for lamps.

.5 Photometric Data and Calculations

.1 Provide Luminaire Data Photometric Testing performed by an independent agency complying with IESNA Lighting Measurement Testing and Calculation Guides.

.2 Submit photometric calculations for typical areas based on layouts as indicated on the drawings.

.1 Submit a photometric calculation for the typical areas based on the conditions.

.2 Submit a photometric calculation for the same typical areas based on the proposed new fixtures.

.3 Clearly indicate mounting heights, heights of calculation zones, light loss factors and surface reflectance values.

.4 Use the follow photometric parameters:

.1 Recoverable Light Loss Factors: 0.8

.2 Ceiling reflectance values of 80 per cent.

.3 Wall reflectance value of 50 per cent.

.4 Floor reflectance value of 20 per cent.

.3 Submittals shall be in PDF format, and the native file of the software used to make the photometric analysis.

.4 Submit IES photometric data files for the proposed luminaires.

1.5 SUBMITTALS FOR CLOSEOUT

.1 Section 01 33 00 and Section 01 78 00: Submittals for project closeout.

.2 Submit manufacturer's operation and maintenance instructions for each product.

.3 Provide a list of all lamp types used on the project, use ANSI and manufacturer’s codes.

1.6 DEFINITIONS

.1 BF: Ballast factor.

.2 CCT: Correlated colour temperature.

.3 CRI: Colour-rendering index.

.4 HID: High-intensity discharge.

.5 LER: Luminaire efficacy rating.

.6 LED: Light Emitting Diode.

.7 Lumen: Measured output of lamp and luminaire, or both.

.8 Luminaire: Complete lighting fixture, including ballast housing if provided.

1.7 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products shall be listed and classified by CSA (Canadian Standards Association), ULC (Underwriter’s Laboratories of Canada), or certified by recognized independent testing organizations that test to CSA standards.

.2 All equipment and parts specified herein shall bear the "ULC Approved" label (or other NRTL label) indicating compliance with UL requirements or as otherwise allowed by the Authority Having Jurisdiction. All luminaires shall be ULC/ NRTL or CSA listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations as required.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.10 EXTRA MATERIALS

.1 Provide the following additional equipment as listed herein.

.1 Provide an additional 2 per cent spare luminaires of each new type to be provided.

.2 Provide 1 per cent of each plastic lens type.

.3 Provide 2 per cent replacement lamps for each lamp type.

.4 Provide three of each type of any special tools required for system use and maintenance.

1.11 WARRANTY

.1 Refer to Section 26 05 00.

.2 LED Luminaires shall have a manufacturer's warranty for a period of not less than five years.

2 Products

2.1 LUMINAIRES

.1 In accordance with related sections.

2.2 MANUFACTURERS

.1 Basis of Design Supplier / Manufacturer:

.1 Peerless Electric (Omnilumen).

.2 Accepted alternate manufacturers and suppliers:

.1 Acuity Brands Lighting.

.2 Cooper Lighting Solutions.

.3 Salex.

.4 Signify.

2.3 LUMINAIRE DISCONNECT PLUGS

.1 Shall be installed on all 120 V luminaires before the ballast or LED driver inputs.

.2 Shall be a bright colour to aid in identification as a safety device.

.3 600V rated.

.4 Types and application:

.1 3-wire disconnect plug to be used for all 3-wire ballasts, such as dimming ballasts using three-wire phase control.

.2 2-wire disconnect plug to be used on all other luminaires.

.5 Code requirements:

.1 Listed to UL 2459

.2 Listed to CSA 182.3

.6 Example Manufacturers:

.1 Thomas and Betts Marrette Series Luminaire Disconnect

.2 Ideal Industries Inc. PowerPlug Series Luminaire Disconnect

3 Execution

3.1 INSTALLATION

.1 Install lighting equipment, including but not limited to luminaires, controls, auxiliary devices and the integration of same in strict conformance with all manufacturers' recommendations and instructions the securing of which shall be the responsibility of the Contractor.

.2 Luminaires shall be integrated with controls in accordance with respective luminaire manufacturers' and controls manufacturers' recommendations and instructions and to provide a complete, trouble-free operation without compromising safety, code and UL/CSA/NOM requirements.

.3 Contractor shall be responsible for sealing all outdoor luminaires for wet locations (i.e. all knock-outs, all pipe and wire entrances, etc.) as is standard industry practice to prevent water from entering luminaires.

.4 The Contractor shall coordinate the lighting system installation with the relevant trades so as to eliminate interferences with hangers, mechanical ducts, sprinklers, pipes, steel, etc.

.5 For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system greater than 1/360 of the length of the total span of the ceiling member.

.6 Mounting heights and configuration of the luminaires shall be as specified in the Luminaire Schedule portion of the Specification or indicated on the drawings, and where conflicts exist, as approved by the Consultant.

.7 All luminaires shall be installed plumb and true and level as viewed from all directions unless specifically identified otherwise in the Luminaire Schedule. Luminaires shall remain plumb and true without continual adjustment or visibly obvious means beyond what is shown on luminaire submittal drawings.

.8 Suspended luminaires shall be installed plumb and true and level unless specifically identified otherwise in the Luminaire Schedule portion of this Specification and at a height from finished floor as specified on the drawings, details and Luminaire Schedule. In cases where this is impractical, refer to the Consultant for a decision. All appurtenances shall be consistently organized for a neat, uniform appearance.

.9 Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Consultant.

.10 Reflector cones, louvers, baffles, lenses, trims and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.

.11 Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, a finishing ring painted to match the ceiling, shall be used to conceal the junction box.

.12 All lamps shall be seasoned for a minimum of 12 hours and a maximum of 100 hours in full-on mode without dimming. All lamps used for convenience lighting during construction shall be replaced with identical new lamps, which shall then be seasoned as described above, immediately prior to the date of substantial completion as determined by the Consultant.

.13 All accessories shall be properly installed and adjusted by Contractor in accordance with specification and installation instructions. Any spare items shall be clearly labeled (indicate type of accessory and associated luminaire types).

.14 Locate and install luminaires as indicated.

.15 Provide adequate support to suit ceiling system.

.16 Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

.17 Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

.18 Install clips to secure recessed grid-supported luminaires in place.

.19 Install wall mounted luminaires at height as indicated.

.20 Install accessories provided with each luminaire.

.21 Install specified lamps in luminaire.

.22 Check lighting luminaires and mountings for their electrical and physical characteristics in relation to conditions due to building construction and mechanical equipment. Make necessary adjustments to luminaires or hanging arrangement without expense to Owners. Give notification at time of shop drawings and before construction if decision on necessary changes is required.

.23 Do not mount luminaires above pipes, ducts or equipment. In event of unavoidably tight locations, provide hangers to clear obstruction. Check layouts of other trades on job and plan co-operatively. Luminaires in any room

shall hang at one height. Obtain approval before any changes are made to layouts shown.

3.2 TESTING AND ADJUSTMENT

.1 As required, all adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Consultant. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor.

.2 All ladders, scaffolds, lifts, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

.3 The Contractor shall be responsible for notifying the Consultant of appropriate time for staking any outdoor luminaire locations which are called out as "to be field located" on drawings and Luminaire Schedule, and shall supply equipment and personnel for staking at the direction of the Consultant.

.4 Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night.

3.3 WIRING

.1 Install luminaire disconnect plugs on all new luminaires not provided as such from the manufacturer.

.2 Connect luminaires to branch circuit outlets provided under Section 26 05 33.13 using flexible conduit.

.3 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

.4 Bond products and metal accessories to branch circuit equipment grounding conductor.

3.4 LUMINAIRE SUPPORTS

.1 Support luminaires independently of ceiling framing, unless ceiling is certified by the manufacturer to support weight of installed devices. Confirm if T-bar ceilings are metric or imperial and provide luminaires to suit ceiling dimensions.

.2 Provide chain hangers for new luminaires.

3.5 LUMINAIRE ALIGNMENT

.1 Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Recessed luminaires shall be installed to permit removal from below. Include accessories and materials to meet applicable codes and regulatory requirements.

.2 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.3 Align luminaires mounted individually parallel or perpendicular to building grid lines.

.4 Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

3.6 FIELD QUALITY CONTROL

.1 Operate each luminaire after installation and connection. Inspect for proper connection and operation.

.2 Wiring connections to the branch circuit shall be made using building wire with insulation suitable for temperature conditions within luminaire.

.3 Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Ceiling framing members must be securely attached to each other and to the building structure as required by all applicable codes and standards. Use of integral clips is not acceptable.

.4 Occupancy Sensors

.1 Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas.

.2 Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s).

.3 Exercise proper judgment in executing the work to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

3.7 CLEANING

.1 All luminaires and accessories shall be thoroughly cleaned after being installed. All fingerprints, dirt, tar, smudges, drywall mud and dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens or louvers prior to final acceptance. All reflectors shall be free of paint other than factory-applied, if any. All reflectors, cones and lenses shall be cleaned only according to manufacturers' instructions.

.2 Clean electrical parts to remove conductive and deleterious materials.

.3 Remove dirt and debris from enclosures.

.4 Clean photometric control surfaces as recommended by manufacturer.

.5 Clean finishes and touch up damage.

3.8 PROTECTION OF FINISHED WORK

.1 Re-lamp luminaires that have failed lamps.

.2 Re-lamp luminaires used for temporary lighting at Substantial Completion.

3.9 COMMISSIONING

.1 Measure samples of each new luminaire type to be replaced as described in PART 1 of this section for demonstration of energy savings.

.2 Sensor placement and orientation for all sensor types.

.3 Occupancy sensor function, sensitivity, and time delays.

.4 Daylight harvesting sensor calibration.

.5 Automated shade operation.

.6 Manual control placement and operation.

.7 Automated control operation, including scheduled on/off functions and dimming trims and presets.

.8 Override operation, access, and functionality.

.9 Centralized control interfaces and operation.

.10 Client education of operations.

.11 Documentation archived to client.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Solid state, light emitting diode (LED) source interior luminaires.

.2 New, fully integrated luminaires for indoor applications.

1.2 RELATED REQUIREMENTS

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 50 00 – Lighting.

.3 Section 26 52 13.13 – Emergency Lighting.

1.3 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code, 25th Edition / 2012.

.3 CSA C22.2 No. 9.0 - General Requirements for Luminaires.

.4 CSA C22.2 No. 250.0 - Luminaires (Bi-National Standard, with UL 1598).

.2 DesignLights Consortium (DLC).

.1 Technical Requirements Table v2.1, or latest edition.

.2 Where the specifications do not explicitly call for DLC qualified LED luminaires, the technical criteria provided in the DLC Technical Requirements provide the basis of the requirements for this section of the Specification.

.3 Energy Star

.1 Program Requirements for Luminaires - Eligibility Criteria, Version 1.2, or latest edition.

.4 Illuminating Engineering Society (IES)

.1 IES HB-10-11 – The Lighting Handbook, 10th Edition.

.2 IES LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.

.3 IES LM-80-08 – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.

.4 TM-21-11- IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.

.5 National Electrical Manufacturer's Association (NEMA)

.1 SSL-1-10 – Electronic Drivers for LED Devices, Arrays, or Systems.

.2 WD 6 - Wiring Devices - Dimensional Requirements.

1.4 DEFINITIONS

.1 CCT: Correlated colour temperature.

.2 CRI: Colour-rendering index.

.3 LED: Light Emitting Diode.

.4 Lumen: Measured output of lamp and luminaire, or both.

.5 Luminaire: Complete lighting fixture, including ballast housing if provided.

1.5 ACTION SUBMITTALS

.1 Refer to Section 26 50 00.

.2 Product submittals shall be accompanied by product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but not limited to):

.1 Maximum power in Watts.

.1 If a transformer is used in conjunction with a driver (for example on some 347 volt lighting circuits), the maximum power shall include the transformer losses.

.2 L70 in hours, when extrapolated for the worse case operating temperature. TM-21 report shall be submitted to demonstrate this.

.3 Product submittals shall be accompanied by performance data that is derived in accordance with appropriate IESNA testing standards and tested in a laboratory that is NVLAP accredited for Energy Efficient Lighting Products.

1.6 INFORMATIONAL SUBMITTALS

.1 Installation instructions.

1.7 CLOSEOUT SUBMITTALS

.1 Section 26 05 00: Submittals for project closeout.

.2 Submit manufacturer's operation and maintenance instructions for each product.

1.8 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

1.9 REGULATORY REQUIREMENTS

.1 Products shall be listed and classified by CSA (Canadian Standards Association), ULC (Underwriter’s Laboratories of Canada), or certified by recognized independent testing organizations that test to CSA standards.

.2 Products shall be certified by a recognized testing agency accredited by the Standards Council of Canada and bear a certification mark from that agency.

.3 All luminaires shall be listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations as required.

.4 Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

1.10 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 26 05 00.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.11 EXTRA STOCK MATERIALS

.1 Provide the following additional equipment as listed herein.

.1 Provide an additional 2 per cent spare luminaires of each new type to be provided.

.2 Provide 1 per cent of each plastic lens type.

.3 Provide three of each type of any special tools required for system use and maintenance.

1.12 WARRANTY

.1 Refer to Section 26 05 00.

.2 The manufacturer shall provide a warranty against loss of performance and defects in materials and workmanship for the luminaires for a period of 5 years after acceptance of the luminaires. Warranty shall cover all components comprising the luminaire.

.3 All warranty documentation shall be provided to customer prior to the first shipment.

.4 LED Luminaires shall have a manufacturer's warranty for a period of not less than five years.

.5 LED boards, drivers and associated components shall have a warranty of 5 years on the LEDs, 5 years on the driver, 10 years on the paint finish.

2 Products

2.1 MANUFACTURERS

.1 Basis of Design Supplier / Manufacturer:

.1 Peerless Electric (Omnilumen).

.2 Accepted alternate manufacturers and suppliers:

.1 Acuity Brands Lighting.

.2 Cooper Lighting Solutions.

.3 Salex.

.4 Signify.

2.2 INDOOR LED LUMINAIRES, GENERAL

.1 Initial delivered lumens – thermal losses should be less than 10 per cent when operated at a steady state at an average ambient operating temperature of 25 degrees C, and optical losses should be less than 15 per cent.

.2 Average Delivered Lumens – Average delivered lumens over 50 000 hours should be minimum of 85 per cent of initial delivered lumens.

.3 All luminaires shall be tested per LM79/80 and published L70 data.

.4 Available in 3500 K correlated colour temperature, CRI greater than or equal to 80, or as indicated.

.5 Accessibility and Maintenance:

.1 All LED luminaires shall be field serviceable, with LED arrays, LED modules, drivers, etc. fully serviceable and easily accessible. In the case of recessed ceiling mounted, and in the case of surface mounted ceiling fixtures, these components must be accessible from below. Luminaires in which any of these components are accessible only from above are not acceptable.

.2 Ballasts, drivers, LED arrays, LED modules, and lamps shall be serviceable while the fixture is in its normally installed position. Ballasts or drivers shall not be mounted to removable reflectors or wireway covers unless so specified. In the case of ceiling mounted luminaires, the serviceable components must be accessible from below.

.6 Housings:

.1 Formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.

.2 Sheet steel housings to be minimum 20 gauge.

.3 Wireways and fittings: free of burrs and sharp edges, and shall accommodate internal and branch circuit wiring without damage to the wiring.

.4 When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.

.5 Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.

.6 Drivers shall not be mounted to removable reflectors or wireway covers unless so specified.

.7 Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

.8 Metal Finishes:

.1 Fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

.2 All metal components of fixtures shall be painted after fabrication to mitigate raw metal edges, and thus prevent premature corrosion.

.3 The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.

.4 Interior light reflecting finishes shall be white with not less than 85 per cent reflectance, except where otherwise shown on the drawing.

.9 Wiring:

.1 Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.

.2 Supplied complete with a luminaire disconnect plug.

2.3 DRIVERS, GENERAL

.1 Electronic LED drivers shall be integral to the luminaire, and be designed to be accessible in the field for replacement and servicing.

.2 Input Voltage:

.1 Driver with a voltage range of (120-277) +/- 10%.

.2 Refer to lighting fixture schedule.

.3 Input frequency 60 Hz.

.4 Load regulation: +/- 1 per cent from no load to full load.

.5 Output ripple less than 10 per cent.

.6 Output should be isolated.

.7 Case temperature: rated for -40 degrees C through +80 degrees C.

.8 Overheat protection, self-limited short circuit protection and overload protected.

.9 Primary fused.

.10 Driver life rating not less than 50 000 hours

.11 Power Factor and Total Harmonic Distortion

.1 Power factor of greater than or equal to 0.9 at full load.

.2 THD of less than or equal to 20 per cent at full load.

.12 Dimming Control:

.1 Coordinate with Section 26 09 23.

.2 0-10 V dimming control typical for all fixtures unless otherwise noted.

.3 Control range: 10 per cent to 100 per cent typical, unless noted otherwise.

.4 Provide a mock-up to demonstrate the luminaire is free of flicker throughout the dimming range when used with the dimming controllers described in related sections.

2.4 INTERIOR WALL-WASH LED LUMINAIRES

.1 Minimum Light Output: 575 lm.

.2 Zonal lumen density:

.1 Minimum 60 per cent between 0 degrees and 90 degrees from nadir.

.2 Minimum 60 per cent of the lumens must be produced in the “forward” hemisphere, towards the wall.

.3 Minimum luminaire efficacy: 45 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.5 DOWNLIGHT LUMINAIRES

.1 Minimum Light Output: 500 lm.

.2 Zonal lumen density: Minimum 75 per cent between 0 degrees and 60 degrees from nadir.

.3 Minimum luminaire efficacy: 45 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.6 NOMINAL 610 MM BY 610 MM (2 FOOT BY 2 FOOT) LUMINAIRES FOR AMBIENT LIGHTING OF INTERIOR SPACES

.1 Minimum Light Output: 2 000 lm.

.2 Zonal lumen density:

.1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.

.3 Spacing Criteria:

.1 0 degrees to 180 degrees: 1.0 to 2.0

.2 90 degrees to 270 degrees: 1.0 to 2.0

.4 Minimum luminaire efficacy: 85 lumens per watt.

.5 Correlated Colour Temperature (CCT): 3500 K

.6 Colour Rendition Index (CRI): 80 CRI minimum.

.7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.7 NOMINAL 305 MM BY 1220 MM (1 FOOT BY 4 FOOT) LUMINAIRES FOR AMBIENT LIGHTING OF INTERIOR SPACES

.1 Minimum Light Output: 1 500 lm.

.2 Zonal lumen density:

.1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.

.3 Spacing Criteria:

.1 0 degrees to 180 degrees: 1.0 – 2.0

.2 90 degrees to 270 degrees: 1.0 – 2.0

.4 Minimum luminaire efficacy: 85 lumens per watt.

.5 Correlated Colour Temperature (CCT): 3500 K

.6 Colour Rendition Index (CRI): 80 CRI minimum.

.7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.8 NOMINAL 610 MM BY 1220 MM (2 FOOT BY 4 FOOT) LUMINAIRES FOR AMBIENT LIGHTING OF INTERIOR SPACES

.1 Minimum Light Output: 3 000 lm.

.2 Zonal lumen density:

.1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.

.3 Spacing Criteria:

.1 0 degrees to 180 degrees: 1.0 – 2.0

.2 90 degrees to 270 degrees: 1.0 – 2.0

.4 Minimum luminaire efficacy: 85 lumens per watt.

.5 Correlated Colour Temperature (CCT): 3500 K

.6 Colour Rendition Index (CRI): 80 CRI minimum.

.7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.9 LINEAR AMBIENT LUMINAIRES: INDIRECT

.1 Minimum Light Output: 500 lm per foot.

.2 Zonal lumen density:

.1 Minimum 50 per cent between 90 degrees and 150 degrees from nadir.

.3 Minimum luminaire efficacy: 85 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.10 LINEAR AMBIENT LUMINAIRES: INDIRECT/DIRECT

.1 Minimum Light Output: 500 lm per foot.

.2 Zonal lumen density:

.1 Minimum 25 per cent between 0 degrees and 60 degrees from nadir.

.2 Minimum 50 per cent between 90 degrees and 150 degrees from nadir.

.3 Minimum luminaire efficacy: 85 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.11 LINEAR AMBIENT LUMINAIRES: DIRECT/INDIRECT

.1 Minimum Light Output: 500 lm per foot.

.2 Zonal lumen density:

.1 Minimum 40 per cent between 0 degrees and 60 degrees from nadir.

.2 Minimum 35 per cent between 90 degrees and 150 degrees from nadir.

.3 Minimum luminaire efficacy: 85 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.12 LINEAR AMBIENT LUMINAIRES: DIRECT

.1 Minimum Light Output: 375 lm per foot.

.2 Zonal lumen density:

.1 Minimum 40 per cent between 0 degrees and 60 degrees from nadir.

.3 Minimum luminaire efficacy: 85 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.13 LOW-BAY LUMINAIRES FOR COMMERCIAL AND INDUSTRIAL BUILDINGS

.1 Minimum Light Output: 5 000 lm.

.2 Zonal lumen density:

.1 Minimum 30 per cent between 20 degrees and 50 degrees from nadir.

.3 Minimum luminaire efficacy: 80 lumens per watt.

.4 Correlated Colour Temperature (CCT): 4000 K

.5 Colour Rendition Index (CRI): 70 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 35 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

3 Execution

3.1 VERIFICATION OF CONDITIONS

.1 Coordinate the lighting system installation with the relevant trades so as to eliminate interferences with hangers, mechanical ducts, sprinklers, piping, steel, etc.

3.2 INSTALLATION

.1 Install lighting equipment, including but not limited to luminaires, controls, auxiliary devices and the integration of same in strict conformance with all manufacturers' recommendations and instructions the securing of which shall be the responsibility of the Contractor.

.2 Integrate luminaires with controls in accordance with respective luminaire manufacturers' and controls manufacturers' recommendations and instructions and to provide a complete, trouble-free operation without compromising safety, code and CSA requirements.

.3 Seal all luminaires for wet locations (i.e. all knock-outs, all pipe and wire entrances, etc.) as is standard industry practice to prevent water from entering luminaires.

.4 Luminaire Alignment

.1 Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Install recessed luminaires to permit removal from below. Include accessories and materials to meet applicable codes and regulatory requirements.

.2 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.3 Align luminaires mounted individually parallel or perpendicular to building grid lines.

.4 Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

.5 Locate and install luminaires as indicated. Mounting heights and configuration of the luminaires shall be as specified in the Luminaire Schedule portion of the Specification or indicated on the drawings as approved by the Consultant.

.6 Installed all luminaires plumb and true and level as viewed from all directions unless specifically identified otherwise in the Lighting Fixture Schedule. Luminaires shall remain plumb and true without continual adjustment or visibly obvious means beyond what is shown on luminaire submittal drawings.

.7 For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system greater than 1/360 of the length of the total span of the ceiling member.

.5 Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

.6 Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, use a finishing ring painted to match the ceiling to conceal the junction box.

.7 Suspended Luminaires:

.1 Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

.2 Suspended luminaires shall be installed plumb and true and level unless specifically identified otherwise in the Luminaire Schedule portion of this Specification and at a height from finished floor as specified on the drawings, details and Luminaire Schedule. In cases where this is impractical, refer to the Consultant for a decision. All appurtenances shall be consistently organized for a neat, uniform appearance.

.8 Install wall mounted luminaires at height as indicated.

.9 Accessories:

.1 Reflector cones, louvers, baffles, lenses, trims and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.

.2 Install accessories provided with each luminaire.

.3 All accessories shall be properly installed and adjusted by Contractor in accordance with specification and installation instructions. Any spare items shall be clearly labeled (indicate type of accessory and associated luminaire types).

3.3 TESTING AND ADJUSTMENT

.1 As required, all adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Consultant. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor.

.2 All ladders, scaffolds, lifts, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

.3 Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night.

3.4 LUMINAIRE SUPPORTS

.1 Provide adequate support to suit ceiling system.

.2 Support luminaires independently of ceiling framing, unless ceiling is certified by the manufacturer to support weight of installed devices. Confirm if T-bar ceilings are metric or imperial and provide luminaires to suit ceiling dimensions.

.3 Provide chain hangers for new luminaires.

.4 Install clips to secure recessed grid-supported luminaires in place.

.5 Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Ceiling framing members must be securely attached to each other and to the building structure as required by all applicable codes and standards. Use of integral clips is not acceptable.

3.5 WIRING

.1 Install luminaire disconnect plugs on all new luminaires not provided as such from the manufacturer.

.2 Connect luminaires to branch circuit outlets provided under Section 26 05 33.13 using flexible conduit.

.3 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

.4 Bond products and metal accessories to branch circuit equipment grounding conductor.

3.6 FIELD QUALITY CONTROL

.1 Operate each luminaire after installation and connection. Inspect for proper connection and operation.

.2 Make wiring connections to the branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

.3 Occupancy Sensors.

.1 Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas.

.2 Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room.

.3 Exercise proper judgment in executing the work to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

3.7 CLEANING

.1 Thoroughly clean all luminaires and accessories after installation. All fingerprints, dirt, tar, smudges, drywall mud, dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens or louvers prior

to final acceptance. All reflectors shall be free of paint other than factory-applied, if any. All reflectors, cones and lenses shall be cleaned only according to manufacturers' instructions.

.2 Clean electrical parts to remove conductive and deleterious materials.

.3 Remove dirt and debris from enclosures.

.4 Clean photometric control surfaces as recommended by manufacturer.

.5 Clean finishes and touch up damage.

.6 Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Consultant.

3.8 COMMISSIONING

.1 In accordance with Section 26 08 50.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Emergency lighting units with battery back-up for emergency illumination of remote emergency fixtures and internally illuminated exit signs.

.2 Remote emergency fixtures.

1.2 RELATED REQUIREMENTS

.1 Section 26 50 00 – Lighting.

.2 Section 26 52 13.16 – Exit Signs.

1.3 REFERENCES

.1 Underwriters Laboratories, Inc. (UL):

.1 UL924 – Standard for Safety of Emergency Lighting and Power Equipment

.2 Canadian Standards Association (CSA):

.1 CSA C22.2 No.141 – Unit Equipment for Emergency Lighting.

.2 CSA C22.1 – Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.3 Ontario Electrical Safety Code.

.3 Ontario Building Code.

.4 National Building Code of Canada.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 26 05 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for emergency lighting and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 26 05 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

1.6 EXTRA MATERIALS

.1 Allow the cost for material and for installation of the following to be installed as directed by the Consultant during construction:

.1 An additional five single head emergency remote units.

.2 An additional five dual head emergency remote units.

.3 An additional one battery unit, based on the maximum battery capacity as specified.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Products shall be free of defects in material and workmanship.

.2 Furnished products are listed and/or certified by third party agencies as suitable for the intended purpose.

.3 All units will be certified that they have been tested prior to shipping.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 26 05 00 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect emergency lighting from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 26 05 00.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 and Section 26 05 200.

1.9 WARRANTY

.1 Product is warranted free of defects in material and workmanship.

.2 Product is warranted to perform the intended function within design limits.

.3 For batteries in this Section, 12 month warranty period is extended to 24 months.

2 Products

2.1 EMERGENCY BATTERY UNITS

.1 Manufacturers:

.1 Lumacell RG12S series.

.2 Approved equal by Emergi-Lite.

.3 Approved equal by Stanpro.

.4 Approved equal by Beghelli.

.2 Battery Unit Features:

.1 Self-contained unit equipment for LED emergency lighting shall be manufactured and labeled as certified to meet CSA C22.2 No 141.

.2 Housing: Constructed of formed and welded 18 gauge cold rolled steel with knockouts for conduit, finished in baked white enamel. Cabinet suitable for direct or shelf mounting to wall. Removable or hinged front panel for easy access to batteries.

.3 Charger:

.1 Solid-state micro-controller PCB, Pulse-Guard charger, features include; auto-equalized, temperature compensated, current limited, short circuit and reverse polarity protected.

.2 Recharges battery within 24 hours in accordance with CSA requirements.

.4 Transfer: Upon failure of the power supply, or voltage dip below 75 per cent of nominal, a sealed relay automatically and instantaneously connects the battery to the emergency lighting load and disconnects when battery discharge reaches 87.5 per cent expectancy.

.5 Batteries: seal lead calcium, maintenance free, and 10 year pro-rated service life.

.6 Auto-test: Unit to perform self-test for 1 minute ever 30 days, 10 minutes on the 6th month and 30 minutes ever 12 months.

.3 Battery Electrical Features:

.1 Input Voltage:120-347 VAC universal input:

.1 Provided with plug and receptacle when connected to 120 volt source panelboard.

.2 direct connected to 347 volt source panelboard.

.2 Output Voltage: 12 VDC; balance loads to battery unit terminals.

.1 Normally "Off" output: wattage capacity as indicated for emergency remotes and internally illuminated exit signs.

.2 Battery Run Time at full load: must meet OBC minimum,

.3 Voltage regulation: ± 5 per cent of nominal maximum.

.3 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

.4 Lamp heads:

.1 Integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment.

.2 Lamp type:

.1 Two 12 V, 6 W MR16 LED lamps mounted on top of the battery cabinet, shall be injection molded thermoplastic, white finish.

.2 Average lamp lumens: 170 lm.

.3 Centre Beam Candlepower: 440 cd.

.4 Beam angle: 30 degrees.

.5 Lamp efficacy: 42.5 lm/W.

.5 Auxiliary equipment:

.1 Ammeter.

.2 Voltmeter.

.3 Test switch.

.4 Time delay relay.

.5 Battery disconnect device.

.6 AC input and DC output terminal blocks inside cabinet.

.7 Shelf Bracket.

.8 Cord and single twist-lock plug connection for AC.

.9 RFI suppressors.

2.2 EMERGENCY LIGHTING EMERGENCY REMOTE HEADS

.1 Refer to drawings and lighting schedule.

.2 One or two lamps, shall be injection molded thermoplastic, white finish, lamps shall be MR16 LED 12 V , 540 lumen, 25 degree beam angle, 6 watt.

.3 Remote heads to be mounted not less than 2100 mm (6’-10") AFF.

.4 LED MR16 lamps:

.1 Lumacell MQM-x-12V4W-LD10 series.

.2 Approved equal by Emergi-Lite.

.3 Approved equal by Stanpro.

.4 Approved equal by Beghelli.

3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections are acceptable for emergency lighting installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Owner.

.2 Inform Owner 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 Owner.

3.2 INSTALLATION

.1 Install emergency lighting in compliance with local inspection authorities.

.2 Wiring:

.1 Connect battery input to source panelboard. Balance the emergency lighting loads connected to battery output terminal blocks. Provide and connect remote fixtures and internally illuminated exit signs as specified and as required for system performance in compliance with OBC minimum egress illumination requirements. Install remotes in locations as shown on the drawings. Connect all remotes to normally "Off" output from battery units.

.2 Contractor is responsible for revisions to system, including relocations, aiming and additional remote heads as determined by testing results. All wiring shall be in accordance with manufacturer's recommendations.

.3 Use minimum #10 gauge or heavier if needed to provide a maximum voltage drop of 5 per cent. Consult manufacturer's table for sizing the minimum gage and length of wire runs permitted for connected loads to ensure a maximum voltage drop of 5 per cent from the battery unit to the farthest emergency remote, in accordance with OBC and local inspection authorities.

.3 Mounting: Suitable for wall mounting, complete with bracket from manufacturer lighting heads, test switch and diagnostic LED indicator shall be visible.

3.3 TESTING AND COMMISSIONING

.1 When installation of emergency lighting equipment is complete, contractor shall commission and test the entire system and adjust if necessary.

.2 Contractor is responsible for arranging and cost of a verification test of emergency illumination levels by the manufacturer’s representative.

.1 Verification test shall be performed with a lux/footcandle meter at 1 m intervals along all paths of egress throughout the space, and record light level readings on floor plans provided by the consultant.

.2 The contractor shall also provide consultant with a letter stating the recorded emergency lighting levels meet the OBC requirements of 10 lx (1 fc) average with minimum readings not less than 1 lx (0.1 fc) on the path of egress.

.3 The manufacturer is to provide a letter of verification confirming testing and operation of all emergency lighting as well as installation to all applicable codes.

.3 Testing shall be performed during non-daylight hours. Contractor shall aim all remotes to optimise illumination on the floor and stair.

.4 Contractor shall certify in writing to the consultant that the system is complete, installed per CSA C22.2 No. 141, has been tested, and operates for the specified battery run time.

.5 Contractor shall notify Owner and consultant at least ten days prior to proposed testing date and schedule testing at time and date acceptable to the Owner.

.6 Installation shall be in accordance to the electrical code and manufacturer's instructions.

.7 Provide breaker lock on emergency lighting circuit at source panelboard.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by emergency lighting installation.

3.5 TESTING, MAINTENANCE, AND WARRANTY SERVICE

.1 Provide complete instructions for the operation and care of the emergency power supply or unit equipment that shall specify testing at least once every month to ensure security of operation. Instructions to be framed under glass.

.2 OBC testing obligations: Owner's facility maintenance personnel are required to document one manual test of the battery units each month, and conduct one full discharge test once a year per OBC and CSA C22.2 No.141 requirements.

.3 Annual Maintenance: The manufacturer recommends maintenance to be performed by a qualified service provider. Contact the manufacturer for any warranty service.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Internally illuminated “Running Man” exit sign units for ordinary location use.

1.2 RELATED REQUIREMENTS

.1 Section 26 52 13.13 – Emergency Lighting: Emergency Battery Units.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No.141-10, Unit Equipment for Emergency Lighting.

.2 CAN/CSA-C860-07, Performance of Internally Lighted Exit Signs.

.2 International Organization for Standardization (ISO)

.1 ISO 7010:2011 – Graphical symbols – Safety colours and safety signs.

.2 ISO 3864-1:2011 – Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs and safety markings

.3 Underwriters Laboratories of Canada (ULC)

.1 ULC/ORD-924-02, Standard for Emergency Lighting and Power Equipment.

.2 CAN/ULC-S572-10, First Edition Standard for Photoluminescent and Self-Luminous Exit Signs and Path Marking Systems.

.4 Ontario Electrical Safety Code.

.5 Ontario Building Code.

1.4 SUBMITTALS

.1 Provide submittals in accordance with Section 26 05 00.

.2 Product Data: Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures and maintenance.

1.1 EXTRA MATERIALS

.1 Allow the cost for material and for installation of an additional five exit signs, single face or dual face, to be installed as directed by the Consultant during construction. Include 15.24 m (50 feet) of wire and conduit per exit sign.

1.2 QUALITY ASSURANCE

.1 Exit signs units shall be ULC Listed and/or CSA Certified to CSA C22.2 No 141 and C860.

.2 Furnished products are listed and/or certified by third party agencies as suitable for the intended purpose.

.3 Manufacturer Qualifications: Products shall be free of defects in material and workmanship.

.4 All units will be certified that they have been tested prior to shipping.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 In accordance with Section 26 05 00.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 26 05 00.

1.5 WARRANTY

.1 Product is warranted free of defects in material and workmanship for a minimum of one year from substantial completion.

2 Products

2.1 EXIT SIGNS, GENERAL

.1 Manufacturers

.1 Aimlite.

.2 Beghelli.

.3 Emergi-Lite

.4 Lumacell.

.5 Stanpro.

.6 Other manufacturers as indicated in Section 26 52 13.13.

.2 Substitution Limitations:

.1 No alternate manufacturers will be accepted.

.2 Manufacturer of exit signs to be the same as manufacturer of emergency lighting battery units and remote heads specified in Section 26 52 13.13.

.3 Description

.1 Green and White LED Pictogram “Running Man” exit sign.

.2 The pictogram sign shall be certified as CSA 22.2 No.141-10, and meet ISO 3864-1 and ISO 7010.

.3 The pictogram legend shall have a minimum illuminated dimension of 5.9" high and 11.13" with ISO 3864-1 and 7010 pictogram printed on a pure-acrylic panel.

.4 The sign shall include a standard single face with optional double-faceplate included.

.5 Not acceptable:

.1 Red LED EXIT signs.

.2 Externally illuminated photoluminescent, or non-electrical radioluminescent type of pictogram signs are unacceptable.

.4 Mounting

.1 The canopy shall universal to allow for wall, end, or ceiling mount.

.5 Electrical

.1 The LED light source shall be long-life white Light-Emitting Diodes and shall provide uniform illumination of the pictogram in normal and emergency operation.

.2 The sign shall operate with universal 2-wire AC input voltage of 120 to 347 Vac at less than 3 Watts, and universal 2-wire DC input voltage from 6 to 24 Vdc at less than 2.5 Watts for single and double face legends with a single arrow either left or right.

.3 If arrow left and arrow right is required for T intersection, the contractor shall supply and install two separate pictogram signs.

.4 The pictogram edge-lit exit sign in a self-powered configuration shall use a sealed Nickel-Cadmium battery of 2.4V nominal voltage and shall stay illuminated during emergency operation for at least two hours upon AC failure.

2.2 DIE-CAST EDGE-LIT PICTOGRAM EXIT SIGNS FOR SURFACE OR RECESSED MOUNTING APPLICATIONS

.1 Manufacturers

.1 Lumacell LDE series.

.2 Equivalent products from manufacturers as described in Article 2.01 of this specification.

.2 Materials

.1 Surface mount:

.1 When specified for surface mount, the unit shall come standard with a trim plate, trim ring, back box and canopy made of die-cast aluminum. Colour as indicated in Emergency Lighting and Exit Sign Schedule on drawings.

.2 The trim plate shall have a flat (fully recessed) profile and allow for wall or ceiling mount installation.

.2 Recessed ceiling mount:

.1 When specified for recessed ceiling-mount, the unit shall come standard with a flat trim plate of die-cast aluminum, a back box of galvanized steel, and a hardware kit for back box installation between ceiling joists. The back box shall be provided with conduit knock-outs at the top, back and end.

.3 The legend shall be printed on a pure-acrylic panel.

.4 The panel shall come standard with double-face legend, for single-face and double-face applications.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 Install exit lights to manufacturer's recommendations, listing requirements, CSA standard and local regulatory requirements.

.2 Connect fixtures to exit light circuits normal power supply and emergency battery units specified in Section 26 52 13.13.

.3 Ensure that emergency lighting circuit breaker is locked in ON position.

.4 If arrow left and arrow right is required for T intersection, the contractor shall supply and install two separate pictogram signs.

3.3 CLEANING

.1 Proceed in accordance with Section 26 05 00.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.4 TESTING AND COMMISSIONING

.1 When installation of emergency lighting equipment is complete, contractor shall commission and test the entire system and adjust if necessary.

.2 Contractor shall certify in writing to the consultant that the system is complete, installed per CSA C22.2 No. 141, has been tested, and operates for the specified battery run time.

.3 Contractor shall notify owner and consultant at least ten days prior to proposed testing date and schedule testing at time and date acceptable to the owner.

.4 Installation shall be in accordance to the electrical code and manufacturer's instructions.

.5 Provide breaker lock on emergency lighting circuit at source panelboard.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by exit sign installation.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Materials and installation for steel lighting poles.

.2 Cast-in-place architectural concrete bases.

1.2 RELATED REQUIREMENTS

.1 Section 26 50 00 – Lighting.

.2 Section 26 56 19 – LED Exterior Lighting.

1.3 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.2 No. 206-17, Lighting Poles.

1.4 SUBMITTALS

.1 Submit product data in accordance with Section 26 50 00.

2 Products

2.1 CAST-IN-PLACE ARCHITECTURAL CONCRETE BASES

.1 Use single-use Concrete Forms.

.2 Provide cast-in-place architectural concrete bases for lighting poles, bollards, floodlights, flagpoles, signs, columns fence posts, other applications.

.3 Provide bases in styles, sizes, depths and profiles indicated.

.4 Reinforce bases with vertical steel reinforcing rods and horizontal steel reinforcing ties as noted on the drawings.

.5 Cast and cure bases.

.6 Coordinate with installation of conduit at bases for lighting poles, bollards, floodlights and signs.

.7 Install self-locking, vandal-resistant, wraparound aluminum color accent band around finished bases, where indicated.

.8 Example Manufacturers:

.1 ArtFORMS International Inc. Tel: 905 642-3225, Fax: 905-642-3227,
Email: ArtFORMS@ArtFORMSConcreteBases.com.

2.2 GALVANIZED STEEL POLES

.1 Galvanized steel or steel poles as indicated on drawings: to CSA C22.2 No. 206 designed for underground wiring and:

.1 Suitable for mounting on concrete anchor base.

.2 Monotube style, minimum 3.0 mm thick, tapered round, or square as indicated.

.3 Access handhole 300 mm (12 inches) above pole base for wiring connections, with welded-on reinforcing frame and bolted-on cover.

.4 Galvanized anchor bolts complete with galvanized double nuts and galvanized washers, and plastic bolt covers.

.5 Two lugs: one for grounding and one for bonding.

.6 Square two-piece aluminium base covers.

.7 Manufacturer’s standard flat pole cap.

.8 Effective Projected Area (EPA) rating to meet or exceed the requirement of luminaires, mounting brackets, etc.

.9 Finishes:

.1 Polyester powder coat finish.

.2 Inner-coating of water-based automotive-grade corrosion preventative.

.10 Manufacturer's nameplate indicating manufacturer's name, model number of pole, and date of manufacture with a permanent, stamped/printed or engraved label.

.2 Example Manufacturers:

.1 Aluminous Lighting Products.

.2 Dynapole.

.3 LSI Industries.

.4 Lumec.

.5 Polefab.

.6 Spina.

.7 Valmont West Coast Engineering.

2.3 LUMINAIRE MOUNTING BRACKETS

.1 Mounting brackets for specified luminaires:

.1 Single, twin, and quad brackets as indicated.

.2 Provide fixture with mounting pattern to suit existing poles, or allow modification of same.

2.4 LUMINAIRES

.1 In accordance with Section 26 56 19.

3 Execution

3.1 BASE INSTALLATION

.1 Install specified below-grade fiber form, reinforcing steel, ducts, etc. to required grade.

.2 Place form on top of empty fiber form. Position vertical seams in desired direction.

.3 Pour specified concrete through open top of form into fiber form below. Avoid contact with inside surface. Bring concrete to top of formwork.

.4 Mechanically vibrate concrete with small vibrator, and vigorously hand tap outside surface of formwork.

.5 Place and center anchor bolt assembly (or post, etc.) into concrete. Trowel-finish top surface of concrete.

.6 Base Stripping:

.1 Strip concrete form within 24 hours of pouring of base.

.2 Cut steel bands. Strip form in two halves. Pry open at the two vertical seams with flat-bladed hand-tool e.g. ice-scraper or square-nose shovel. Insert blade and separate form at top, middle, and bottom of first seam. Repeat for second seam.

.3 Wire brush any traces of form material remaining on finished concrete base.

.4 Use rubbing stone to make smooth any rough concrete edges around top of base and along vertical seams.

.5 If there is risk of damage by construction equipment to exposed base, protect base by tie-wiring or duct taping the two formwork halves back in place around base until safe to remove protection.

.6 Install color accent band(s), where applicable, in horizontal reveal(s) around finished base.

3.2 POLE INSTALLATION

.1 Install poles true and plumb, complete with brackets in accordance with manufacturer's instructions.

.2 Provide label on each pole to allow for individual identification of each pole, minimum 125 mm (5 inch) text height of contrasting colour to that of pole finish, installed at approximately 3048 mm (10 feet) above finished grade.

.3 Install luminaires on pole and install lamps.

.4 Check luminaire orientation, level, and tilt.

.5 Connect luminaire to lighting circuit.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Pole mounted, wall mounted, and canopy mounted solid state, light emitting diode (LED) source exterior luminaires.

1.2 RELATED REQUIREMENTS

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 50 00 – Lighting.

.3 Section 26 56 13 – Lighting Poles and Standards.

1.3 REFERENCES

.1 Canadian Standards Association (CSA):

.1 CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code.

.3 CSA C22.2 No. 9.0 – General Requirements for Luminaires.

.4 CSA C22.2 No. 250.0 – Luminaires (Bi-National Standard, with UL 1598).

.5 CAN/CSA-C22.2 No. 250.13 – Light Emitting Diode (LED) equipment for lighting applications.

.2 DesignLights Consortium (DLC):

.1 Technical Requirements table v4.4, or latest edition.

.2 Where the specifications do not explicitly call for DLC qualified LED luminaires, the technical criteria provided in the DLC Technical Requirements provide the basis of the requirements for this section of the Specification.

.3 Illuminating Engineering Society (IES)

.1 IES HB-10-11 – The Lighting Handbook, 10th Edition.

.2 IES LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.

.3 IES LM-80-08 – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.

.4 IES TM-21-11- IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.

.4 National Electrical Manufacturer's Association (NEMA)

.1 SSL-1-10 – Electronic Drivers for LED Devices, Arrays, or Systems.

.2 WD 6 - Wiring Devices - Dimensional Requirements.

.5 Underwriters Laboratories Inc. (UL):

.1 ANSI/UL 1449, (3rd Edition), Standard for Safety, Surge Protective Devices.

1.4 ACTION SUBMITTALS

.1 Submit product data in accordance with Section 26 05 00.

.2 Manufacturer Reports: Provide a point-by-point photometric analysis of the site, in accordance with the procedures laid out in IES RP-20-14, for review by the Consultant. Include point-by-point calculation zones along the property line.

.3 Product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but not limited to):

.1 Cut sheets:

.1 Luminaire cut sheets.

.2 Cut sheets for LED driver(s).

.3 Cut sheets for surge protective device, if applicable.

.2 Highlight lumen package, IES distribution type (if applicable), and input watts of the luminaire.

.3 Instructions for installation and maintenance.

.4 Performance data:

.1 Maximum power, in Watts.

.2 L70 lumen maintenance data, in hours, when extrapolated for the worse case operating temperature. Submit IES TM-21 report to demonstrate this.

.5 Performance data that is derived in accordance with appropriate IES testing standards and tested in a laboratory that is NVLAP accredited for Energy Efficient Lighting Products. Include:

.1 Name of test laboratory.

.2 Report number.

.3 Data.

.4 Complete luminaire catalogue number.

.5 Provide explanation if catalogue number in test report does not match catalogue number of luminaire submitted. Clarify whether discrepancy does not affect performance, e.g. in the case of differing luminaire housing colour.

1.5 QUALITY ASSURANCE

.1 Luminaire tested to IESNA LM 79-08.

.2 Design Qualification Testing performed by a National Voluntary Laboratory Accreditation Program (NVLAP) testing facility. Such testing may be performed by the manufacturer, or an independent testing lab hired by the manufacturer on new luminaire designs, and when a major design change has been implemented on an existing design. A major design change is defined as a design change (electrical or physical) which changes any of the performance characteristics of the luminaire, results in a different circuit configuration for the power supply, or changes the layout of the individual LED's in the module.

.3 Products certified by a recognized testing agency accredited by the Standards Council of Canada, and bearing a certification mark from that agency. Certification shall include wet location rating.

1.6 WARRANTY

.1 Manufacturer Warranty against loss of performance and defects in materials and workmanship for the luminaires for a period of 5 years after acceptance of the luminaires. Warranty to cover all components comprising the luminaire.

.2 All warranty documentation shall be provided to customer prior to the first shipment.

.3 Manufacturer to confirm that the addition of third party bird spikes will not compromise luminaire warranty.

2 Products

2.1 MANUFACTURERS

.1 Basis of Design Supplier / Manufacturer:

.1 Peerless Electric (Omnilumen).

.2 Accepted alternate manufacturers and suppliers:

.1 Acuity Brands Lighting.

.2 Cooper Lighting Solutions.

.3 Salex.

.4 Signify.

2.2 OUTDOOR LED LUMINAIRES, GENERAL

.1 Maximum nominal luminaire input wattage as specified for each luminaire type as indicated on the Lighting Fixture Schedule. Nominal input wattage accounting for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.

.2 Luminaires designed for ease of component replacement and end-of-life disassembly.

.3 Input Voltage:

.1 As indicated on Lighting Fixture Schedule.

.2 Driver to be compatible with system voltage without use of a step-down transformer. If the manufacturer's standard product offering cannot achieve this, clearly indicate on the shop drawings and clearly indicate location of transformer.

.4 Surge Protection

.1 UL 1449 recognized surge protective device that is wired in front of the driver(s) and protects the luminaire to a minimum Category C Low (per ANSI/IEEE C62.41.2).

.5 Power Factor and Total Harmonic Distortion

.1 Power factor of greater than or equal to 0.9.

.2 THD of less than or equal to 20 per cent.

.6 Gasket: neoprene seal between refractor and housing.

.7 Light Distributions:

.1 Fixtures available with IES distribution types I, II, III, IV, V, and other distributions, as noted, and distribution shall be adjustable or replaceable in the field.

.2 Pole mounted luminaire shall have an available option for low-profile house-side shield.

.8 Self-locking latches of stainless steel and aluminum.

.9 Factory wired including integral driver, terminated at terminal block.

.10 Luminaires with cast aluminum weatherproof housing.

.11 Ingress protection: sealed against moisture and environmental contaminants to IP65 rating or better for both light engines/optics and overall luminaire.

.12 Finishes

.1 Housing and heat sink finished in polyester powder coat paint, minimum 2.5 mil nominal thickness.

.2 Standard finish colours to include black, bronze, grey, white, dark platinum and graphite metallic.

.3 RAL and custom color matches to be available as indicated on the lighting fixture schedule.

2.3 OUTDOOR POLE/ARM MOUNTED AREA AND ROADWAY LED LUMINAIRES

.1 Pole mounted luminaires suitable for the EPA rating of the pole.

.2 Pole finish colour to match that of luminaire.

.3 Lamp type: Light Emitting Diode (LED) source.

.1 Minimum Light Output: 1 000 lm.

.2 Zonal Lumen Density:

.1 100 per cent between 0 degrees and 90 degrees from nadir.

.2 Less than or equal to 10 per cent between 80 degrees and 90 degrees from nadir.

.3 Minimum luminaire efficacy: 70 lumens per watt.

.4 Correlated Colour Temperature (CCT): 4000 K

.5 Colour Rendition Index (CRI): 70 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation. LM-80 testing is to utilize 10 000 hour testing data.

2.4 OUTDOOR WALL MOUNTED AREA LED LUMINAIRES

.1 Lamp type: Light Emitting Diode (LED) source.

.1 Minimum Light Output: 300 lm.

.2 Zonal Lumen Density:

.1 100 per cent between 0 degrees and 90 degrees from nadir.

.2 Less than or equal to 10 per cent between 80 degrees and 90 degrees from nadir.

.3 Minimum luminaire efficacy: 70 lumens per watt.

.4 Correlated Colour Temperature (CCT): 4000 K

.5 Colour Rendition Index (CRI): 70 CRI minimum.

.1 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation. LM-80 testing is to utilize 10 000 hour testing data.

2.5 FIXTURE MOUNTED CONTROLS PROVISION

.1 Provide NEMA 7-pin receptacle on all pole mounted luminaires, complete with shorting cap.

.1 Shorting Cap, Locking-Type Mounting:3-prong locking-type plug connector. It is used with luminaries with a photocontrol receptacle to complete circuit when a photocontrol is not required.

.2 Basis of design: Intermatic K4500 series.

3 Execution

3.1 INSTALLATION

.1 Install luminaires on poles in accordance with Section 26 56 13.

.2 Check luminaire orientation, level, and tilt.

.3 For wall mounted luminaires:

.1 General Contractor to provide a smooth grinding of brick to ensure a flush contact between luminaires and wall.

.2 Provide a silicone seal around the luminaire.

.4 Connect luminaire to lighting circuit.

.5 Provide field installed bird spikes on all luminaires.

.1 Fasten to luminaire with adhesive, or ties to maintain manufacturer’s warranty on luminaire.

.2 Fastening by screws or nails: not permitted.

.6 Perform tests in accordance with Section 26 50 00.

3.2 SITE TESTS AND INSPECTIONS

.1 Perform lighting system commissioning in accordance with Section 26 08 50.

.2 Perform light meter testing at night and report values to the Consultant.

End of Section

The Corporation of the City of Brampton

IT Performance Specification Division 27, Communications New Build

Version 1.6
March 18, 2021

Revised by:
Marc Flores
Network Administrator – Cable Plant

This document is a living document and will be updated as needed.
It is the Consultant / Contractors responsibility to inquire with CoB IT Department that the latest version of this document is being used.

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REVISION HISTORY

Version #	Date	Revised by	Description of Revisions
1.1	18-Jan-06	MCW Consultants	Initial Creation
1.2	26-Feb-10	David Barnwell	Addition of test-results/as-built documentation requirements, cabinet layout, triple became double drop standard. UPS requirements added
1.3	23-Feb-15	David Barnwell	Removed Cat5e and lower performance fibre
1.4	15-Jun-17	Marc Flores	Updated Labeling, added Appendixes, removed part numbers from spec materials and referred to appendixes (Refer to Appendix for part number changes). Document combined into 1 Living document. Added Fire stopping section.
1.5	31-Jan-19	Marc Flores	Updated patch cable colouring standards Removed Gigaspeed patch panel and replaced with only M2000 patch panels Revised appendix drawings
1.6	18-March-21	Marc Flores	Added CAT6a cabling for Wifi Access Points Revised part numbers in Wireless section 271544 appendix.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply, installation, inspection and testing of grounding and bonding systems and items contained within as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes grounding and bonding requirements of communication systems.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of grounding and bonding systems and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI – Customer-Owner Outside Plant Design Manual
- CISCA – Ceiling and Interior Systems Construction Association

2.2 All bonding and grounding elements shall be constructed from copper.

2.3 Provide a solid copper tin plated busbar with holes for use with standard-sized two hole lugs, have minimum dimensions of 6.3 mm x 100 mm x 610 mm (0.25 in x 4 in x 12 in) within the main communication room mounted to the backboard.

2.4 Provide a solid copper tin plated busbar with holes for use with standard-sized two hole lugs, have minimum dimensions of 6.3 mm x 100 mm x 305 mm (0.25 in x 4 in x 6 in) within each communication room mounted to the backboard.

2.5 Provide a continuous unbroken Telecommunication Bonding Backbone (TBB) wire between the main communication room grounding busbar and the grounding busbar of the communication room on the top floor of a multi-story building. TBB shall be sized based on the following:

TBB Length Linear m (ft)	TBB Size AWG
Less than 4 (13)	6
4 to 6 (13 to 20)	4
6 to 8 (20 to 26)	3
8 to 10 (26 to 33)	2
10 to 13 (33 to 44)	1
13 to 16 (44 to 52)	1/0
16 to 20 (52 to 66)	2/0
Greater than 20 (66)	3/0

2.6 Each communication room in a multi-story building shall be bonded to the TBB with a wire sized to match that of the TBB. The bonding wire shall be coupled to the TBB with an exothermic weld.

2.7 All cabinets, cable trays, conduits and intrabuilding armoured cable shall be bonded to the busbar in the room to which they are located with a minimum #6 AWG wire.

2.8 All metal parts of the access floor shall be bonded to ground in accordance with CEC Rule 10-406. A minimum of every fourth pedestal shall be bonded to ground with a minimum #6 AWG wire.

2.9 Bond wire basket cable trays to ground in the following way:

.1 Ground at the end of a continuous run

.2 Ground continuous runs every 18.3 m (60 ft).

.3 All on-site fabricated sections (any sections that have been cut in any way) shall be bonded to ground at both ends. This includes but is not limited to Bends, Crosses, Tees, “Y” fittings and vertical fittings.

.4 Each section of tray that is spliced to another section of tray shall be spliced with a minimum of four (4) splices. Either Flexmate or Splice Washers shall be used for splicing.

3 MATERIALS

NIL

4 FIELD QUALITY CONTROL

NIL

INTERIOR PATHWAYS FOR COMMUNICATION SYSTEMS

1 **SCOPE OF WORK**

1.2 Include detailed design, manufacturer, supply, installation and inspection of communication pathway systems as described in these performance specifications and summarized in the following elements of the work:

.2 The scope of work included within the section includes conduits, cable trays and slings supports.

2 **DESIGN AND PERFORMANCE REQUIREMENTS**

2.1 Design, manufacturer, supply and installation of pathway systems shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure
- BICSI – Telecommunication Distribution Methods Manual

2.2 Outlet boxes shall be 100 mm (4 in) x 100 mm (4 in) x 57 mm (2.25 in) with a single gang adapter plate. Outlet boxes designated for an open office area shall be mounted at 775 mm (30.5 in) AFF. Outlet boxes designated as voice for a wall mounted public phone shall be mounted at 1120 mm (44 in) AFF. Mounting heights measured from the bottom of the outlet box.

2.3 A minimum of one 27 mm (1 in) conduit shall run from the outlet box to the ceiling space. A conduit run shall serve no more than one outlet box.

2.4 Sling supports shall support the cable every 1.2 m (4 ft) from the conduit to the nearest cable tray.

2.5 Cable tray sized not to exceed 40% fill shall be the main pathway system. Run cable tray in a continuous run through every main corridor and walk way and up to the exterior wall of the communication rooms.

2.6 Cable shall pass through into the communication rooms from the cable tray with the use of an appropriately rated re-enterable firestop sized to not exceed 40% fill.

2.7 Cable tray sized not to exceed 40% fill shall be the main pathway system within the communications rooms and data centres. Run cable tray in such a way as to continuously support horizontal cable and backbone cable between cable entrance points, backboards and cabinets.

2.8 Cable tray shall be modified on-site by the contractor as per manufacturer's specifications to suit the design and on-site conditions.

2.9 All cable tray inner corners shall consist of a 45-degree angle not a 90 degree angle. In corridors, a sweep bend shall be used consisting of a 300 mm (11.8 in) radius for 150 mm (6 in) wide cable tray, 400 mm (15.85 in) radius for 300 mm (12 in) wide cable tray and 500 mm (19.7 in) radius for 450 mm (18 in) wide cable tray.

2.10 Cable trays shall be installed a minimum of 75 mm (3 in) above T-bar ceilings and have a minimum of 150 mm (6 in) of clear space above the cable tray.

2.11 Cable trays shall be supported at both ends of each section of 3m (10 ft.), 600 mm (12 in) from the ends.

2.12 All pathways shall avoid potential sources of electromagnetic interference by maintaining clearances of at least:

a. 305 mm (1 ft.) from fluorescent ballasts.

b. 305 mm (1 ft.) from electrical power distribution conduit and cable, less than 1kV.

c. 1000 mm (3.3 ft.) from electrical power distribution conduit and cable, more than 1kV.

d. 1220 mm (4 ft.) from motors and transformers.

e. 305 mm (1 ft.) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and power distribution and conduits.

f. 305 mm (1 ft.) from HVAC equipment, ducts and pipes

2.13 Conduit capacity shall never exceed 40% fill as per TIA/EIA-569-B standards. Conduit capacity shall be as follows:

Conduit Size mm (in)	**Cable Diameter mm (in)**	
	<=6.1 (0.24)	**7.4 (0.29)**
21 (0.75)	3	2
27 (1)	6	3
35 (1.25)	10	6
41 (1.5)	15	7
53 (2)	20	14
63 (2.5)	30	17
78 (3)	40	20

2.14 If the capacity of the conduit is exceeded, then the next trade size shall be used.

2.15 If conduit has an internal diameter of 53 mm (2 in) or less, then the bend radius shall be at least six times the internal diameter. If conduit has an internal diameter of more than 53 mm (2 in) then the bend radius shall be at least ten times the internal diameter.

2.16 The maximum number of bends between cable pull boxes in a conduit run shall be two 90^{o} bends.

2.17 Conduit runs shall have no continuous sections longer than 30 m (100 ft.).

2.18 If a conduit run requires a reverse bend between 100 º and 180 º then a pull box shall be inserted at the bend.

2.19 Pull boxes shall be adequately sized for the radius of the connecting conduits and the manufacturer's specified cable bend radius, as follows:

Conduit Size mm (in)	Pull Box Width mm (in)	Pull Box Length mm (in)	Pull Box Depth mm (in)	Width Increase for Additional Conduit mm (in)
27 (1)	102 (4)	406 (16)	76 (3)	51 (2)
35 (1.25)	152 (6)	50 (20)	76 (30)	76 (3)
41 (1.5)	203 (8)	686 (27)	102 (4)	102 (4)
53 (2)	203 (8)	914 (36)	102 (4)	127 (5)
78 (3)	305 (12)	1219 (48)	127 (5)	152 (6)

2.20 Pull boxes shall be installed in fully accessible ceiling spaces.

2.21 Support and secure all boxes independent of the conduit connected thereto.

2.22 All conduit ends shall be protected by insulating bushings.

2.23 Use only manufacturer approved cable lubricants. Any excess lubricant shall be cleaned to leave conduit exteriors suitable for painting.

2.24 All conduits shall be left with a nylon pull string installed.

3 MATERIALS

3.1 Obtain cable tray components through one source from a single manufacturer.

3.2 Cable tray shall have the following characteristics:

.1 Continuous, rigid, welded steel wire mesh.

.2 Continuous T-weld on top rail of tray.

.3 All cable tray shall be purchased in 3 m (10 ft.) straight sections.

.4 Finish: electroplated zinc coating

3.3 Obtain sling support components through one source from a single manufacturer.

3.4 Sling supports shall have the following characteristics:

.1 Comply with UL and EIA/TIA requirements for structured cabling systems.

.2 Comply with NFPA 90A for plenum spaces.

.3 Rated load weight shall be 100 lbs.

4 FIELD QUALITY CONTROL

4.1 NIL

EXTERIOR PATHWAYS FOR COMMUNICATION SYSTEMS

1 **SCOPE OF WORK**

1.3 Include detailed design, manufacturer, supply, installation and inspection of communication pathway systems as described in these performance specifications and summarized in the following elements of the work:

.3 The scope of work included within the section includes underground ducts and maintenance holes.

2 **DESIGN AND PERFORMANCE REQUIREMENTS**

2.1 Design, manufacturer, supply and installation of pathway systems shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- TIA/EIA
    - Provide a minimum of three 103mm (4”) conduits from the property line (location to be recommended by the utility) to the entrance facility designated for Access Provider use. Do not include more than two 90-degree bends in the conduit run between pull points. Never exceed a 90-degree bend. Conduits entering the room shall extend above the floor by 103 mm (4 in) AFF or extend down below the ceiling to 2.4 m (8 ft.) AFF. All conduits entering the building shall be sealed with a rubber plug or water plug.
-
- -606-A Administration Standard for Commercial Telecommunications Infrastructure
- BICSI – Telecommunication Distribution Methods Manual
- BICSI - Customer Owner Outside Plant Design Manual

2.2 A minimum of four (4) 103 mm (4 in) underground ducts shall connect two campus buildings. All campus buildings shall be connected to the building containing the main campus equipment room or data centre in a star configuration.

2.3 Only data, voice, CATV, security and fire alarm communication cables shall occupy these underground ducts. All other services such as power shall be run in a separate duct system.

2.4 Data, voice, CATV and security/fire alarm shall each be run in a separate conduit within the same duct system.

2.5 A maintenance hole shall be located within a duct run whenever one of the following apply:

- When calculation results for conduit pulling, tension exceeds the cable manufacturers recommended limits (typical cable cannot exceed a total installation load of 2700 Newton, 600 lbs.).
- When a cables maximum available reel length is exceeded and a splice to a second length of cable is required.
- Whenever a splice is required to split a large cable into two or more cables (for example a 24-strand fibre cable spliced to two 12-strand fibre cables).

2.7 The following equation shall be used to calculated pulling tensions for straight inclined or horizontal conduit: $T = T_0 + w (fx +/- h)$

- T = the pulling tension.
- T_0 = the tail load at the reel, typically a load of 890 Newton (200 lbf).
- f = coefficient of friction between the cable and conduit, typically 0.36 for PVC conduit and low density polyethylene.
- w = weight per unit length of cable (N/m or lb/ft). For metric units, the cable weight (Kg) must be converted to the force of its weight by multiplying it by 9.8 N/Kg.
- x = horizontal projection of segment.
- h = vertical projection of segment (h is positive for an increase in elevation, negative for a decrease in elevation and 0 for no change in elevation).

2.8 The following equation shall be used to calculated pulling tensions for uniformly curved segment of conduit: $T = (wr) PTR$

- T = the pulling tension.
- T_0 = the tail load from the previous section.
- f = coefficient of friction between the cable and conduit, typically 0.36 for PVC conduit and low density polyethylene.
- w = weight per unit length of cable (N/m or lb/ft.). For metric units, the cable weight (Kg) must be converted to the force of its weight by multiplying it by 9.8 N/Kg.
- r = radius of curvature of the bend (m or ft.).
- a = displacement angle of bend (degrees).
- PTR = pulling tension ratio as calculated from the chart below:

T_0/(wr)	f a													
	5	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**
0.2	0.29	0.38	0.48	0.58	0.68	0.79	0.90	1.02	1.15	1.29	1.44	1.59	1.76	1.95
0.4	0.50	0.60	0.70	0.81	0.92	1.05	1.18	1.32	1.47	1.63	1.80	1.99	2.19	2.41
0.7	0.81	0.92	1.05	1.18	1.32	1.47	1.63	1.80	1.99	2.19	2.41	2.65	2.90	3.18
1.1	1.23	1.38	1.53	1.70	1.88	2.07	2.28	2.50	2.75	3.01	3.30	3.62	3.96	4.33
1.8	1.99	2.19	2.41	2.64	2.90	3.18	3.48	3.81	4.17	4.56	4.99	5.45	5.96	6.51
2.8	3.07	3.36	3.68	4.03	4.41	4.82	5.27	5.76	6.29	6.87	7.50	8.19	8.95	9.77
4.5	4.92	5.38	5.88	6.42	7.01	7.66	8.36	9.13	10.0	10.9	11.9	13.0	14.1	15.4
6.5	7.10	7.75	8.47	9.24	10.1	11.0	12.0	13.1	14.3	15.6	17.1	18.6	20.3	22.2
9.3	10.2	11.1	12.1	13.2	14.4	15.7	17.2	18.7	20.4	22.3	24.3	26.6	29.0	31.6
12.0	13.1	14.3	15.6	17.0	18.6	20.3	22.1	24.2	26.4	28.8	31.4	34.2	37.4	40.8
16.0	17.5	19.1	20.8	22.7	24.8	27.0	29.5	32.2	35.1	38.3	41.8	45.6	49.8	54.3
20.0	21.8	23.8	26.0	28.4	31.0	33.8	36.9	40.2	43.9	47.9	52.3	57.0	62.2	67.9
24.5	26.7	29.2	31.8	34.7	37.9	41.4	45.1	49.3	53.7	58.7	64.0	69.8	76.2	83.2
30.0	32.7	35.7	39.0	42.5	46.4	50.6	55.3	60.3	65.8	71.8	78.4	85.5	93.3	102
37.0	40.4	44.1	48.1	52.5	57.2	62.5	68.2	74.4	81.2	88.6	96.6	105	115	126
45.0	49.1	53.6	58.5	63.8	69.6	76.0	82.9	90.5	98.7	108	118	128	140	153
54.0	58.9	64.3	70.2	76.6	83.5	91.2	99.5	109	118	129	141	154	168	183
65.0	70.9	77.4	84.5	92.2	101	110	120	131	143	156	170	185	202	221
77.0	84.0	91.7	100	109	119	130	142	155	169	184	201	219	239	261
89.0	97.1	106	116	126	138	150	164	179	195	213	232	254	277	302
100	109	119	130	142	155	169	184	201	219	239	261	285	311	339

2.9 Pulling tensions shall be calculated from both ends as if the cable were pulled from either end and the worst case shall be used as the reference. However installers should pull from the end with the lower tension.

2.10 Maintenance holes shall have the following characteristics:

- Precast
- Minimum interior dimensions of 3.6m (12ft) long x 1.8m (6ft) wide x 2.1m (7ft) high
- Equipped with a built-in sump
- Minimum entrance opening of 762 mm (30”) interior diameter
- Equipped with a corrosion-resistant pulling iron at either end
- Grounding system
- Cable racks on both side
- Fixed or movable ladder
- Capable of supporting the heaviest anticipated weight, based on the following table:

Rating	**Heaviest anticipated weight**
Light duty	Pedestrian traffic only
H-5 (5,000 Kg)	Sidewalk applications and occasional non-deliberate traffic
H-10 (10,000 Kg)	Driveways, parking lots, and off-road applications subject to non-deliberate heavy traffic
H-20 (20,000 Kg)	Deliberate heavy traffic

2.11 Maintenance holes shall be located based on the following:

- Out of the roadway (when possible)
- Away from locations where water is likely to pool
- Allow for adequate traffic control when the MH is open
- Not jeopardize vehicular or pedestrian traffic flow.
- Not in or near an intersection or near a point where a curve occurs in a road.

2.12 Duct systems shall have the following clearances:

- Below the frost line
- 150 mm (6 in) when crossing pipes
- 300 mm (12 in) when parallel to pipes
- 75 mm (3 in) from power run in concrete
- 300 mm (12 in) from power direct buried

2.13 All duct runs and maintenance holes shall be clearly shown on as built drawings indicating number and size of ducts and the cable size in fibre strands and copper pairs contained within.

3 MATERIALS

3.1 NIL

4 FIELD QUALITY CONTROL

4.1 NIL

IDENTIFICATION FOR COMMUNICATION SYSTEMS

1 **SCOPE OF WORK**

1.2 Include detailed identification and administration of communication system as described in these performance specifications and summarized in the following elements of the work:

.3 The scope of work included within the section includes identification and administration of an end-to-end structured cabling system and its pathways and spaces.

2 **DESIGN AND PERFORMANCE REQUIREMENTS**

2.1 Inspection, testing and administration of identification and administration shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI - Customer Owner Outside Plant Design Manual

2.2 Labelling shall be in accordance with the following:

.1 All labelling shall be mechanically printed and follow the TIA/EIA-606-A guidelines and be in accordance with the requirements of this specification. Hand written labels are not permitted.

.2 Cable labels shall be Vinyl construction with a white printing area and a clear tail that self-laminate the printed area when wrapped around the cable. The clear area should be of sufficient length to wrap around the cable at least 1.5 times.

.3 Vinyl identification labels shall appear on the following locations with the designations indicated on the cable schedule and drawings:

- Port identification on both ends of every cable
- Port identification on the front of all faceplates
- Port identification on the front of all patch panels
- Panel identification on the front top right hand corner of all patch panels
- Pair identification on the front of termination fields
- Wireless identification on the front of all wireless access points

.4 Lamicoid identification labels shall appear on the following locations with the designations indicated on the cable schedule and drawings:

- Cabinet identification on the top right hand side of the cabinet

.5 All firestops shall be labelled stating "WARNING FIRESTOP SEAL DO NOT DISTURB" and also the contractors name, address and phone number, date installed, fire rating.

.6 Horizontal cabling systems (faceplate ports, cable, patch panel ports) shall use the following labelling scheme: (DO NOT USE **X** IN THE LABELING USE LAN ROOM LETTER)

- 1st Data = **X**-001A where '**X' = 'LAN ROOM LETTER**, '001' = 'port number' and 'A' = 1st data port
- 2nd Data = **X**-001B where **'X' = 'LAN ROOM LETTER**, '001' = 'port number' and 'B' = 2nd data port

.7 Backbone cabling shall use the following labelling scheme (DO NOT USE **X** IN THE LABELING USE LAN ROOM LETTER):

- TC**X**-**2**-001-200 where 'TC**X**' = 'Telecommunication **X**', '2' = '2 floor communication room and '001-200' = 'port 1-200'

8 Cabinets shall use the following labelling scheme:

- TC**X**-**1A** where 'TCA' = 'Telecommunication LAN Letter', ''Cabinet Number

.9 Wireless access points shall use the following labelling scheme: *(See Appendix for Cable and Jack Colours)*

- **X-**W-01 where WL = 'WIRELESS', 01 = 'wireless port number' increasing by 1 for each extra wireless access point. W-02, W-03 etc**. (Where X is the LAN room Letter this drop terminates to)**

.10 Elevator drops shall use the following labelling scheme: *(See Appendix for Cable and Jack Colours) X = Lan room Letter*

- **X**-EL-01 where EL = 'Elevator', 01 = 'port number' **. (Where X is the LAN room Letter this drop terminates to)**

.11 Fire control panels shall use the following labelling scheme: *(See Appendix for Cable and Jack Colours) X = Lan room Letter*

- **X**-FR-01 where FR = 'Fire', 01 = 'port number'**(Where X is the LAN room Letter this drop terminates to)**

.12 Bonding and grounding systems shall use the following labelling scheme:

- TMGB where 'TMGB' = 'Telecommunication Main Grounding Busbar'
- TGB-4B where 'TGB' = 'Telecommunication Grounding Busbar' and '4B' = '4th floor communication room B' and
- ESBC where 'ESBC' = 'Electrical Service Bonding Conductor'
- TBB-4B where 'TBB' = Telecommunication Bonding Backbone' and '4B' = '4th floor communication room B' and
- EBC-TCA where 'EBC' = 'Equipment Bonding Conductor', 'TCA' = 'Telecommunication Cabinet A'
- CBC-TCA-4B-001-200 where 'CBC' = 'Cable Bonding Conductor', 'TCA' = 'Telecommunication Cabinet A', '4B' = '4th floor communication room B' and '001-200' = 'port 1-200'

2.3 As-built drawings shall include, but are not limited to, the following:

- Work area port designations
- Main routing of pathways
- Cabinet elevations
- Backboard elevations
- Communication room layouts
- Riser routing and cable counts

2.4 A full-size copy of the as-built drawings shall be placed in every communication room.

3 **MATERIALS**
NIL

4 **FIELD QUALITY CONTROL**
NIL

FIRESTOPPING

NOTE TO SPECIFIER: in the design using EZ-Path - do not take tray through wall: Coordinate drawings to show tray terminating at wall or floor and resuming on other side.

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes Labor, materials and equipment necessary to complete the installation required for the items specified under this Section, including but not limited to:

1. Firestopping of Through Penetrations in Fire Rated Assemblies.

1.2 RELATED SECTIONS

A. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

B. This Specification should be considered as an augmentation to Section 07 84 00 Firestopping and any or all sub sections of Section 07 84 00.

C. This Section addresses those unique elements that affect the Firestopping of Information Technology cabling systems which may not be addressed in 07 85 00 or any of its sub-sections.

1.3 REFERENCES

A. CAN4-S115-M, “Standard Method of Fire Tests of Firestop Systems”.

B. CAN/ULC-S115, “Standard Method of Fire Tests of Firestop Systems”.

C. Underwriters Laboratories Canada Inc. (ULC) – Fire Resistance Directory

D. Underwriters Laboratories, Inc. (cUL) – Fire Resistance Directory of Products Certified for use in Canada.

1.4 PERFORMANCE REQUIREMENTS

A. Fire rated cable pathway devices shall be used for ALL low-voltage, video, data and voice cabling, optical fibre raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:

1. Meet the hourly fire-rating of fire rated wall and or floor penetrated.

2. Be tested for the surrounding construction and cable types involved.

3. Have ULC, cUL or cULus Systems permitting cable loads from; “*Zero to 100% Visual Fill*.” This requirement eliminates need for fill-ratio calculations to be made

by cable technicians to ensure cable load is within maximum allowed by ULC, cUL or cULus System.

4. Not have a constrictive inner liner that tightens around or compresses cables tightly together encouraging potential cross-talk or interference.

5. Be “Zero-Maintenance”, zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
   a. Opening or closing of doors.
   b. Spinning rings to open or close fabric liner.
   c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
   d. Furnish letter from manufacturer certifying compliance with this definition of “Zero-Maintenance”.

6. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.

7. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.

8. Cable Pathway Devices passing vertically through floors shall have equal FT Rating. (See UL System # F-A-3037, Item #4 “EZ-PATH Grid T-Rating Kit” Part # TRK444)

9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.

B. Where non-mechanical pathways must be utilized, such as sealing (caulking) around single or grouped conduits, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction. Provide letter from manufacturer certifying compliance with this section.

C. Cable pathway shall replace conduit sleeves in walls and floors, and;
   a. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
   b. When multiple units are ganged in floors, devices shall be anchored by means of a tested grid.
   c. When installed individually in walls, devices shall pass through core drilled opening utilizing tested wall plates.
   d. When multiple units are ganged in walls, devices shall be anchored by means of a tested grid.

D. Cable tray shall terminate at each fire barrier and resume on the other side such that cables pass independently through devices. Cable tray shall be properly supported on each side of fire barrier.

Note to Specifier: Coordinate drawings to show tray terminating at wall or floor and resuming on other side.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.

C. Schedule of ULC, cUL or cULus System Drawings: Submit schedule of all expected opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings. If engineering recommendations are necessary, list these in the schedule too.

D. ULC, cUL or cULus System Drawings: Furnish copies of all ULC, cUL or cULus Systems identified in schedule above. Include any engineering recommendations.

E. Certificates: Product Certificate of Compliance from the firestop system manufacturer certifying material compliance with applicable code and specified performance characteristics.

F. Installation Instructions: Submit manufacturer's printed installation instructions.

1.6 QUALITY ASSURANCE

A. Products/Systems: Provide firestopping systems that comply with the following requirements:

1. Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is ULC, cUL or cULus, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.

2. Firestopping products bear the classification marking of qualified testing and inspection agency.

B. Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency's classification marking; and mixing instruction for multi-component products.

2. Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.

B. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 PROJECT CONDITIONS

A. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.

B. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.

C. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.

D. Do not use materials that contain flammable solvents.

E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

F. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

G. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Specified Technologies Inc., or Approved Alternative.

B. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.2 MATERIALS

A. General: Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

B. Firestop Sealants: STI SpecSeal® Brand or Approved Alternate single component latex formulations that upon cure do not re-emulsify during exposureto moisture, the following products are acceptable:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSS Sealant or Approved Alternate.

2. Specified Technologies Inc. (STI) SpecSeal® Series LCI Sealant or Approved Alternate.

C. Firestop Putty: STI SpecSeal® Brand or Approved Alternate intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSP Putty or Approved Alternate

D. Firestop Pillows: STI SpecSeal® Brand or Approved Alternate re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows or Approved Alternate.

E. Fire Rated Cable Pathways: STI EZ-PATH™ Brand or Approved Alternate device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:

1. Specified Technologies Inc. (STI) EZ-PATH™ or Approved Alternate Fire Rated Pathway
   a. Series 22 or Approved Alternate
   b. Series 33 or Approved Alternate
   c. Series 44 or Approved Alternate

Note to Specifier: Coordinate drawings to show size device desired to accommodate future cabel capacity. If no size is specified, contractors will use smallest size. Labor to install all three sizes is approximately the same.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.

B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.

C. Provide masking and temporary covering to protect adjacent surfaces.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

3.3 FIELD QUALITY CONTROL

A. Inspections: Owner shall engage qualified independent inspection agency to inspect through-penetration firestop systems.

B. Keep areas of work accessible until inspection by authorities having jurisdiction.

C. Where deficiencies are found, repair firestopping products so they comply with requirements.

3.4 ADJUSTING AND CLEANING

A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

3.5 **SCHEDULES**:

Review this list and update as required, Contact STI for assistance

Penetrant Type	Concrete Floor	Concrete Wall	Gypsum Board Wall
Blank Opening	C-AJ-0100, C-AJ-0101	C-AJ-0100, C-AJ-101	
Metal Conduits	C-AJ-1080, C-AJ-1240, C-AJ-1353	C-AJ-1080, W-J-1098, W-J-1100	W-L-1049, W-L-1222, W-L-1168
Plastic Conduits/ Raceways	C-AJ-2140, C-AJ-2292	W-J-2018, W-J-2076	W-L-2093, W-L-2241
Cables	C-AJ-3214, C-AJ-3231, F-A-3015	C-AJ-3214, C-AJ-3231, W-J-3098, W-J-3099	W-L-3218, W-L-3219
Cable Trays	C-AJ-4029	W-J-4021, W-J-4022, W-J-4033	W-L-4008, W-L-4029, W-L-4043

3.6 DOCUMENTATION

A. Place system stickers on each side of wall penetrations.

B. Place a reproduction (photo copy) of the UL System description in a document protector and mount to the wall next to the wall penetration

1. Highlight the section of the system description that lists the allowed cable types.

COMMUNICATION EQUIPMENT ROOMS

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply, installation, inspection and testing of communication rooms and items contained within as described in these performance specifications and summarized in the following elements of the work:

.2 The scope of work included within the section includes architectural requirements, electrical systems, environmental requirements, cable management and pathways, and cabinets.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of communication rooms and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI – Customer-Owner Outside Plant Design Manual
- CISCA – Ceiling and Interior Systems Construction Association

2.2 Locate communication rooms in accordance with the following:

.1 As close to the centre of, and on the same floor as the area it is intended to serve.

.2 Accessible to hallways or common areas and access for delivery of large equipment.

.3 In multifloored buildings the communication rooms shall be stacked vertically.

.4 Avoid locations that may be subject to water infiltration, steam infiltration, humidity exceeding 55%, sources of heat such as direct sunlight, corrosive or adverse environmental conditions and sources of excessive EMI such as machinery.

.5 Avoid spaces in or adjacent to mechanical rooms, boiler rooms, washrooms, janitor closets, storage rooms, and loading docks.

2.3 Size communication rooms in accordance with the following:

.1 If the serving area is 500 m^2 (5000 ft^2) or less the room shall be 3.0 m x 2.4 m (10 ft. x 8 ft.).

.2 If the serving area is larger than 500 m^2 (5000 ft^2) and less than or equal to 800 m^2 (8000 ft^2) the room shall be 3.0 m x 2.7 m (10 ft. x 9 ft.).

.3 If the serving area is larger than 800 m^2 (8000 ft^2) and less than or equal to 1000 m^2 (10,000 ft^2) the room shall be 3.0 m x 3.4 m (10 ft. x 11 ft.).

.4 If the serving area exceeds 1000 m^2 (10,000 ft^2) a second communication room shall be required on the same floor.

2.4 A separate room shall be provided for the entrance facility. The room shall be located next to or directly below the main equipment room. A space of at least 1.2 m x 1.8 m (4 ft. x 6 ft.) shall be provided for each Access Provider.

2.5 A separate room shall be provided for the main equipment room. A space of at least 3 m x 4.6 m (10 ft. x 15 ft.) is required.

2.6 Design communication rooms to have fully outward opening, lockable doors that are a minimum of 0.91 m (3 ft.) wide and 2 m (80 in) tall. Access Provider rooms sized at 1.2 m x 1.8 m (4 ft. x 6 ft.) shall have two outward opening 0.91 m (3 ft.) wide and 2 m (6.7 ft.) tall doors.

2.7 False ceilings are not permitted.

2.8 Ceiling height shall be a minimum of 3 m (10 ft).

2.9 Communication room walls shall extend to the structural ceiling, install high-pressure laminate tile and treat walls and ceiling. Walls shall be 2-hour fire rated.

2.10 All walls, floors and ceiling surfaces shall be white in color.

2.11 Design access floors in accordance with the following:

.1 Shall meet the requirements of CISCA.

.2 Shall be covered in high-pressure laminate or other durable tile.

.3 Have a uniform load capacity of 12 kPa (250 lbs/ft^2).

.4 Have a concentrated load capacity of 8.8 kN (2000 lbs.).

.5 All metal parts of the access floor shall be bonded to ground in accordance with CEC Rule 10-406. A minimum of every fourth pedestal shall be bonded to ground with a 6 AWG wire.

2.12 Access floors shall only be installed in data centre applications.

2.13 In a multifloored building vertically interconnect communication rooms with a minimum of four 103 mm (4 in) sleeves or conduits. All conduits and sleeves shall be installed with bushing and appropriately rated firestop. Sleeves and conduits entering the communication room shall extend above the floor by 78 mm (3 in) AFF or extend down below the ceiling to 2.4 m (8 ft.) AFF.

2.14 Horizontally interconnect multiple rooms on a floor with conduit sized to 40% fill or cable tray that provides equivalent capacity. Regardless of cable counts there shall always be a minimum of two 53 mm (2") conduits or cable tray that provides equivalent capacity between rooms. All conduits shall be installed with bushing and appropriately rated firestop. Conduits entering the communication room shall extend down below the ceiling to 2.4 m (8 ft.) AFF.

2.15 Provide a minimum of three 103mm (4") conduits from the property line (location to be recommended by the utility) to the entrance facility designated for Access Provider use. Do not include more than two 90-degree bends in the conduit run between pull points. Never exceed a 90-degree bend. Conduits entering the room shall extend above the floor by 103 mm (4 in) AFF or extend down below the ceiling to 2.4 m (8 ft) AFF. All conduits entering the building shall be sealed with a rubber plug or water plug.

2.16 Design communication rooms to have the following power requirements:

.1 Provide a 15 amp 120-volt duplex convenience receptacle on standard power every 1.8 m (6 ft) around the perimeter walls.

.2 In rooms containing active equipment, provide a dedicated communication power panel with Transient Voltage Surge Suppression (TVSS). Identify the panel on the front door with a lamicoid label stating "Communication Panel" and panel designation. If a main UPS is installed in a data centre, all communication power panels shall be powered from that UPS.

.3 Provide one 20 amp 120 volt duplex receptacle (5-20RA) and one 20 amp 120 volt duplex twist lock receptacle (L5-20), both black in colour, for each cabinet and rack installed, mounted on the side of the cable tray or below the raised floor where applicable. These receptacles must be fed from the dedicated communication power panel.

.4 Provide two 20 amp 120 volt duplex receptacles (5-20RA), black in colour, for every 4ft wide section of backboard installed. These receptacles must be fed from the dedicated communication power panel.

2.17 Design communication room to have the following lighting requirements:

.1 Minimum of 500 lux (50 fc) measured 0.91 m (3 ft.) above finished floor, in front and behind cabinets installed. Position fixtures to minimize shadows.

.2 Do not use dimmer switches.

.3 Locate fixtures a minimum of 2.6 m (8.5 ft.) above finished floor.

.4 Power for lighting shall not come from the dedicated power panel in the communication room but from standard power.

.5 A minimum of 50% the fixtures shall be on emergency power, if available.

2.18 Design communication rooms to have a grounding and bonding system as per Specification Section 270526 'Grounding and Bonding for Communication Systems'.

2.19 Line a minimum of two walls within the communication room with AC grade or better, void-free plywood, 2.4 m (8 ft) high with a thickness of 19 mm (¾ in). The plywood shall be installed with the 'C' grade facing the wall. Plywood shall be pressure impregnated with fire-retardant chemicals in conformance with CAN/CSA-O80 Series-M and have a flame-spread rating not more than 25. A plywood backboard shall always appear where backbone sleeves enter and leave the communication room, in order to support backbone cables.

2.20 Design communication rooms containing active equipment to have the following environmental conditions and controls:

.1 Maintain continuous and dedicated environmental control (24 hours per day, 365 days per year). Connect HVAC system to emergency power where available.

.2 Maintain positive pressure with a minimum of one air change per hour.

.3 Dissipate the heat generated by active equipment. Coordinate with the City of Brampton IT department for equipment lists. Regardless of heat loads the cooling provided shall never be less than 0.5 tons/hr (6,000 Btu/hr) in general communication rooms and never less than 1 ton/hr (12,000 Btu/hr) in the main communication room. To include model #?

.4 Maintain a temperature of 18 ^{0}C to 22 ^{0}C.

.5 Maintain a relative humidity of 30% to 55%.

2.21 Design cabinet installations to be run side by side, with a minimum clearance of 0.91 m (3 ft) in the front and rear of the cabinets. Provide two vertical cable managers in each cabinet. Provide a solid side panel at both ends of a cabinet run, but never between cabinets.

2.22 Provide 2 vertical power bars in each floor standing cabinet.

2.23 Each cabinet shall have an UPS installed at the bottom of the cabinet. UPS shall be supplied and installed by the City of Brampton. *(See Appendix A for Part Numbers).*

3 MATERIALS

3.1 Acceptable manufacturer of all cabinets and associated accessories shall be RF Mote or equivalent.

3.2 Floor standing cabinets shall have the following characteristics:

.1 Model of cabinet shall be *(See Appendix A for Part Numbers)*

.2 CSA and UL approved.

.3 Standard EIA 19" mounting with 44U unit capacity.

.4 Dimensions: 762 mm (30 in) W x 914 mm (36 in) D x 2109 mm (83 in) H

.5 #10-32 EIA universal mounting hole spacing.

.6 Constructed from 11 gauge steel, textured black colour.

.7 Side panel shall be solid.

.8 Front door shall be smoked acrylic, with lockable recessed handles.

.9 Rear door shall be mesh, with lockable recessed handles.

.10 Cable management shall be a vertical internal ladder style.

.11 Exhaust fans shall exhaust a minimum of 200 CFM.

.12 Rear mounting rails shall be installed.

3.3 Vertical power bars shall have the following characteristics:

.1 CSA and UL approved.

.2 Rating: 20 amps, 120 volts.

.3 10 outlets, 20 amps, 120 volts (5-20RA).

.4 10 ft power cord, with a 20 amp plug (5-20P).

.5 Built in surge and spike protection.

.6 Power to the bar shall be switch disabled.

3.4 Wall mounted cabinet shall have the following characteristics:

.1 Model of cabinet shall *(See Appendix A for Part Numbers)*

.2 Standard EIA 19" hinged cabinet with 12U, 20U, and 26U unit capacity.

.3 Dimensions shall be at minimum: 762 mm (30 in) W x 477 mm (18.75 in) D x 565 mm (22.25 in) H.

.4 Extender brackets for cabinets shall be installed *(See Appendix A for Part Numbers)*, to increase depth by 152mm (6 in).

.5 Constructed from 11 gauge steel, textured black colour.

.6 CSA and UL approved.

.7 #10-32 EIA universal mounting hole spacing.

.8 Built-in vertical cable management.

.9 Provision for two exhaust fans.

4 FIELD QUALITY CONTROL

NIL

COPPER BACKBONE CATEGORY 3

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes voice end-to-end structured cabling between communication rooms.

.2 Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI – Customer Owned Outside Plant Design Manual

2.2 For every horizontal cable intended for voice, provide two (2) pairs plus 25% spare pairs in the backbone cable between the general communication room and the main communication room or data centre.

2.3 No means of splicing shall be used.

2.4 Provide 3 m (10 ft) of cable slack within the communication room. All cable slack shall be stored in a neat extended loop or figure of eight within the cable tray or on the backboard. Cable shall not be stored in a bundled loop.

2.5 All pairs shall be directly cabled back to a backboard mounted wiring block located within the communication room.

2.6 Backbone cable channel link shall not exceed 800 m (2624 ft); this length shall include the cable slack.

2.7 Maintain minimum bend radii of four times the cable diameter for twisted pair cable.

2.8 Do not exceed the maximum cable pulling force of 110 N (25 lbs) for twisted pair cable.

2.9 Neatly bundle cable in logical bundles with minimum 3/4" Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable. Where tie-wraps are used in a plenum space, only UL listed plenum rated tie-wraps shall be used.

2.10 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.

2.11 The twist of the individual pairs shall be maintained up to the point of termination. The maximum amount of untwisting in a pair as a result of termination shall be no greater than 13 mm (0.5 in).

2.12 All twisted pair terminations shall use a T568A wire map.

2.13 Cables shall be properly supported and protected from damage always and shall be installed in such a way as to ensure that cable will not deform over time.

2.14 Where cables are exposed to potential damage, split loom tubing shall be used.

2.15 Allow no rough handling, kinking, denting or abrasion of the cable.

2.16 Where cables are run in cable tray, neatly bundle and tie-wrap all cables. Separate voice, data and fibre cables into individual bundles.

2.17 Vertical riser cable shall be supported a minimum of three (3) times per floor. Supports shall be placed 1 m (3 ft) apart.

2.18 Bix Block to be cross connected to 24 Port patch panel in LAN closet with all pairs terminated to Patch Panel.

3 MATERIALS

3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.

3.2 Obtain components through one source from a single manufacturer.

3.3 Voice Backbone cabling shall have the following characteristics:

.1 Model of cable shall be *(See Appendix A for Part Numbers)*.

.2 Cable shall meet or exceed Category 3 requirements per TIA/EIA-568-B.

.3 Conductors: Multipair 24 AWG solid copper

.4 UL and CSA rated as CMP/FT6.

.6 Insulation: colour coding as per TIA/EIA-568-B

.7 Jacket: printed at intervals stating cable code, AWG, manufacturer and length markings, grey in colour.

3.4 Wiring Block shall have the following characteristics:

.1 Model of wiring block shall be BIX System Kit

.2 25 pair capacity

.

4 FIELD QUALITY CONTROL

4.1 Refer to ‘Testing of Communications Systems’ section.

COMMUNICATIONS FIBRE BACKBONE MULTIMODE 550

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes data end-to-end structured cabling between communication rooms.

.2 Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated.

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
- TIA/EIA-568-B.3-1 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard – Addendum 1 – Additional Transmission Performance Specifications for 50/125 um Optical Fibre Cables
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- TIA/EIA-492AAAB Detail Specification for 50-um Core Diameter/ 125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibre
- TIA/EIA-492AAAC-A Detail Specification for 850-nm Laser Optimized, 50-um Core Diameter/ 125-um Cladding Diameter Class Ia Grade-Index Optical Fibre
- BICSI – Telecommunication Distribution Methods Manual

- BICSI – Information Transport Systems Installation Manual
- BICSI - Customer Owner Outside Plant Design Manual

2.2 In a new building, each general communication room shall be connected to the main communication room or data centre with a fibre backbone cable.

2.3 In the case of an extension to an existing building each general communication room shall be connected to the existing main communication room or data centre with a fibre backbone cable, unless stated otherwise by the City of Brampton.

2.4 For every forty eight (48) horizontal cables being run to a communication room, provide two (2) multimode strands in the backbone, with a minimum of a twenty four (24) strand cable.

2.5 Provide 3 m (10 ft) of cable slack within the communication room. All cable slack shall be stored in a neat extended loop or figure of eight within the cabinet cable management. Cable shall not be stored in a bundled loop.

2.6 Maintain a bend radius during installation of fibre cable of 20 times the cable diameter and 10 times the cable diameter after installation.

2.7 Do not exceed the maximum cable pulling force of 222 N (50 lbs.) for fibre cable.

2.8 Neatly bundle cable in logical bundles with minimum 3/4” Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable.

2.9 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.

2.10 Cables shall be properly supported and protected from damage always and shall be installed in such a way as to ensure that cable will not deform over time.

2.11 Vertical riser cable shall be supported a minimum of three (3) times per floor. Supports shall be placed 1 m (3 ft) apart.

2.12 Allow no rough handling, kinking, denting or abrasion of the cable.

3 MATERIALS

3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.

3.2 Obtain components through one source from a single manufacturer.

3.3 Fibre Backbone Cabling shall have the following characteristics:

.1 Model of cable shall be *(See Appendix A for Part Numbers)*..

.2 Meet or exceed 50/125um requirements per TIA/EIA-568-B.

.3 UL and CSA rated as OFNR/FT4, on condition the cable is run within plenum rated corrugated loom tubing at all times.

.4 Capable of supporting up to 1 Gigabit fibre channel up to 900 m (1804 ft) at 850 nm.

.5 Capable of supporting up to 10 Gigabit fibre channel up to 550 m (1804 ft) at 850 nm.

.6 Minimum fibre strand count of 24.

.7 Fibre sub-units: colour coding as per TIA/EIA-568-B

.8 Jacket: printed at intervals stating cable code, manufacturer and length markings, aqua in colour.

3.4 Communication Room Fibre Patch Cords shall have the following characteristics:

.1 Model of cord shall *(See Appendix A for Part Numbers)*.LC/LC only.

.2 Cable characteristics shall match or exceed those of the backbone cable the cord is patching.

.3 UL and CSA rated as OFNR/FT4.

.4 Jacket: printed at intervals stating cable code, manufacturer, aqua in colour.

.5 Factory terminated LC (simplex) connector on both ends.

.6 Durability: 500 insertions.

3.5 Data Centre Fibre Patch Cords shall have the following characteristics:

.1 Model of cord shall be *(See Appendix A for Part Numbers)*. LC / LC only.

.2 Cable characteristics shall match or exceed those of the backbone cable the cord is patching.

.3 UL and CSA rated as OFNR/FT4.

.4 Jacket: printed at intervals stating cable code, manufacturer, aqua in colour.

.5 Factory terminated LC (simplex) connector on both ends.

.6 Durability: 500 insertions.

3.6 Fibre Patch Panels shall have the following characteristics:

.1 Models of patch panels shall be *(See Appendix A for Part Numbers)*..

.2 Shelves: *(See Appendix A for Part Numbers)*.- (houses up to 4 modules), *(See Appendix A for Part Numbers)*.- (houses up to 8 modules), *(See Appendix A for Part Numbers)*. - (houses up to 12 modules),

.1 Compatible with standard 19" rack.

.2 All plastic materials shall be fire-retardant, UL94V-0 rated.

.3 Black in color.

.4 Hinged front door

.5 Comes with trough cable manager.

.6 Top cover panel

.3 Modules: *(See Appendix A for Part Numbers)*.for communication rooms and for data centres.

.1 6 front mounted LC duplex adapters or 24 front mounted LC duplex adapters.

.2 Transmission performance characteristics shall match those of LazrSPEED 550.

.4 Splices: *(See Appendix A for Part Numbers)*. (for up to 32 splices), *(See Appendix A for Part Numbers)*. (for up to 64 splices), *(See Appendix A for Part Numbers)*. (for up to 96 splices),

4 FIELD QUALITY CONTROL

4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION HORIZONTAL CABLING CAT 6

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes data and voice end-to-end structured cabling between the communication room and the work are

.2 **Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.**

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
- TIA/EIA-568-B.1-2 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 2 – Grounding and Bonding Requirements for Screened Balanced Twisted-Pair Horizontal Cabling
- TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling

- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual

2.2 All work area jacks shall be housed in wall recessed outlets specifically dedicated to a particular work area, unless a 'MUTOA' section is included in the specification package. When a 'MUTOA' section is included, they shall only be used in open office concepts using modular furniture, unless stated otherwise.

2.3 Voice and Data outlet requirements shall be as follows:

.1 Each workstation shall consist of two data ports, all within one outlet.

.2 Each meeting room and conference room shall consist of two data ports, all within one outlet, located on each of the walls within the room.

.3 Each office large enough to house a separate meeting table shall contain a second outlet containing two data ports. Located local to the meeting table.

.4 Each fax machine, printer station and photocopier station shall consist of two data ports, all within one outlet.

2.4 Data ports contained within one outlet shall be arranged as follows:

- 1st data at the top
- 2nd data on the bottom

2.5 No data outlets shall be required for wireless access points, unless a 'wireless access point' section is included in the specification package.

2.6 Each jack shall require a dedicated horizontal cable. The splitting of pairs within a cable between different jacks is not permitted.

2.7 All ports shall be directly cabled back to a cabinet mounted patch panel located within the local communication room on the same floor, unless a 'consolidation point' section is included in the specification package.

2.8 Provide 1.5 m (5 ft) of horizontal cable slack within the communication room and 3 m (10 ft) of horizontal cable slack within the ceiling space above the work area outlet. All cable slack shall be stored in a neat tie wrapped extended loop or figure of eight. Cable shall not be stored in a bundled loop.

2.9 Horizontal cable permanent link shall not exceed 90 m (295 ft.); this length shall include the cable slack. This length is based on a patch cord length not exceeding 5 m (16 ft.). Should the patch cord length exceed 5 m (16 ft.), then the permanent link shall be reduce to match the following equation result:

- Permanent cable length = 102 - (Total combined length of patch cords * 1.2)

2.10 Outlet may be re-located up to 3 m (10 ft.) at the cost of the contractor if notified prior to installation. This shall not affect the cable slack lengths.

2.11 Maintain minimum bend radii of four times the cable diameter for twisted pair cable.

2.12 Do not exceed the maximum cable pulling force of 110 N (25 lbs.) for twisted pair cable.

2.13 Neatly bundle cable in logical bundles with minimum 3/4" Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable. Where tie-wraps are used in a plenum space, only UL listed plenum rated tie-wraps shall be used.

2.14 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.

2.15 The twist of the individual pairs shall be maintained up to the point of termination. The maximum amount of untwisting in a pair as a result of termination shall be no greater than 13 mm (0.5 in).

2.16 The maximum amount of cable jacket that shall be removed as a result of termination shall be no greater than 25 mm (1 in).

2.17 All twisted pair terminations shall use a T568A wire map.

2.18 Cables shall be properly supported and protected from damaged always and shall be installed in such a way as to ensure that cable will not deform over time.

2.19 Where cables are exposed to potential damage, split loom tubing shall be used.

2.20 Allow no rough handling, kinking, denting or abrasion of the cable.

2.21 Where there are unused port positions in a faceplate, a blank insert shall be provided.

2.22 Where cables are run in cable tray, neatly bundle and tie-wrap all cables. Separate voice, data and fibre cables into individual bundles.

2.23 Patch cord lengths and counts shall be as follows:

.1 Each patch cord length used within a communication room shall be either 0.6 m (2 ft.) or 1.2 m (4ft) or 2.1 m (7ft) long, the appropriate length shall be based on the specific cabinet layout.

.2 Each patch cord length used within a work area shall be either 4.2 m (14 ft.) or 7.6 m (25 ft.) long, the appropriate length shall be based on the specific furniture layout.

.3 Patch cords shall always be sized to provide a neat and professional installation and include adequate slack for routing through vertical and horizontal cable management.

.4 Patch cord counts shall include 10% spare of each length.

3 MATERIALS

3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.

3.2 Obtain components through one source from a single manufacturer.

3.3 Voice and Data Horizontal cabling shall have the following characteristics

.1 Model of cable shall be *(See Appendix A for Part Numbers)*.

.2 Cable shall meet or exceed Category 6 requirements per TIA/EIA-568-B.

.3 Conductors: 4-pair 23 AWG solid copper

.4 UL and CSA rated as CMP/FT6.

.5 Capable of supporting up to 1 Gigabit Ethernet.

.6 Insulation: colour coding as per TIA/EIA-568-B

.7 Jacket: printed at intervals stating cable code, AWG, manufacturer and length markings, blue in colour for data and white in color for voice.

3.4 Data and Voice Work Area Jacks shall have the following characteristics:

.1 Model of jack shall be *(See Appendix A for Part Numbers)*.

.2 Meet or exceed Category 6 requirements per TIA/EIA-568-B.

.3 8-pin, RJ45

.4 All plastic materials shall be fire-retardant, UL94V-0 rated.

.5 Data jacks shall be blue in color and voice jacks shall be slate grey.

.6 Durability: 750 insertions

3.5 Data and Voice Patch Cords shall have the following characteristics:

.1 Model of cord shall be *(See Appendix A for Part Numbers)*.

.2 Meet or exceed Category 6 requirements per TIA/EIA-568-B.

.3 Conductors: 4-pair 24 AWG stranded copper

.4 UL and CSA rated as CMR/FT4.

.5 Insulation: colour coding as per TIA/EIA-568-B

.6 Jacket: printed at intervals stating cable code, AWG, manufacturer, grey in colour for voice and blue in colour for data.

.7 Factory terminated RJ45 connector on both ends.

.8 Durability: 750 insertions.

3.6 Copper Data and Voice Patch Panels shall have the following characteristics:

.1 Model of patch panel shall be *(See Appendix A for Part Numbers)*.

.2 48-port, 2U or 24-port, 1U

.3 Compatible with standard 19” rack.

.4 Jacks shall meet or exceed Category 6 requirements per TIA/EIA-568-B. Category 6A for wireless.

.5 Jacks shall be 8-pin, RJ45.

.6 All plastic materials shall be fire-retardant, UL94V-0 rated.

.7 Jacks shall be (See Appendix in C for colours).

.8 Durability: 750 insertions.

3.7 Wall faceplates shall be *(See Appendix A for Part Numbers)*.2, 4-port, white in colour.

3.8 Furniture faceplate shall be *(See Appendix A for Part Numbers)*.2, 4-port, white in colour.

4 FIELD QUALITY CONTROL

4.1 Refer to ‘Testing of Communications Systems’ section.

COMMUNICATION CONSOLIDATION POINTS

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply, installation and inspection of consolidation points as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes consolidation point configurations within a horizontal cable run.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of consolidation points and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware

- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- CISCA – Ceiling and Interior Systems Construction Association

2.2 Consolidation points shall be located in fully accessible and permanent locations. Consolidation point must not be located in an obstructed area.

2.3 The consolidation point shall be sized to have a minimum of 40% spare capacity for future additions.

2.4 The consolidation point shall be located at least 15 m (50 ft) from the local communication room and horizontal cross-connect.

2.5 A consolidation point located within the ceiling space or raised access floor shall follow the following rules:

.1 All items installed within a plenum space shall be UL listed as plenum rated or be completely enclosed within a plenum rated container.

.2 Ceiling space or raised access floor space must be fully accessible without moving building fixtures, equipment, or heavy furniture or disturbing building occupants. Heavy furniture is defined as 45 kg (100 Ib) or more as per TIA/EIA-569-B.

.3 The ceiling or floor tile shall be clearly and permanently labelled as concealing a consolidation point.

.4 Shall not contain any active equipment.

.5 Shall be bonded to the nearest communication grounding busbar with a minimum 6 AWG.

.6 Cable entering and exiting the consolidation point shall pass through plenum rated fire foam.

.7 Shall be located along side a main communication pathway such as a cable tray.

2.6 When consolidation points are located within the office space they shall be mounted to a permanent building structure.

2.7 A consolidation point shall only be used for making direct connections to communication outlets. A consolidation point shall never be used as a cross-connect location, for patching, or for direct connections to active equipment with patch cords.

3 **MATERIALS**

3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.

3.2 Obtain components through one source from a single manufacturer.

3.3 Consolidation points shall have the following characteristics:

.1 Model of consolidation point shall be M48 Zone Wiring Box only.

.2 Accommodates up to 48 M-series jacks.

.3 UL listed for plenums spaces

.4 Twelve 19 mm (0.75 inch) knockouts for use with conduits.

.5 Removable cover.

4 **FIELD QUALITY CONTROL**

4.1 Refer to ‘Testing of Communications Systems’ section.

COMMUNICATION WIRELESS ACCESS POINT OUTLETS CAT6A

1 **SCOPE OF WORK**

1.1 Include detailed design, manufacturer, supply, installation and inspection of wireless systems as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes wireless access point outlet configurations.

2 **DESIGN AND PERFORMANCE REQUIREMENTS**

2.1 Design, manufacturer, supply and installation of wireless access point outlet and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5

- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- CISCA – Ceiling and Interior Systems Construction Association

2.2 All horizontal and backbone cabling related to wireless access points shall confirm to the appropriate specification section included in this package.

2.3 Horizontal cable permanent link shall not exceed 80 m (262 ft), this is due to the extended length of the access point patch cord.

2.4 Two data outlets shall be installed per wireless access point.

2.5 Data outlets in 2.4 shall be terminated to a SYSTIMAX 24-port patch panel in the local LAN room, used specifically for wireless outlet data drops. (W-01, W-02, etc)

2.6 No power outlet shall be required; all power to the access point shall be via Power over Ethernet (PoE) – (by others).

2.7 Each outlet shall be located above the T-bar ceiling mounted to the structural ceiling and consist of two data jacks housed in a two-port metallic faceplate mounted to a metallic single gang surface mount box. One 19 mm (0.75 in) grommet lined hole shall be used for all cables.

2.8 Every effort shall be made to enclose all non-plenum rated items within the metallic box.

2.9 Two outlets in a single assembly shall be placed in a cell like pattern to cover the entire usable area of the building (usable area does not include washrooms, changing rooms, stairs, electrical or mechanical rooms). Spacing of these outlets shall be based on the following table:

	Cell diameter of a 54 Mbps access point
Open space (warehouse)	46 m (151 ft)
Semi Open area (cubicle area)	32 m (105 ft)
Closed Office	22 m (72 ft)

2.10 One 4.2 m (14 ft) or 7.6 m (25 ft) plenum rated patch cord shall be included for every outlet. The appropriate length shall be based on the specific location of the access point, and as dictated by the City of Brampton IT division.

3 **MATERIALS**

3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.

3.2 Obtain components through one source from a single manufacturer.

3.3 Data horizontal cabling shall be **CAT6A** all other horizontal cable specified in other sections.

3.4 Patch cord shall match performance characteristics specified in other sections, with the following physical differences:

.1 Two (2) 4.2 m (14 ft) or 7.6 m (25 ft) in length

.2 UL and CSA rated as CMP/FT6.

.3 Red in color

4 **FIELD QUALITY CONTROL**

4.1 Refer to ‘Testing of Communications Systems’ section.

COMMUNICATION MUTOA OUTLETS

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply, installation and inspection of Multi-User Telecommunications Outlet Assembly (MUTOA) as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes MUTOA configurations within a work area.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of MUTOAs and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5

- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual

2.2 MUTOA's shall be used in open office concepts, for modular furniture designs only, unless stated otherwise.

2.3 MUTOA's shall be located in fully accessible locations on building columns or permanent walls. MUTOA's shall never be installed in ceiling spaces, under access floors or in obstructed areas.

2.4 The MUTOA shall be sized to have a minimum of 40% spare capacity for future additions.

2.5 A MUTOA shall only be used for making direct connections to work area equipment. A MUTOA shall never be used as a cross-connect location.

2.6 Patch cords connected to a MUTOA shall never exceed 22 m (72 ft) in length; this is based on a horizontal cable length not exceeding 70 m (230 ft). Refer to the horizontal cable section of the specification for specifics.

3 MATERIALS

3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.

3.2 Obtain components through one source from a single manufacturer.

3.3 MUTOA shall have the following characteristics:

.1 Model of MUTOA shall be M224 Zone Wiring Box only.

.2 Accommodates up to 24 M-series jacks.

.3 Removable cover.

.4 White in colour.

4 FIELD QUALITY CONTROL

4.1 Refer to 'Testing of Communications Systems' section.

TESTING OF COMMUNICATIONS SYSTEMS

1 SCOPE OF WORK

1.1 Include detailed inspection, testing and administration of communication system as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes testing, identification and administration of an end-to-end structured cabling system and its pathways and spaces.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Inspection, testing and administration of communication system shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
- TIA/EIA-568-B.1-2 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 2 – Grounding and Bonding Requirements for Screened Balanced Twisted-Pair Horizontal Cabling
- TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination

- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
- TIA/EIA-568-B.3-1 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard – Addendum 1 – Additional Transmission Performance Specifications for 50/125 um Optical Fibre Cables
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI - Customer Owner Outside Plant Design Manual

3 MATERIALS

NIL

4 FIELD QUALITY CONTROL

4.1 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.

4.2 Test procedures and test equipment shall comply with the following standards (in their latest draft including all addendums):

.1 TIA/EIA-568-B

.2 TIA/EIA TSB-140

.3 TIA/EIA-526-14-A

.4 TIA/EIA-526-7-A

4.3 The copper test equipment testing Category 5e cable shall comply with the accuracy requirements for Level III field testers and Category 5e cabling as defined in the above standards. All software shall be the latest versions, and licensed.

4.4 The copper test equipment testing Category 6 cable shall comply with the accuracy requirements for Level III field testers and Category 6 cabling as defined in the above standards. All software shall be the latest versions, and licensed.

4.5 The copper test equipment testing Category 6A cable shall comply with the accuracy requirements for Level IIIe field testers and Category 6A cabling as defined in the above standards. All software shall be the latest versions, and licensed.

4.6 The optical fibre test equipment shall comply with the accuracy requirements for field testers and fibre optic cabling as defined in the above standards. The OTDR shall operate within the range of 850 nm +/- 30 nm and 1300 nm +/- 20 nm for multimode fibre and 1310 nm +/- 10 nm and 1550 nm +/- 20 nm for singlemode fibre testing.

4.7 All installed cable runs shall be tested and must pass the requirements of the standards defined above. Any failing link shall be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The passing result of the tests for all links shall be provided in the test results documentation.

4.8 All Category 5e, 6 and 6A cable links shall be tested for channel link performance and the following parameters:

- T568A wire map for continuity on all pairs
- Length – using an accurate NVP value, the pair with the longest electrical delay shall be used for the maximum length.
- Insertion Loss
- NEXT Loss must be tested from both ends of the cabling
- ELFEXT must be tested from both ends of the cabling
- Propagation delay and delay skew
- Return Loss must be tested from both ends of the cabling
- PSNEXT must be tested from both ends of the cabling
- Power Sum ELFEXT must be tested from both ends of the cabling
- ANEXT must be tested from both ends of the cabling (for Cat 6A only)

4.9 All fibre cable shall be tested before installation while still on the reel for attenuation at both 850 nm and 1300 nm for multimode and 1310 nm and 1550 nm for singlemode to ensure that it meets or exceeds the manufacturer stated performance. The contractor shall provide a soft copy of the test results to the Communications Consultant. The Communications Consultant must approve this report prior to any installation activity.

4.10 All fibre cable links shall be tested for channel link performance for the following parameters:

- End-to-end attenuation tested at both 850 nm and 1300 nm for multimode to ensure predicted system performance.
- A-B Polarity where duplex connectors are used
- OTDR signature trace documentation for as-built records

4.11 Testing will be considered completed once records show that all installations meet the 100% pass rate.

SYSTIMAX STANDARDS SPECIFICATION GUIDELINES

1.0 TEST RESULTS

1.1.1 Cabling Contractor is required to submit test results in native tester format to the City of Brampton. Cabling Contractor is to provide the software required to view the results.

1.1.2 The report should be divided into sections by building floors

1.1.3 The report should indicate for each cable when it was tested successfully, the result, and the length.

1.1.4 The entire report must be signed by an authorized person for the Communications Cabling Contractor and a Registered Communication Distribution Designer (RCDD) at the end of the project.

1.1.5 The test result documentation is to be submitted to the City of Brampton for review no later than 5 working days following the completion of the installation.

2.0 AS-BUILT DRAWINGS

2.1.1 Communications Cabling Contractor is required to provide as-built drawings of the cable installation for all cabling included in this specification. All drawings to be provided to City of Brampton at the end of the project for any changes due to on-site conditions.

2.1.2 The as-built drawings are to include, but are not limited to, the following:

1. Cable numbers on the floor plans.
2. Changes on the floor plans.
3. Cable routing on the floor plans.
4. Rack Elevation drawings and changes.
5. Backboard Elevation drawing and changes.
6. Riser Routing Drawing.

2.1.3 Communications Cabling Contractor to provide one (1) soft copy in AutoCAD 2014 format and six (6) plotted copies for the City of Brampton after the City of Brampton 's final review and acceptance of the drawings.

2.1.4 Within 30 working days after approval, the Communications Cabling Contractor is to distribute one copy of the plotted copies to each of the telecommunications closets

3.0 CHANGE NOTICES

3.1.1 All change notice pricing will include, by line item, a detailed breakdown including :

1. Part number
2. Unit cost
3. Labour Units
4. Labour Cost as per this document.
5. HST
6. Mark-ups for overhead and profit
7. Total Price for the change notice

3.1.2 Labour cost and mark-ups will apply for the duration of the project.

3.1.3 Change Notices are to reference the City of Brampton Change Notice Number or Site Instruction. Work is not to proceed without prior approval.

4.0 MANDITORY REQUIREMENTS

4.1.1 Cabling contractor must be registered as CommScope SYSTIMAX Value Added Re-Seller (VAR) (Prestige, Authorized, Authorized Installer) as of the date of the Tender closing.

4.1.2 Provide a proof of company's CommScope's SYSTIMAX Solutions VAR Certification including expiry date and duration of experience.

4.1.3 Provide a copy of SYSTIMAX SCS Design & Engineering Certification including expiry date for each Project Manager designated to work on the City of Brampton sites.

4.1.4 Provide a copy of SYSTIMAX SCS Installation and Maintenance including expiry date for each installer designated to work on the City of Brampton sites.

4.1.5 Provide a copy of RCDD's Certification including expiry date for each designer designated to work on the City of Brampton site. Must be able to sign off on as-built documentation.

4.1.6 A 20 Year Systimax Certification Warranty on cabling shall be provided to the City of Brampton no later than 30 working days following the completion of the installation.

APPENDIX A – APPROVED MATERIALS LIST

Section	Material	Manufacture	Model
270528			
	Cable Tray	Flextray	
	Cable Tray	Cablofil	
	Sling Support System	Erico Caddy Cablecat	
271100			
	Floor standing cabinets	RF Mote	RFM-303083
	Floor standing cabinets	RF Mote	RFM-303059
	Wall mounted cabinet	RF Mote	RFM-3022-WM
	Wall mounted cabinet	RF Mote	RFM-3036-WM
	Wall mounted cabinet	RF Mote	RFM-3048-WM
	6" Extender Brackets	RF Mote	RFM-6X-WM
	6" Extender Brackets	RF Mote	RFM-6X-WM-36
	6" Extender Brackets	RF Mote	RFM-6X-WM-48
	UPS	APC	SMX1500RM2UNC **(City Supplied and Installed)**
271313			
	Voice Backbone Cable	Systimax	Plenuum 2010
	Wiring Block	Belden	BIX
271323			
	Fibre BackBone Cable	Systimax	LazrSPEED 550 - Plenum rated
	Fibre Patch Panel	Systimax	600G2-1U-MOD-SD-360
	Fibre Patch Cords	Systimax	FEXLCLC42-MXF0XX
	Shelves	Systimax	360G2-1U-MOD-SD
	Shelves	Systimax	360G2-2U-MOD-SD
	Shleves	Systimax	360G2-4U-MOD-SD
	Modules	Systimax	360DP-12LC-LS
	Modules	Systimax	360DP-24LC-LS
	Splices	Systimax	RS-2AF-16SF
	Splices	Systimax	RS-4AF-16SF
	Splices	Systimax	SW-6AF-16SF
271513			
	Horizontal Cable (**Data)**	Systimax	GigaSPEED XL 2071E
	Horizontal Cable **(WIRELESS)**	Systimax	GigaSPEED XL 2091B / Alternate 2091SD
	Jack (Data) / Jack (Wireless)	Systimax	MGS400 (DATA) / MGS600-XXX (WIRELESS)
	Patch Cords **Floor Racks** for wireless see 271544	Systimax	CPC3312-0xFyyy
	Patch Cords **Wall Mounts** for wireless see 271544	Systimax	MINO6-XX
	Patch Panel	Systimax	CPP-UDDM-M-1U-24 / CPP-UDDM-M-2U-48
	Data Jacks for M2000	Systimax	MGS400-XXX

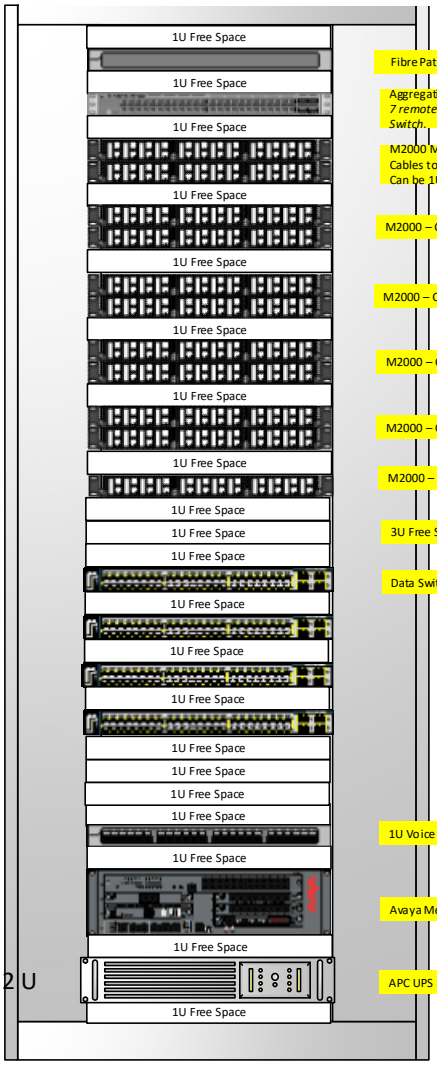
Section	**Material**	**Manufacture**	**Model**
271513	Wall faceplates	Systimax	M12LE-266
cont.	Wall faceplates	Systimax	M13LE-266
	Wall faceplates	Systimax	M16LE-266
	Wall faceplates	Systimax	M13SP
	Wall faceplates	Systimax	M16SP
	Furniture faceplate	Systimax	M13C-262
271520			
	Consolidation point	Systimax	M48 Zone Wiring Box
271544			
	Dual Port Surface Box	Systimax	M202 Plenum SMB-262
	Patch Cable for Ceiling	Systimax	CPCSSY2-07F015 (Plenum Rated)
	Patch Cable for Ceiling	Systimax	CPCSSY2-07F025 (Plenum Rated)
	Patch Cable for Ceiling	Systimax	CCA-CAT6A-PLENUM (Plenum Rated)
	Patch Cords Floor Racks	Systimax	CPCSSX2- (Red)
	Patch Cords Wall Mounts	Systimax	CO199K2- (Red)
271545			
	MUTOA	Systimax	M224 Zone Wiring Box
OTHER	Wire Mold	Wire Mold	V750 (Colour to match wall being installed on)

APPENDIX B – TYPICAL LAN ROOM LAYOUTS

City of Brampton IT Cabinet Design

Main LAN Room A with Aggregation Switch

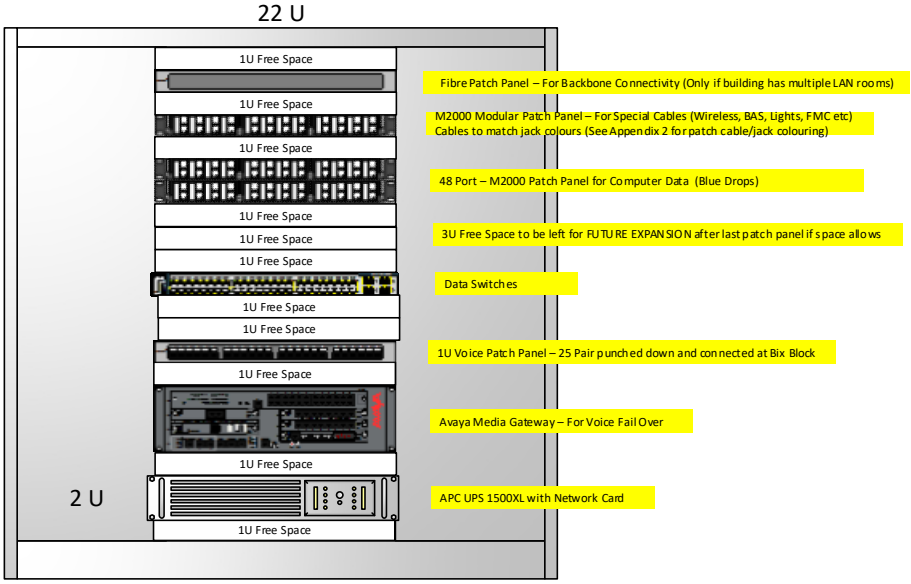
Part Number for Cabinet: Refer to Appendix A for approved Materials



City of Brampton IT Wall Mount Design

Main LAN Room A

Part Number for Cabinet: Refer to Appendix A for approved Materials

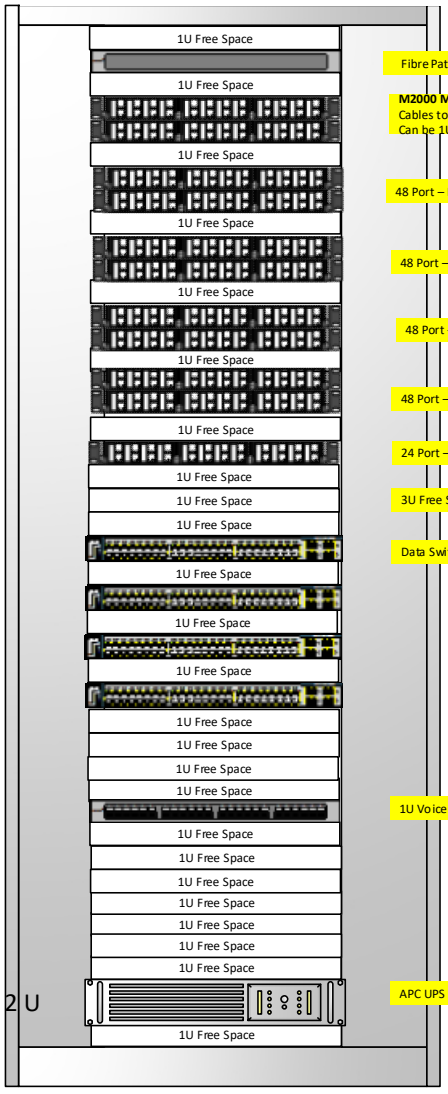


Please note: When designing wall mount cabinets, the patch cables used in these cabinets will be a different part number, please pay attention.

City of Brampton IT Cabinet Design

Remote LAN Room (B,C,D etc)

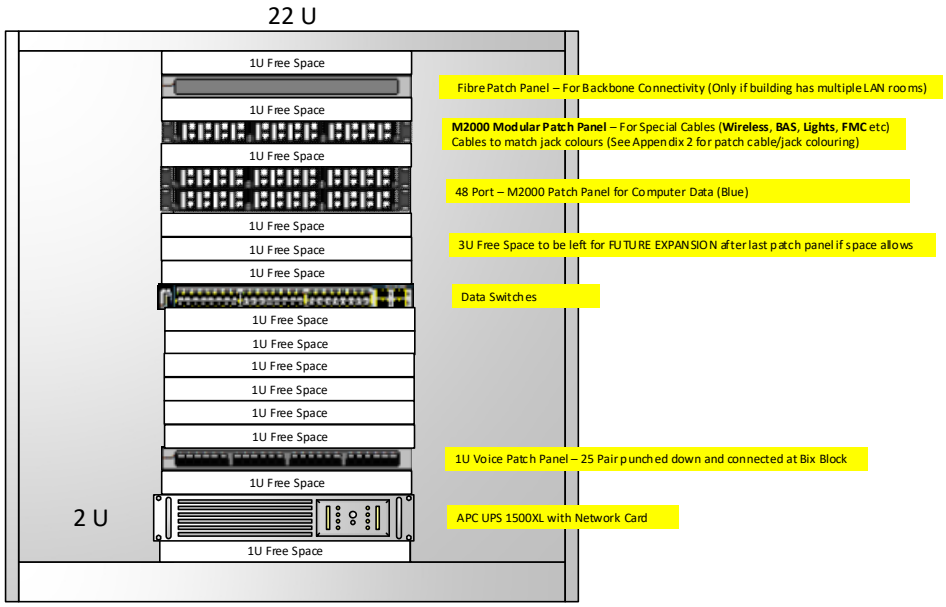
Part Number for Cabinet: Refer to Appendix A for approved Materials



City of Brampton IT Wall Mount Design

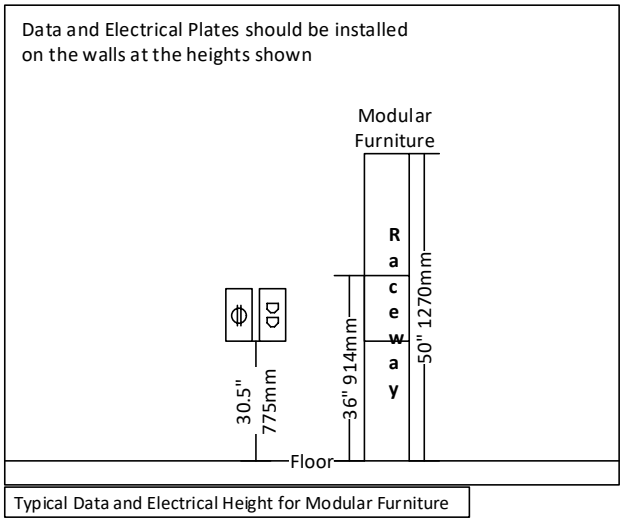
Remote LAN room (B,C,D etc)

Part Number for Cabinet: Refer to Appendix A for approved Materials

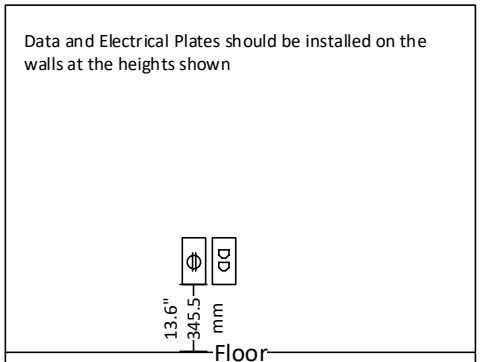


Please note: When designing wall mount cabinets, the patch cables used in these cabinets will be a different part number, please pay attention.

APPENDIX C – OUTLET MOUNTING HEIGHTS AND PATCH CABLE COLOURS



Typical Data and Electrical Height for Modular Furniture



Typical Data and Electrical Height for Meeting Rooms

All Cables terminating into patch panels are to be Blue in Colour with the exception of security cabling.

Red Patch Cables will be used for:
Wireless and UPS (Red Jacks in M2000 Patch Panel)

Green Riser/Patch Cables will be used for:
Security ONLY

Blue Patch Cables will be used for:
All Data Drops (Computers)

Grey Patch Cables will be used for:
All Voice related Devices including Avaya Gateway

Orange Patch Cables will be used for:
All Monitoring Devices
BAS, FMC, Brine, Fuel, Electric Charging, People Counter etc.
(Orange Jacks in M2000 Patch Panel)

Purple Patch Cables will be used for:
AV Devices
(Purple Jacks in M2000 Patch Panel)

IT Network Services Department - MF	**Typical Cable Runs / Patch Cable Colouring**	Jan 2019 V1.1	BRAMPTON Flower City

1 General

1.1 CONDITIONS AND REQUIREMENTS

.1 Refer to the General Conditions, Supplementary General Conditions, and General Requirements.

.2 Provisions of this Section shall apply to all Sections of Division 27.

.3 Refer to Consultant's drawings for exact location of electrical equipment and devices. Refer to Designer drawings for additional notes which complement these specifications.

.4 The Division 26 specification documents shall be followed in conjunction with the specification in this section.

.5 Coordinate with the Division 26 contractor (hereafter referred to as the "electrical contractor").

1.2 RELATED DIVISIONS

.1 Division 25 – Integrated Automation.

.2 Division 26 – Electrical.

.3 Division 28 – Electronic Safety and Security.

1.3 INTENT

.1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter. Sections of this specification are not intended to delegate functions nor to delegate work and supply to any specific Trade. It shall be your responsibility to ensure that the systems specified hereafter are complete and operative.

1.4 CODES AND STANDARDS

.1 The equipment, material and installation shall conform to the latest version of the applicable Codes, Standards (including technical service bulletins and addenda) and regulations of authorities having jurisdiction.

.2 BICSI

.1 Telecommunications Distribution Methods Manual

.2 Cabling Installation Manual

.3 Outside Plant Manual

.3 Canadian Standards Association (CSA)

.1 CSA C22.1 – Canadian Electrical Code, Part 1

.2 CSA T529 – Commercial Building Telecommunications Cabling Standard (ANSI/EIA/TIA-568-B).

.3 CSA T530 – Commercial Building Standard For Telecommunications Pathways And Spaces (TIA/EIA 569-A).

.4 CSA T528 – Administration Standard For The Telecommunications Infrastructure Of Commercial Buildings (ANSI/EIA/TIA-606).

.5 CSA T527 – Commercial Building Grounding And Bonding Requirements For Telecommunications (ANSI/EIA/TIA-607).

.6 CSA C22.2 No. 214 – Communications Cables.

.7 CSA C22.2 No. 232-M – Fibre Optic Cables.

.8 CSA C22.2 No. 182.4-M90 – Plugs, Receptacles, and Connectors for Communication Systems.

.4 TIA

.1 TIA/EIA-568-B.1 – Commercial Building Telecommunications Cabling Standard

.2 TIA/EIA-568-B.2 – Balanced Twisted Pair Cabling Components

.3 TIA/EIA-568-B.3 – Optical Fibre Cabling Components Standard

.5 ISO

.1 ISO/IEC IS 11801A – Generic Cabling for Customer Premises.

.6 CENELEC EN 50173 – Performance Requirements for Generic Cabling Schemes.

.7 IEC

.1 IEC 603-7, PART 7 – Detailed Specification For Connectors, 8-Way, Including Fixed And Free Connectors With Common Mating Features.

.2 IEC 807-8 – Rectangular Connectors For Frequencies Below 3 MHz, Part 8: Detailed Specification For Connectors, Four-Signal Contacts And Earthing Contacts For Cable Screens, First Edition.

.8 FIPS PUB 174 – Commercial Building Telecommunications Wiring Standard. Federal Information Standard Publication.

.9 UL 444 and 13 – Adopted Test and Follow-Up Service Requirements For the Optional Qualification of 100Ω Twisted-Pair (Cables).

.10 NEMA WC 63 – Performance Standard For Field Testing Of Unshielded Twisted-Pair Cabling System.

.11 ANSI/EIA/TIA

.1 ANSI/EIA/TIA-492AAAA – Detailed Specification For 62.5µm Core Diameter / 125µm Cladding Diameter Class 1a Multimode, Graded-Index Optical Waveguide fibres.

.2 ANSI/EIA/TIA-492BAAA – Detailed Specifications For Class Iva Dispersion-Unshifted Singlemode Optical Waveguide Fibres Used In Communication Systems.

.3 ANSI/EIA/TIA-472CAAA – Detailed Specifications For All Dielectric (Construction 1) Fibre optic Communications Cable For Indoor Plenum Use, Containing Class 1a, 62.5µm Core Diameter / 125µm Cladding Diameter Fibre optic(s).

.4 ANSI/EIA/TIA-472DAAA – Detailed Specifications For All Dielectric Fibre optic Communications Cable For Outdoor Plant Use, Containing Class 1, 62.5µm Core Diameter / 250µm Cladding Diameter Fibre optic(s).

.5 ANSI/EIA/TIA-455 – Test Procedures For Fibre optics, Cables And Transistors.

.6 ANSI/EIA/TIA-598 – Colour Coding of Fibre Optic Cables.

.7 ANSI/EIA/TIA-604-3 – FOCIS 3 Fibre Optic Connector Intermateability Standard.

.8 ANSI/EIA/TIA-606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

.9 ANSI/EIA/TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.

.12 ANSI Z136.2 – American Standards For The Safe Operation of Fibre optic Communication Systems Utilizing Laser Diode And LED Sources.

.13 ANSI/CEA

.1 ANSI/ICEA S-83-640 – Fibre Optic Outside Plant Communications Cable.

.2 ANSI/ICEA S-83-596 – Fibre Optic Premises Distribution Cable.

.14 The Corporation of the City of Brampton

.1 IT Performance Specification Division 27, Communications New Build, Version 1.5.

1.5 WORK SEQUENCE

.1 Prior to start of each work period in occupied area, temporary protection shall be installed to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.

.2 Owner's representative shall approve temporary protection plan prior to use.

.3 Necessary steps shall be taken by contractor to ensure that required fire fighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

1.6 INSPECTIONS

.1 The Engineer and/or the Project Manager will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.

1.7 DRAWINGS AND SPECIFICATIONS

.1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Engineer in writing before submitting Tender. If this is not done, the maximum, the most expensive alternate or option will be provided in base tender bid.

.2 All drawings and all Divisions of these specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.

.3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of cabling is not assured. Exact requirements shall be governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull and junction boxes, etc. necessitated by such conditions shall be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.

.4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job.

.5 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

.6 Before ordering any conduit, cable tray, cables, fittings, etc., this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.8 MATERIAL

.1 This contractor is responsible to ensure that all items submitted meet all requirements of the drawings and specification, and fits in the allocated space. The final determination of a product being acceptable shall be determined by the Engineer.

1.9 TESTING DATA

.1 The contractor shall provide a complete testing report utilizing a testing device as specified in the applicable TIA/EIA standard with the correct adapter and test. All copper tests shall be compliant to the current TIA/EIA standards: Perm Link or Channel.

.2 The Summary report shall provide be provided to the end user in a universal format so that there is no need to purchase any software to read and print the report.

.1 Utilizing Adobe Acrobat is an acceptable manner.

1.10 PAINTING AND FINISHES

.1 Minor damages to finish on factory finished equipment shall be touched up to the Engineer's satisfaction. Items suffering major damage to finish shall be replaced at the direction of the Engineer. Protect work so that finishes

will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.

1.11 SAFETY

.1 The Contractor shall be responsible for the safety of his workmen and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations shall prevail.

1.12 WARRANTY

.1 Submit a written performance warranty to the Owner for one year for the complete installation for a period of no less than five years from the date of testing and acceptance. The system warranty shall be based on industry standards.

.2 The contractor shall also provide a one year labour warranty on the installation.

2 Products

2.1 MATERIAL APPROVAL

.1 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.

.2 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical inspection Services, or other government agency.

2.2 SHOP DRAWINGS

.1 Before delivery to site of any item of equipment, the electrical contractor shall submit 6 copies of shop drawings c/w all data, pre-checked and stamped accordingly, for approval to the Engineer. Indicate project name on each brochure or sheet. Submit shop drawings within 1 week after award of contract, for the following:

.1 Copper Cabling

.2 Fibre Optic Cabling

.3 Fabric Innerduct

.4 Racks, managers

.5 Patch Panels

.6 Telecommunications Outlets, Faceplates

.7 Fibre Optic Routing System

.8 Rack Power Distribution Units

2.3 AS-BUILT DRAWINGS

.1 To Section 01 78 00.

.2 Red lines, mark-ups by this contractor.

2.4 OPERATION AND MAINTENANCE MANUALS

.1 Refer to Division 01.

3 Execution

3.1 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

.1 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Engineer. Any unsatisfactory workmanship will be replaced at no extra cost.

.2 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this Specification. This Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all equipment and materials in dry locations.

.3 Provide foreman in charge of this work at all times.

.4 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker's Compensation, and Employer's Liability Insurance.

3.2 COORDINATION

.1 Coordinate work with other trades.

.2 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report all necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.

.3 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades. Cooperate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other Trades.

3.3 MANUFACTURERS' INSTRUCTIONS

.1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.

.2 Follow manufacturer's instructions where they cover points now specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

3.4 QUALITY ASSURANCE

.1 See General Provisions of the Contract.

.2 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.

.3 The Contractor shall ensure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

.4 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.

3.5 LABELS AND SIGNS

.1 Labelling shall be as per TIA/EIA-606.

3.6 ADJUST AND CLEAN-UP

.1 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this Trade. At the completion of this work, the installation is to be left in a clean and finished condition to the satisfaction of the Engineer.

3.7 TESTS AND ACCEPTANCE

.1 The operation of the equipment does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfils the requirements of the drawings and the specifications.

.2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.

.3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that work is complete and in perfect operating condition. In the presence of the Owner, the Contractor shall demonstration the proper operation of all miscellaneous systems.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Provide a complete system of empty conduits, pull boxes, outlets, and sleeves for enclosure of wiring by general contractor. Refer to General Requirements.

1.2 RELATED REQUIREMENTS

.1 Section 26 05 33.13 – Conduit for Electrical Systems.

.2 Section 26 05 33.16 – Boxes for Electrical Systems.

.3 Section 28 46 21.11 – Addressable Fire Alarm Systems.

1.3 REFERENCES

.1 BISCI Telecommunications Distribution Methods Manual, 13th Edition (2014).

2 Products

2.1 OUTLETS

.1 Wall outlets shall be 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted.

2.2 CONDUITS

.1 Conduit size shall be in accordance with recommended standard for conduits in Building as published by BICSI.

.2 Minimum conduit size shall be 21 mm diameter.

.3 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:-
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.4 Plenum cables are permitted in accessible ceilings. Provide 'J' hooks in these locations for later cable installation by others.

.5 Plywood backboards shall be minimum 1200 mm by 2400 mm, 19 mm thick, painted with two coats of fire retardant light grey enamel.

.6 Provide a minimum of two duplex receptacles on separate circuits at each backboard.

.7 Provide fire alarm over-ride feature at fire alarm control panel (FACP) to deactivate public address system when Fire Alarm System is in alarm.

3 Execution

3.1 INSTALLATION

.1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.

.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8" nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.

.3 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.

.4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30,000 mm in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:-
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by Cash Allowance installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.1 SUMMARY

.1 Provide a complete system of empty conduits, terminal cabinets, plywood backboards, pull boxes and outlets for enclosure of wiring by Security Contractor.

1.2 RELATED REQUIREMENTS

.1 Section 26 05 33.13 – Conduit for Electrical Systems.

.2 Section 26 05 33.16 – Boxes for Electrical Systems.

2 Products

2.1 OUTLETS

.1 Wall and door outlets shall be single boxes, or 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted. Coordinate with Security Contractor.

2.2 CONDUITS

.1 Provide conduit in all walls, exposed areas and inaccessible ceilings. All conduit work shall be concealed.

.2 Minimum conduit size shall be 21 mm diameter.

.3 Provide J hooks in accessible ceilings for plenum rated wiring.

.4 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:-
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.5 Plywood backboards shall be minimum 1200 x 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.

.6 Provide a minimum of 2 duplex receptacles on separate circuits at each backboard.

3 Execution

3.1 INSTALLATION

.1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.

.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8" nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.

.3 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.

.4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30,000 mm in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by Security installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.1 SUMMARY

.1 Provide a complete system of empty conduits, terminal cabinets, plywood backboards, pull boxes and outlet boxes for enclosure of cabling by Owner under a separate contract.

1.2 RELATED REQUIREMENTS

.1 Section 26 05 33.13 – Conduit for Electrical Systems.

.2 Section 26 05 33.16 – Boxes for Electrical Systems.

2 Products

2.1 VIDEO SURVEILLANCE EQUIPMENT (BY OWNER)

.1 Video Surveillance equipment shall be based on IP cameras. Size conduits based on industry practices based on Category 6 communications cabling.

2.2 OUTLETS

.1 Wall and door outlets shall be single boxes, or 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted. Coordinate with Owner's video surveillance contractor.

2.3 CONDUITS

.1 Provide conduit in all walls, exposed areas and inaccessible ceilings. All conduit work shall be concealed.

.2 Minimum conduit size shall be 21 mm diameter.

.3 Provide J hooks in accessible ceilings for plenum rated wiring.

.4 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:-
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.5 Plywood backboards shall be minimum 1200 mm by 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.

.6 Provide a minimum of two duplex receptacles on separate circuits at each backboard.

3 Execution

3.1 INSTALLATION

.1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.

.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8 inch nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.

.3 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.

.4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 000 mm in each run, so that wire or cables may be pulled in or

withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by Security installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Cabling requirements for IP based CCTV cameras.

1.2 RELATED REQUIREMENTS

.1 Division 27 – Communications.

2 Products

2.1 OWNER-FURNISHED PRODUCTS

.1 New IP cameras, and associated equipment shall be supplied and installed by others under a separate contract.

.2 This contractor shall be responsible for coordinating rough-in requirements.

2.2 CABLING

.1 Plenum rated Category 6 cabling in accordance with Division 27.

3 Execution

3.1 INSTALLATION

.1 In accordance with sections of Division 27.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Communications conductors and cables for fire detection, suppression, and alarm systems.

.2 Conduit for fire detection, suppression, and alarm systems.

1.2 RELATED REQUIREMENTS

.1 Section 28 46 11 - Fire Sensors and Detectors.

.2 Section 28 46 21.31 - Fire Detection, Suppression, and Preaction Releasing Panels.

.3 Section 28 46 21.33 - Fire Detection, Suppression, and Preaction Releasing Panel Sequences of Operation.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 In accordance with Section 01 61 00.

1.4 WARRANTY

.1 All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one year from the date of acceptance.

2 Products

2.1 CONDUIT AND WIRE FOR FIRE ALARM SYSTEM

.1 Conduit:

.1 In accordance with Section 26 05 33.13.

.2 Conduit shall be in accordance with the Electrical Safety Authority (ESA), local and provincial requirements.

.3 All wiring shall be installed in conduit or raceway.

.2 Terminal Boxes, Junction Boxes and Cabinets:

.1 All boxes and cabinets shall be listed for their purpose and use.

.3 Fire Alarm Cable

.1 Wiring shall be in accordance with local, provincial and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as outlined in the Ontario Electrical Safety Code and as recommended by the fire alarm system manufacturer.

.2 All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system, as outlined in the Ontario Electrical Safety Code.

.3 Conductors: 300V rated multiconductor, insulated, colour coded, copper conductor, minimum size to be #16 AWG for device loops and 14 AWG for signal circuits.

.4 Certified by CSA as fire alarm and signal cable type FAS 105 to CSA C22.2 No. 208.

.5 Non-Fire rated cable:

.1 Insulation: 105 degrees C flame retardant PVC

.2 Outer Jacket: 105 degrees C flame retardant PVC Red.

.3 Armour: Interlocking aluminum without overall Jacket. For drops to devices in suspended ceilings from conduit system.

.6 Fire rated fire alarm cable:

.1 Pentair Pyrotenax 1850 series mineral insulated (MI) cable with 2 hour fire rating to ULC S139 and to meet Ontario Building Code Rule 3.2.7.10.

.2 Alternates such as “Lifeline” installed in conduit may only be considered if listed by ULC under ULC Category Code ‘FHJRC’ after October 2014.

.3 Acceptable alternate: VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code ‘FHJRC’, dated 19 May 2015).

3 Execution

3.1 INSTALLATION

.1 All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

.2 The entire system shall be installed in accordance with the latest edition of CAN/ULC-S524 and the approved manufacturer’s manuals and wiring diagrams.

.3 The contractor shall furnish all labour, conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for installation of system devices.

.4 Provide all necessary power supply, interconnecting and remote signal wire in dedicated conduit throughout and installed in accordance with the manufacturer’s wiring diagrams and the requirements of the Ontario Electrical Safety Code and the Inspection Authority.

.5 All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes.

.6 Install all wiring in metal raceways.

.7 Provide wiring suitable for fire alarm circuits.

.1 Class “A” wiring for initiating circuits.

.2 Class “A” wiring for signalling circuits.

.8 Fire rated conductors:

.1 Install 1 hour fire rated cables for fire alarm circuits as required by the building code where transponders (data gathering panels) or annunciators are installed in a separate fire compartments from the main FACP CPU.

.2 Install 1 hour fire rated cables for fire alarm system branch circuits where the transponder or DGP is not within the same storey as the first initiation, signalling, or voice communication device in the loop for that storey.

.3 In lieu of fire rated cables for the above noted cases, Contractor may, when reviewed beforehand by the Consultant, install non rated conductors in be located in a service space that is separated from the remainder of the building by a fire separation that has a fire resistance rating of not less than 1 hour.

.9 End-of-line resistors shall be furnished as required for mounting as directed by the manufacturer on Class B circuits.

.1 Install EOL resistors maximum 1800 mm above finished floor in interior spaces.

3.2 TESTING AND INSPECTION

.1 The manufacturer’s representative shall make an inspection of the fire alarm equipment. The inspection shall comprise an examination and test of such equipment for the following:

.1 That the type of conductors and cables installed are that designated by the specifications.

.2 That the specified equipment has been installed in accordance with the manufacturer's recommendations.

.3 That the supervisory wiring of all devices connected to a supervised circuit is operating and that the wiring has been met to the satisfaction of the inspecting officials.

.2 Testing to be done in the presence of the local building inspector, and the local fire inspector.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Wireless Access Points for WiFi network communications.

2 Products

2.1 OWNER-SUPPLIED PRODUCTS

.1 WAP (Wireless Access Points).

.1 Free issued by Owner to this Contractor for installation at locations as indicated on the drawings.

.2 Power Over Ethernet (PoE) powered.

3 Execution

3.1 INSTALLATION

.1 Allow for site wireless survey for the final locations of WAPs

.2 Allow for 5 m cable slack at WAP outlets end for final location adjustment.

End of Section

1 General

1.1 SECTION INCLUDES

.1 A fully functional master clock system including time reference source, master timer unit, clock displays, programming software, network interface, SNTP and NTP network interfaces.

.2 Conduits, cables, connectors, connections, equipment mounting hardware and cabinets, display unit mounting hardware required to install and make the master clock system fully functional and operational.

.3 Power limited transformers for step down from 120 V to 24 V for Class 2 wiring distribution to a maximum of 100 VA per circuit.

.4 Field adjustments to installed display units to ensure clearance from obstructions so as to permit unobstructed viewing as far as reasonable and practicable. Make field changes after mechanical systems have been installed. Make field changes to elevation and orientation of display units to accommodate and be clear from operational machinery installed in this contract or by others under separate contract as far as reasonably possible and within practicable limitations.

.5 Radio controlled wireless synchronization of displays using a radio signal operating in a licensed band.

1.2 MANUFACTURER QUALIFICATIONS

.1 Supply products and systems produced by manufacturers with a minimum of 5 years of continuous production and with established national service representation.

2 Products

2.1 MANUFACTURERS

.1 ATS Clocks.

.2 BRG Precision.

.3 Franklin Instruments.

.4 Inova Solutions.

.5 Lathem Time.

.6 National Time and Signal.

.7 Primex.

.8 Simplex.

.9 Spectracom.

2.2 WIRELESS CLOCK SYSTEM

.1 Time reference source

.1 GPS derived time source as primary reference

.1 GPS off-air derived time using self-contained GPS signal receiver, window mounted or roof mounted antenna, antenna mounting brackets and weather protection, with time code signal output.

.2 NTP or SNTP as secondary source of time reference.

.1 Networked time based reference signal using self-contained, internet derived, reference time signal and using SNTP (Simple Network Time protocol or Network Time Protocol) to decode and distribute time reference signals.

.3 System internal clock as default.

.1 Substitute a primary signal with a secondary signal if the one is absent for 4 consecutive hours. Restore signals when sources return for uninterrupted period of 1 hour or more.

2.3 PROGRAMMABLE SEQUENCE AND TIMING CONTROLLER

.1 Provide a master controller of solid state design and construction suitable for surface, rack or semi-flush mounting, equipped with an LED display, displaying hours, minutes, seconds and day of the week, and keyboard for programming, and editing; self-contained memory, so that in the event of a total power failure, including battery removal for servicing, programme and stored data will not be lost; of “fail-safe” design so that on replacement of failed part, synchronization of system and display devices can occur without manual intervention or device reset.

.2 Master controller using external time reference source or in event of external source signal failure internal clock as default. Internal clock accuracy better than 1 second error in any 24 hour period, not synchronized to electrical supply. Visual indication of absence of external reference and/or operation on default time source.

.3 Master system capable of seven day, twenty-four hour programming and equipped with a 4 year, 365/366 day calendar with ability to record 31 preset exceptions including holidays.

.4 Master system with auto recognition and indication of Daylight Saving Time.

.5 Master system able to transmit time information to run and synchronize secondary clocks. Communications protocol to ensure accurate and reliable synchronization.

.6 Self-contained battery supply to maintain 24 hours of autonomous operation.

.7 Equipment supplier to furnish all software and programming of master clock system features and provide any software enhancements necessary to accommodate specified functions.

.8 Time signal distribution systems

.1 Radio transmitter operating in licenced frequency Range, at maximum radiated power 1 watt (30 dBm) adjustable, operating temperature 0 degrees C. to 70 degrees C

.2 Transmitter antenna vertical polarized dipole, gain less than 2.2 dB.

.3 Operator set controls including local time zone over-ride, saving time override, 12/24 hour presentation over-ride.

.4 Operation from 120 V ac with internal or external backup battery to permit 24 hours autonomy.

.5 Internal memory protection against loss of configuration.

2.4 DIGITAL DISPLAY CLOCKS

.1 Wall, surface, flush or pendant mounted wireless units, 7 segment LED display, polycarbonate frame and polycarbonate lens with display character heights:

.1 63.5mm (2.5 inch) for admin office area

.2 100mm (4 inch) for garage area

.2 Single or double sided display, 6 digit LED digits, Red only, or Green only, or selectable red or green or red and green (orange), to be confirmed with Owner.

.3 Digital clocks synchronized to master time reference, able to operate in absence of signal, to accuracy of 1 second error in any 24 hours.

3 Execution

3.1 INSTALLATION

.1 GPS Wireless Clock system head-end equipment to be installed in IT room.

.2 Digital display clocks to be installed

.1 Repair garage area

.2 Dispatch Office (inside and outside)

.3 Any other area assigned by the owner

.4 Allow for total of 12 - 4 inch and 12 - 2.5 inch display clocks.

.5 Provide unit price for add or delete one 4 inch or one 2.5 inch display clock, including cost for labour and electrical power supply.

End of Section

1 General

1.1 REFERENCES

.1 CAN/ULC-S1001-11 – Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.2 PURPOSE

.1 To verify that installations are in accordance with project requirements.

.2 To ensure proper system operation.

1.3 COMMISSIONING ORGANIZATIONS

.1 Certified member of Electrical Contractors Association of Ontario (ECAO) or Canadian Fire Alarm Association (CFAA).

2 Products – Not Used

3 Execution

3.1 SITE TESTS AND INSPECTIONS

.1 Perform Commissioning of integrated systems in accordance with CAN/ULC-S1001.

.2 Follow manufacturer's recommendations for testing.

.3 Inspect wiring connections to all devices comprising the system.

.4 Verify supervision of wiring at every device connection to a supervised circuit.

.5 Test operation of every device on a system to verify its function.

.6 Examine equipment for any apparent damage or tampering that may interfere with its intended operation.

.7 Test equipment with capabilities for field adjustment to establish that it functions as intended under the conditions prevailing at its point of installation.

.8 Examine devices for evidence of damage or obstructions which may interfere with their operating mechanisms.

.9 Test automatic devices by simulating an operating condition.

.10 Wiring:

.1 Inspect every device and test to demonstrate that disconnection of the device from the circuit or malfunction of the equipment or wiring activates the required supervisory signals. Inspection shall include verification that:

.1 Supervisory signals operate in response to open circuits, short circuits, ground faults and disconnection of plug-in components;

.2 Terminations of conductors entering and leaving equipment have been made;

.3 Circuit polarities are in accordance with the system design, where applicable.

.2 In addition, test to establish that the power supplied to any device is within its recommended operating range and that the required voltage levels are maintained and that the fusing is correct.

.11 Initiating Devices - Manual:

.1 Inspect manual alarm stations in consideration of the following:

.1 The device shall be mounted with sufficient clearance to facilitate ease of access and proper operation;

.2 Operate each manual alarm station, toggle switch and key switch to verify proper functions.

.12 Automatic heat detectors:

.1 Use a heat source reproducible in its intensity, as recommended by the manufacturer of the device, to initiate an alarm.

.2 Test equipment - Heat lamp or Air heater. DO NOT USE AN OPEN FLAME HEAT SOURCE.

.3 Apply heat source as to not damage or operate fusible disc parts.

.13 Automatic smoke detectors - area type:

.1 Test by introducing smoke into its detecting chamber. This may consist of actual smoke from burning materials or artificially generated smoke aerosol spray as recommended by the manufacturer. The sensitivity should be noted and adjusted if necessary.

.14 Automatic smoke detectors:

.1 Examine the air sampling arrangements of the detectors under actual conditions of balanced air circulation by conducting a check of the field sensitivity and a check of the air velocity in accordance with the manufacturers' recommendations.

.2 Test gas to be used similar to Automatic Smoke Detector.

.15 Alarm signals - audible:

.1 Test on main power supply and standby power supply with the maximum expected load on the system.

.2 The audible signalling appliances shall function as intended and shall be audible throughout the building over the background noise present.

.3 Decibel recordings in each area covering 100 sq. metres shall be taken.

.4 The level of sound should usually be 15 dB above ambient noise level.

.16 Alarm signals - visual:

.1 The visual signal appliances shall function as intended and shall be clearly visible.

.17 Fire suppression supervision:

.1 Coordinate with the requirements of Section 21 12 00, and Section 21 13 00.

.2 Sprinkler and standpipe trade to active each sprinkler and standpipe supervisory and alarm device by operating valves and producing flows as required in conjunction with fire alarm technician to observe activation of flow switches, pressure switches, supervised valves, etc.

.18 Annunciators, printers and workstations:

.1 Inspect and operate to establish that their operation in conjunction with the control equipment and other system components, is as intended. The equipment shall be inspected to ensure:

.1 The zone of each alarm initiating device is properly indicated;

.2 The legend is clearly visible;

.3 Adequate voltage under local conditions is present;

.4 Wiring connections have been made in a workmanlike manner.

.5 Proper care must be taken to establish that each item is complete and satisfactory.

.19 Standby power supplies - batteries:

.1 Examine batteries for possible damage and consideration of the following:

.1 The charging system functions as intended;

.2 The installation has not resulted in the bypassing of a fuse or a similar protective device;

.3 The installation protects the batteries from accidental or mechanical damage.

.4 The batteries must be able to operate the fire alarm system with the charger input disconnected for one rated load cycle.

.20 Control equipment and transponders:

.1 Test to establish that they function as intended. The following examinations and tests shall be performed:

.1 A visual and physical inspection of all cables, plug interconnections, plug-in circuit components, lamps, sockets and controls to establish that their mechanical and electrical connections and mounting are as required for intended function and, where applicable, to confirm electrical supervision;

.2 Verification that all field wiring is terminated in a workman-like manner;

.3 All lamps and indicators shall be tested for operation and intended function;

.4 All keypad functions shall be tested for operation and intended function;

.5 All control unit functions shall be operated to verify appropriate response including all software routines and programme functions are simulated;

.6 Simulation of open circuits, short circuits and ground faults on all relevant internal circuits in order to confirm the appropriate supervisory response;

.2 Commissioning Report:

.1 Provide in accordance with requirements of Section 01 91 13, supplemented as specified herein.

.2 Report to include relevant information of the system including:

.3 Each system part described.

.4 How the system is operated.

.5 What functions the system performs.

.6 Requirements for tests and service.

.7 Itemization of all devices connected on the system, their general location.

.8 The date of the performed tests.

.9 All pertinent details of the report sheets requested.

.3 Verification:

.1 The Commissioning Report to be submitted to the Commissioning Manager upon completion of commissioning and will be subject to verification by the Commissioning Manager.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Single stage addressable fire alarm systems.

.2 System testing and verification.

.3 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing, and putting into proper operation a complete Fire Alarm System as shown, as specified, and as otherwise required. Complete system shall be left ready for continuous and efficient satisfactory operation.

1.2 RELATED REQUIREMENTS

.1 Section 21 10 00 – Water-Based Fire-Suppression Systems.

.2 Section 26 05 00 – Common Work Results for Electrical.

1.3 REFERENCES

.1 Definitions

.1 FACP: Fire Alarm Control Panel. This is the central component of a fire alarm/detection/communication system and consists of a control panel(s) and contains the system power supply, system CPU, circuit terminations, and system annunciation functions.

.2 INITIATION DEVICE: Examples are smoke detectors, heat detectors, water flow switches, valve tamper switches, and manual pull stations. These are devices which initiate a signal and send it to the FACP telling it that an abnormal event has taken place. Data Centre extinguishing systems, kitchen hood extinguishing systems, and other special extinguishing system control panels are additional examples of initiating devices.

.3 NOTIFICATION DEVICE: Examples are alarm horns, alarm speakers, and strobe lights. These devices are used to indicate through visual and audible means the existence of an abnormal event throughout all areas of the protected premises.

.4 CONTROL DEVICE: Examples are electronic relays or solenoids. These devices allow the FACP to automatically take certain actions during an abnormal event. For example, the FACP may energize a relay which, in turn, shuts down an air handling unit.

.5 CENTRAL PROCESSING UNIT (CPU): The central computer of a multiplex fire alarm system.

.6 CONCEALED: Where used in connection with installation of piping or conduit and accessories shall mean "hidden from sight" as in shafts, furred spaces, soffits or above suspended ceilings.

.7 EXPOSED: Where used in connection with installation of piping or conduit and accessories shall mean "visible" or "not concealed."

.8 AHJ: Authority Having Jurisdiction.

.9 LISTED: Materials or equipment included in a list published by a nationally recognized laboratory that maintains periodic inspection of production of listed equipment and materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

.10 NFPA: National Fire Protection Association.

.11 CLASS A: Applies to wiring from transponder to central processing unit. The CPU will detect circuit trouble and transponder will retain the ability to transit alarm upon a single fault condition.

.12 CLASS B: Applies to wiring from initiating device to transponder. A trouble signal will be transmitted to the panel upon a single fault condition.

.13 TRANSPONDER: Single or multiple zone/point data collection panel used within a multiplex system.

.14 UL, and ULC: Underwriters Laboratories, Inc., and Underwriters Laboratories of Canada, Inc.

.15 ULC Listed: Materials or equipment listed by Underwriters Laboratories of Canada and included in the most recent edition of the UL and ULC Fire Protection Equipment Directory.

.16 AHU: Air Handling Unit.

.17 FM: Factory Mutual Research Corporation/Factory Mutual Engineering Association.

.2 Reference Standards

.1 The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only. The equipment and installation shall comply with the latest edition/amendment referenced code, standard, or publication.

.1 Canadian Standards Association

.1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (OESC), 27th Edition, 2018.

.3 CSA C22.2 No. 208-14 - Fire Alarm and Signal Cable.

.2 Ontario Regulations

.1 2012 Ontario Building Code.

.2 2007 Ontario Fire Code.

.3 Underwriters Laboratories of Canada Standards

.1 CAN/ULC-S524-14 – Standard for Installation of Fire Alarm Systems.

.2 CAN/ULC-S525 – Audible Signal Appliances for Fire Alarm Systems.

.3 CAN/ULC-S526 – Visual Signal Appliances for Fire Alarm Systems.

.4 CAN/ULC-S527 – Control Units for Fire Alarm Systems.

.5 CAN/ULC-S528 – Manual Pull Stations for Fire Alarm Systems.

.6 CAN/ULC-S529 – Smoke Detectors for Fire Alarm Systems.

.7 CAN/ULC-S530 – Heat Detectors for Fire Alarm Systems.

.8 CAN/ULC-S533 – Egress Door Securing and Releasing Devices.

.9 CAN/ULC-S536 – Inspection and Testing of Fire Alarm Systems.

.10 CAN/ULC-S537 – Verification of Fire Alarm Systems.

.11 CAN/ULC-S548 – Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems.

.12 CAN/ULC-S561-13 – Standard for Installation and Services for Fire Signal Receiving Centres and Systems.

.13 CAN/ULC-S1001-11 (R2018) - Integrated Systems Testing of Fire Protection and Life Safety Systems.

.4 All requirements of the Authority Having Jurisdiction (AHJ).

.2 In the case of any discrepancy between these specifications, the project drawings, and any applicable local codes, the installed Fire Alarm / Life Safety System shall comply with the most stringent requirement.

1.4 ACTION SUBMITTALS

.1 In accordance with Section 26 05 00.

.2 Shop Drawings: Provide annunciator layout and system wiring diagram showing each device and wiring connection required.

.3 Product Data: Provide electrical characteristics and connection requirements.

.4 Test Reports: Indicate satisfactory completion of required tests and inspections.

.5 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

.6 Submit drawings to municipal Fire Department, showing annunciation devices, manual pull stations, complete wiring diagrams and annunciator details and obtain their approval.

.7 Shop Drawings:

.1 Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

.2 Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, and device arrangement.

.3 Show annunciator layout and main control panel module layout, configurations and terminations.

.4 Show device layout, complete riser diagram, and auxiliary functions.

.5 The supplier of the system shall prepare a complete zoning schedule and artwork layout for passive graphic to be included with submittal package.

1.5 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data

.1 Operation Data: Operating instructions.

.2 Maintenance Data: Maintenance and repair procedures.

.2 Record Documentation

.1 Record actual locations of initiating devices, signaling appliances, and end-of-line devices.

.2 Electrical Safety Authority (ESA) inspection certificate.

.3 Fire alarm verification report.

.4 Audibility test.

.3 Manuals

.1 Submit complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets (with model numbers to be used indicated).

.2 Wiring diagrams shall indicate terminals and the interconnections between the items of equipment.

.3 Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment.

1.6 SPARE PARTS

.1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.

.1 Supply six keys of each type.

.2 Supply three of each type of addressable detector base, smoke detector, heat detector, and fire alarm pull station.

.3 Supply three of each type of other installed initiating, notification, or controlling devices.

.4 Supply three of each type of any special tools required for system use and maintenance.

.5 Supply three of each type of signalling device used on the project.

.2 Provide (supply and install) an additional three of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:

.1 Section 28 46 11:

.1 Smoke detectors.

.2 Duct smoke detectors.

.2 Section 28 46.23.11:

.1 Fire alarm horns.

.2 Combination Horn/Strobes.

.3 Section 28 46 41:

.1 Fire alarm speakers.

.2 Combination speaker/strobes.

1.7 QUALITY ASSURANCE

.1 Manufacturer shall examine drawings and specifications prior to award of contract to ensure that detectors, control panels and miscellaneous devices being supplied will provide a satisfactory working installation.

.2 Each and all items of the fire alarm system shall be listed as the products of a single manufacturer under the appropriate category by Underwriters Laboratories of Canada and shall bear the “ULC” label.

.3 The fire alarm control, panel shall meet the modular listing requirements of ULC. Each subassembly of the FACP, including all printed circuit boards, shall include the appropriate ULC modular label.

.4 Each and all items of the fire alarm system shall be covered by a one-year parts and labour warranty covering defects resulting from faulty workmanship and materials. The warranty shall be deemed to begin on the date the system is accepted by the Project Manager on issuance of the substantial performance certificate for the project.

.5 Regulatory Requirements

.1 Provide products listed and classified by ULC as suitable for purpose specified and indicated.

.6 Qualifications of Manufacturer

.1 Equipment and materials shall be provided by an experienced reputable manufacturer to ensure proper specification adherence, final connection, test, turnover, warranty compliance, and service.

.2 The manufacturer is required to have been in the fire alarm industry (service and installation) for a minimum of ten years.

.3 The manufacturer shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall perform the detailed engineering design of central and remote control equipment.

.4 International Standards Organization. The system and all components will be manufactured to ISO 9001 international Quality Management and Quality Assurance Standards.

.5 Manufacturer must have service facilities within a 50 km radius of the installation location.

.7 Qualifications of Installers

.1 All work performed to comply with this specification shall be carried out by and/or managed by a competent firm regularly engaged in the installation and testing of fire alarm systems for commercial buildings. All subcontractors of the contractor including the chosen fire alarm equipment distributor shall also be competent firms which are regularly engaged in the design, installation, testing, and servicing of fire alarm systems for commercial buildings.

.2 Review of cut-sheets, shop drawings, calculations and other materials submitted by the contractor shall not relieve the contractor's responsibility for full compliance with the design drawings and specification unless written approval is requested by the contractor and obtained from the Consultant for each non-complying feature. Finalized agreements for all equipment deviations from the drawings and specification shall be completed prior to award of the installation contract.

.3 For those instances where the contractor cannot conform to the drawings and specification, a proposed variance shall be submitted in writing to the Consultant at least five working days prior to the bidding date. The Consultant will respond to all proposed variances within two working days of receipt.

.4 All questions concerning interpretation of the design drawings and specification shall be submitted to the Owner's purchasing division in writing no later than five working days prior to the bidding date. Requests for interpretations received after this date will not be answered. The Owner's purchasing dvision will respond to all requests for interpretations in writing and will provide a summary of each request and the response to all bidding contractors.

.5 The contractor shall utilize the services of a fire alarm equipment distributor who is a factory authorized representative and a full line stocking distributor of the equipment manufacturer and shall maintain a constant inventory of the parts typical of those used in the system installation covered under this specification.

.6 The contractor, installation subcontractor, and the fire alarm equipment manufacturer or distributor shall each have a minimum of 7 years of continuous experience in the design and/or installation of fire alarm systems and shall have completed a minimum of five projects of similar scope and complexity which were completed using addressable/analog systems. It is intended that these projects incorporated the same equipment, manufacturer and model number, as is being proposed for this project. To verify the qualifications, the contractor, installing subcontractor, and the fire alarm equipment distributor shall submit a brief design narrative which covers at least five fire alarm systems selected for references. This narrative shall indicate the project location, approximate contract value, system size by device counts, and a functional overview. These narratives shall provide an end-user contact name and telephone number for each referenced system. Where a fire alarm equipment distributor is a branch office of a fire alarm manufacturer, the references shall be chosen from projects in which the branch office completed both the design implementation and the installation.

.7 The Owner reserves the right to request documentation from the contractor with respect to any pending litigation against the contractor or any subcontractor. Further, the Owner reserves the right to review an audited financial statement of the contractor or any subcontractor for the most recently completed fiscal year.

.8 The Owner reserves the right to disqualify any contractor who does not comply with all requirements of the Contractor Performance Standard of this specification.

.9 Installer must be certified by the Province of Ontario as a fire alarm installer.

1.1 DELIVERY, STORAGE, AND HANDLING

.1 In accordance with Section 26 05 00.

1.2 WARRANTY

.1 All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one year from the date of acceptance.

2 Products

2.1 MANUFACTURERS

.1 All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.

.1 Notifier by Honeywell; Onyx NFS2-3030 series (as per City of Brampton standard).

.2 All equipment and components shall be the manufacturer's current model.

.3 The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system.

.4 The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

.5 The contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications.

.6 Manufacturer is to support a 20 year product.

2.2 CONDUIT AND WIRE FOR FIRE ALARM SYSTEM

.1 Conduit:

.1 In accordance with Section 26 05 33.13.

.2 Conduit shall be in accordance with the Electrical Safety Authority (ESA), local and provincial requirements.

.3 All wiring shall be installed in conduit or raceway.

.2 Terminal Boxes, Junction Boxes and Cabinets:

.1 All boxes and cabinets shall be listed for their purpose and use.

.3 Fire Alarm Cable

.1 Wiring shall be in accordance with local, provincial and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as outlined in the Ontario Electrical Safety Code and as recommended by the fire alarm system manufacturer.

.2 All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system, as outlined in the Ontario Electrical Safety Code.

.3 Conductors: 300 V rated multiconductor, insulated, colour coded, copper conductor, minimum size to be #16 AWG for device loops and 14 AWG for signal circuits.

.4 Certified by CSA as fire alarm and signal cable type FAS 105 to CSA C22.2 No. 208.

.5 Non-Fire rated cable:

.1 Insulation: 105 degrees C flame retardant PVC

.2 Outer Jacket: 105 degrees C flame retardant PVC Red.

.3 Armour: Interlocking aluminum without overall Jacket. For drops to devices in suspended ceilings from conduit system.

.6 Fire rated fire alarm cable:

.1 Pentair Pyrotenax 1850 series mineral insulated (MI) cable with 2 hour fire rating to ULC S139 and to meet 2012 Ontario Building Code rule 3.2.7.10.

.2 Alternates such as “Lifeline” installed in conduit may only be considered if listed by ULC under ULC Category Code ‘FHJRC’ after October 2014.

.3 Acceptable alternate: VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code ‘FHJRC’, dated 19 May 2015).

2.3 ADDRESSABLE FIRE ALARM SYSTEM

.1 The system to be electrically supervised, non-coded, annunciated, single-stage, addressable fire alarm system using addressable devices.

2.4 FIRE ALARM ANNUNCIATOR PANEL (FAAP) AND GRAPHIC

.1 To Section 28 46 21.22.

2.5 ULC MONITORING TRANSMITTER

.1 To Section 28 46 21.24.

2.6 FIRE ALARM SYSTEM ACCESSORIES

.1 To Section 28 46 25.

2.7 FIRE ALARM INITIATION DEVICES

.1 Automatic Initiating Devices to Section 28 46 31.

.2 Manual Pull Stations to Section 28 46 31 31.

.3 Supervisory Signal devices and Sprinkler Flow Switch alarms to Section 28 46 31.41.

2.8 FIRE-ALARM SUPERVISED INTERFACE HARDWARE

.1 Door Hardware Fire Alarm Integration to Section 28 46 51.08.

.2 HVAC Integration to Section 28 46 51.23.

2.9 SIGNALLING DEVICES

.1 Horns and visual signal devices (strobes) to Section

.2 Horns and Strobes: to Section 28 46 41.

.1 Strobe Frequency

.1 Strobe frequency shall have a maximum of 5 Hz.

.3 Programmable Electronic Sounders:

.1 Shall be flush mounted as required.

.4 Audible/Visual Combination Devices:

.1 Shall meet the applicable requirements listed above for audibility.

.2 Shall have a built in strobe, 75 candela.

.5 Strobe Synchronizing Modules:

.1 Synchronize strobes at 1 Hz and horns at temporal over single wire pan.

2.10 OPERATION SEQUENCE

.1 To Section 28 46 15.

3 Execution

3.1 INSTALLATION

.1 The entire system shall be installed in accordance with the edition of CAN/ULC-S524 as adopted by the applicable legislation, and the manufacturer's manuals and wiring diagrams.

.2 The contractor shall furnish all labour, conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for a complete, functional life safety fire alarm system.

.3 Provide all necessary power supply, interconnecting and remote signal wire in dedicated conduit throughout and installed in accordance with the manufacturer's wiring diagrams and the requirements of the Canadian Electrical Code and the Inspection Authority.

.4 All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes.

.5 Power supply:

.1 Connect fire alarm system power supply to a dedicated circuit.

.2 Circuit breaker(s) feeding fire alarm system to be coloured red, clearly labelled, and be locked in the ON position.

.6 Wiring:

.1 Install all wiring in metal raceways.

.2 Provide wiring suitable for fire alarm circuits.

.1 Class "A" wiring for initiating circuits.

.2 Class "A" wiring for signalling circuits unless noted otherwise.

.3 Provide fire rated cables for fire alarm circuits as required by applicable codes and standards.

.4 Provide separate signalling circuits for audible and visual devices.

.5 End-of-line resistors shall be furnished as required for mounting as directed by the manufacturer on Class B circuits.

.1 Install EOL resistors maximum 1800 mm above finished floor in interior spaces.

.7 Install manual pull stations at 1200 mm above finished floor.

.8 Identification

.1 Provide lamacoid label (white text on red background) for all supporting field devices indicating function of the device.

3.2 FIELD QUALITY CONTROL

.1 The installing contractor shall provide a qualified project superintendent for the overall management and supervision of the work.

.2 The project superintendent shall assure that adequate supervision is provided during all periods of installation of the fire alarm system. The project superintendent and all job site supervisors shall have a minimum of five years of continuous experience in the installation of fire alarm systems of similar scope and complexity.

.3 Upon completion of the installation, the installing contractor shall test all alarm initiating devices, supervisory devices, control devices and notification devices for proper response and effectiveness. Operation of all annunciating devices including the FACP, printer and remote LCD panel shall be verified. Testing shall include thorough sound level measurements of audible notification devices. These tests shall be fully documented. All testing up to the point of conducting the final acceptance tests shall be recorded using a temporary printer. The permanent printer of the system, where such has been provided, shall not be installed prior to the final acceptance tests.

.4 All smoke detectors shall be suitably protected against contamination up to the time of the final acceptance tests.

.5 An itemized test report in accordance with CAN/ULC-S524, CAN/ULC-S536, and CAN/ULC-S537 shall be submitted to the Consultant. This report shall provide complete details of the testing completed for all devices as well as circuit testing parameters. Data shall be submitted indicating the sensitivity level of all system smoke detectors.

.6 Following completion of a 100 per cent system functional test, the contractor shall perform a thorough acceptance test of the system at the direction of and to the satisfaction of the Owner and Consultant. This test shall not be carried out until at least 15 days after completion of all contractor's testing, modification and repairs following the original contractor's functional test and submittal of the functional testing documentation to the Consultant. The 15 day interval is also intended to be a system "burn-in" period. Any false activations of the system which occur within the burn-in period which are determined to be the result of a system fault shall result in the restart of the 15 day period.

.7 In the event that the acceptance test of the system results in the need for system repair or modification, the contractor shall demonstrate the operability of the system to the full satisfaction of the Owner and Consultant following the completion of repairs or modification.

.8 In the event that the AHJ requires a separate demonstration of the operability of the system for acceptance purposes, these additional tests shall be carried out by the Contractor without expense to the Owner.

.9 The contractor shall conduct an independent quality assurance review of all developed "record" drawings to assure accuracy and completeness of these drawings. Any discrepancies shall be brought to the attention of the Consultant prior to construction start.

.10 Only directly prior to verification, remove smoke detector protectors, and clean smoke detectors thoroughly.

.11 Inspect and check each individual device in entire system for proper connection, supervision and function in accordance with CAN/ULC-S537. Identify detectors, manual pull stations and signal appliances not installed within requirements of CAN/ULC-S524 in remarks column of verification report.

.12 Obtain verification certificate and verification report from manufacturer showing each device checked, and that work has been carried out. Utilize standard verification forms similar to Canadian Fire Alarm Association (CFAA) forms.

3.3 ADJUSTING

.1 Contractor to verify programming of room names prior to fire alarm system programming, and allow for a revision to the fire alarm system programming should the Owner or AHJ wish to revise the room names.

3.4 MONITORING

.1 Fire alarm control panel to be located as indicated. Coordinate third party CUL Listed monitoring with Owner.

3.5 MANUFACTURER SERVICES

.1 At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

.2 The manufacturer’s representative shall make an inspection of the fire alarm equipment, including those components necessary to the direct operation of the system such as manual stations, thermal and smoke actuated detectors and controls, whether or not manufactured by the manufacturer. The inspection shall comprise an examination and test of such equipment for the following:

.1 That the type of equipment installed is that designated by the specifications.

.2 That the wiring connections to all equipment components show that the installer undertook to have observed ULC requirements. That all products of combustion (smoke) detectors have been properly calibrated and adjustments set correctly.

.3 That the representative's equipment has been installed in accordance with the manufacturer's recommendations.

.4 That the supervisory wiring of all devices connected to a supervised circuit is operating and that the wiring, having been met to the satisfaction of the inspecting officials.

.3 Testing to be done in the presence of the local building inspector, and the local fire inspector.

.4 The manufacturer(s) of the fire alarm shall make a complete inspection of all existing and new components installed for system(s), such as manual stations, horns, and annunciators and sprinkler and standpipe valves and smoke detectors to ensure the following:

.1 That the system is complete in accordance with Specifications.

.2 That the system is connected according to ULC requirements.

.3 That the system is connected in accordance with the manufacturer's recommendations.

.4 That the regulations concerning the supervision of components have been adhered to (e.g. stations, detectors, supervised valves, bells), and are properly wired and supervised.

.5 That all valves are properly connected and displayed correctly on each annunciator.

.6 That any subsequent changes necessary to conform to the above will be carried out with technical advice supplied by the Manufacturer.

.7 That all thermal detectors, smoke detectors and manual pull stations have been operated and are in good working order.

.8 That all sprinkler system and standpipe system valves have been operated and are in good working order.

.9 That all annunciators correctly pin-pint the origin of any fire alarm.

.10 That actual smoke concentration of sufficient density, have been applied to each smoke detector to cause the detector to be set off and that the sensitivity of each smoke detector has been set.

.11 That all existing devices are in good working order. Include for replacing any defective/damaged devices at no extra cost to Owner.

.12 That signal audibility is acceptable in all areas. Submit audibility readings for every Room.

3.6 SITE TESTS AND INSPECTIONS

.1 Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

.2 All initial testing shall be in accordance with the latest issue of ULC-S537 Verification of Fire Alarm Systems standard.

.3 A representative of the electrical contractor shall be present to participate and assist the manufacturer representative during the course of the verification. The electrical contractor shall make good any deficiencies discovered during the verification. All devices, new and existing, shall be verified. The electrical contractor shall provide one person for assistance with the verification.

.4 The verification report shall be submitted for approval to the Consultant.

.5 On completion of the inspection the manufacturer shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed, supervised and operate in accordance with Article "System Verification".

.6 Audibility Test:

.1 Provide audibility test of signalling devices after other systems have been commissioned to verify operation at ambient sound levels.

.2 Provide audibility test report to the Consultant.

.3 Implement varied tone to suit audibility requirements.

3.7 CLOSEOUT ACTIVITIES

.1 The System Supplier shall schedule and present documented formalized instruction for the building owner, detailing the proper operation and maintenance of the installed System.

.2 The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

.3 The instruction shall cover the schedule of maintenance required by ULC and any additional maintenance recommended by the system manufacturer.

.4 Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

.5 The contractor shall provide for a minimum of three training sessions of two hours in length. At least one of these training sessions shall be carried out for key personnel prior to the system being initially placed on-line for the beginning of the burn-in period.

.6 Three bound copies which summarize the training instruction shall be submitted to the Owner for future reference.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Single stage addressable fire alarm system Sequence of Operation.

1.2 RELATED REQUIREMENTS

.1 Section 28 46 13 – Fire-Alarm Systems.

1.3 CLOSEOUT SUBMITTALS

.1 Manuals

.1 Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment.

2 Products

2.1 OPERATION SEQUENCES

.1 An alarm is caused by actuation of any one of the following devices:

.1 Pulling a manual station.

.2 Operation of an automatic fire alarm detector.

.3 Operation of a sprinkler flow switch.

.4 Operation of a smoke detector.

.2 If, in any area of the building, an alarm is caused by actuation of the aforementioned devices, the following shall occur:

.1 Signals in the building shall sound.

.2 Annunciators shall indicate exact zone where alarm originated.

.3 The activation of a manual pull station, automatic fire detector, automatic smoke detector, or sprinkler flow switch shall initiate the following sequence of operation:

.1 Sound an alarm signal throughout building.

.2 Control panel and remote annunciators shall indicate exact location of alarm via a zoned RED LED.

.3 Fans shall be automatically turned off.

.4 Initiate alarm origin on CPU and at graphic annunciator.

.5 Display the alarm event on all annunciator panels.

.6 Actuate CPU causes evacuation signal to sound and strobes to operate.

.7 The internal audible device shall sound at the control panel.

.8 Signal transmission to external systems:

.1 Transmit signal to monitoring station.

.2 Central station shall be automatically alerted via telephone lines connected for fire alarm system.

.3 Transmit signal to Building Automation System.

.4 Transmit signal to Access Control System.

.9 Door Releases:

.1 All stairwell/exit doors shall unlock throughout the building.

.2 All self-closing fire/smoke doors held open shall be released.

.3 Site entrance and exit gates open.

.10 HVAC Shutdowns:

.1 Shut down air supply and return air fans.

.2 Activate smoke dampers.

.11 CPU indicates trouble when any fault occurs within the system

.4 Alarm

.1 Actuate CPU causes evacuation signal to sound and strobes to operate.

.2 The internal audible device shall sound at the control panel.

.3 Signal transmission to external systems:

.1 Transmit signal to monitoring station.

.2 Transmit signal to Building Automation System.

.3 Transmit signal to Access Control System.

.4 Door Releases:

.1 All stairwell/exit doors shall unlock throughout the building.

.2 All self-closing fire/smoke doors held open shall be released.

.3 Site entrance and exit gates open.

.5 HVAC Shutdowns:

.1 Shut down air supply and return air fans.

.2 Activate smoke dampers.

.5 Supervisory

.1 If, in any area of the building, supervised valves of the sprinkler, systems are operated or exhibit short or open circuits, the following shall occur:

.1 The annunciator shall identify, as a separate zone, the item causing the trouble signal.

.2 The trouble buzzer on the annunciator(s) shall sound.

.3 The signals in the building shall not be sounded.

.2 The activation of a sprinkler supervised valve or pressure switch shall initiate the following sequence of operation:

.1 The control panel and remote annunciator shall indicate exact location of activity via a zoned AMBER LED

.2 Activate an audible tone on the control panel and remote annunciator

.3 The signals in the building shall <u>not</u> be sounded.

.6 Trouble

.1 A short, ground fault or open circuit to any fire alarm conductor, the tamper or removal of any field device or the loss of primary or standby power to any control equipment will result in the following trouble sequence of operation:

.1 The control panel and remote annunciator shall indicate exact location of activity via a zoned YELLOW LED.

.2 Activate an audible tone on the control panel and remote annunciator.

.3 The signals in the building shall <u>not</u> be sounded.

3 Execution – Not Used

End of Section

1 General

1.1 SECTION INCLUDES

.1 Fire alarm annunciator panels.

.1 Main annunicator panel and remote LCD annunicator panels.

.2 Firefighter entrances.

.3 Passive graphics.

1.2 RELATED REQUIREMENTS

.1 Section 21 10 00 – Water-Based Fire-Suppression Systems.

.2 Section 26 05 00 – Common Work Results for Electrical.

.3 Section 28 46 13 – Fire-Alarm Systems.

1.3 REFERENCE STANDARDS

.1 The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only. Comply with the latest edition/amendment referenced code, standard, or publication.

.1 Ontario Regulations

.1 Ontario Building Code.

.2 Ontario Fire Code.

.2 Underwriters Laboratories of Canada

.1 CAN/ULC-S524 – Installation of Fire Alarm Systems.

.2 CAN/ULC-S525 – Audible Signal Appliances for Fire Alarm Systems.

.3 CAN/ULC-S526 – Visual Signal Appliances for Fire Alarm Systems.

.4 CAN/ULC-S527 – Control Units for Fire Alarm Systems.

.5 CAN/ULC-S528 – Manual Pull Stations for Fire Alarm Systems.

.6 CAN/ULC-S529 – Smoke Detectors for Fire Alarm Systems.

.7 CAN/ULC-S530 – Heat Detectors for Fire Alarm Systems.

.8 CAN/ULC-S533 – Egress Door Securing and Releasing Devices.

.9 CAN/ULC-S536 – Inspection and Testing of Fire Alarm Systems.

.10 CAN/ULC-S537 – Verification of Fire Alarm Systems.

.11 CAN/ULC-S548 – Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems.

.12 ULC/ORD 693 – Central Station Fire Protective Signaling.

.3 All requirements of the Authority Having Jurisdiction (AHJ).

.2 In the case of any discrepancy between these specifications, the project drawings, and any applicable local codes, comply with the most stringent requirement.

1.4 COORDINATION

.1 Coordinate between all trades for inclusion of information to be included on passive graphic.

1.5 ACTION SUBMITTALS

.1 In accordance with Section 28 46 13.

.2 Shop Drawings:

.1 Annunciator:

.1 Provide annunciator layout and system wiring diagram showing each device and wiring connection required.

.2 Show annunciator layout and main control panel module layout, configurations and terminations.

.2 Passive Graphic:

.1 Prepare a complete zoning schedule and artwork layout for each passive graphic to be included with submittal package.

.2 Submit colour PDF (electronic submittal) using the identical colours as will be used in a temporary graphic for use during occupancy review by municipal fire inspector.

.3 After occupancy review, incorporate comments from municipal fire inspector, and submit colour PDF (electronic submittal) using the identical colours as will be used in the final production graphic.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 In accordance with Section 26 05 00.

1.7 WARRANTY

.1 All work performed and all material and equipment furnished to be warranted as free from defects and for a period of at least one year from the date of acceptance.

2 Products

2.1 MANUFACTURERS

.1 In accordance with Section 28 46 13.

2.2 FIRE ALARM ANNUNCIATOR PANEL (FAAP)

.1 Annunciator panels will have an alphanumeric display for each detection device, and will identify the detection device initiating an alarm.

.2 Annunciator panel located at the firefighter's entrance will have separate zone indication for each zone.

.3 Install panel in a recessed enclosure with brushed aluminum finish [to suit the construction of the vestibule]. Coordinate exact location and dimensions with Architectural drawings.

.4 Identify emergency exit door numbers/identifiers, and on the control panel/annunciator panel LED labels in order to identify the manual pull stations adjacent to said doors when being activated when cross referenced with the passive graphic.

.1 Coordinate with architectural plans indicating door IDs.

2.3 PASSIVE GRAPHIC DISPLAYS

.1 Provide passive colour graphic display to be mounted adjacent to the fire alarm control panel and each annunciator panel as indicated on the drawings.

.1 Provides building and zone layout while defining zone boundaries.

.2 Visual reference of user's location within the building.

.2 Multicoloured Passive Graphics:

.1 Plastic laminate type, on white background, framed and under glass, 600 mm by 600 mm (24 inch by 24 inch) minimum size.

.2 Different brilliant colours used to distinguish the various fire alarm zones and building outline from one another, silk-screened with durable acrylic-based inks on a white matte 3 mm (1/8 inch) thick acrylic sheet. Use UV protected inks to protect against fading or colour changes for life.

.3 Provide a minimum of six different colours.

.4 Uppercase text, minimum height of 4 mm (0.15 inches).

.5 Graphical display will indicate the following at minimum. Coordinate between all trades for inclusion of this information.

.1 "YOU ARE HERE" indicated in red (unique to each passive graphic location), and properly oriented to the viewer when standing in front of the graphic.

.2 Zone colours to clearly indicate the extents of all fire alarm zones.

.1 Define all egress corridors in a distinctive (dot) black hatch pattern.

.2 All enclosed stairs and elevators to be coloured yellow.

.3 Indicate the extents of zones served by air handling units with shut downs.

.4 Indicate the location of the fire alarm control panel, all annunciators, and network panels/nodes.

.5 Indicate the location and designation of sprinkler and standpipe monitoring devices.

.6 Indicate the location of Sprinkler Room(s), and all supervised fire protection devices. Coordinate with the fire protection trade(s) for exact locations of devices.

.7 Emergency exit doors with door numbers shown. These will be needed to cross reference with the annunciator panel labels for pull stations that are activated next to these doors.

.8 Label all Stair Letters. Designations to match Architectural drawings.

.9 Main gas shut off location.

.3 Frame

.1 Stainless steel frame with concealed mounting hardware and concealed screws

.2 Brushed silver finish.

.3 Concealed security mounting hardware.

.4 Frame to permit future replacement of graphic if the building or zone layouts change in future.

.4 Allow for other requirements per the Authorities Having Jurisdiction, including the Municipal Building Inspector, and Municipal Fire Inspector.

3 Execution

3.1 INSTALLATION

.1 Installation in accordance with Section 28 46 13.

.2 Install annunciators and passive graphics with the top no greater than 1800 mm (70 in) above finished floor.

.3 Install main annunciators with temporary passive graphics in the following locations:

.1 Ground floor main entrance (firefighter's entrance).

.4 Install temporary passive graphic at fire alarm control panel.

3.2 SITE TESTS AND INSPECTIONS

.1 Review passive graphics and annunciators with municipal fire inspector on site during occupancy review. Incorporate any comments and resubmit to Consultant for review.

.2 Include reprogramming of zone nomenclature by system manufacturer to suit municipal review comments.

.3 After review by Consultant, fabricate final passive graphics, and replace temporary graphics on site.

End of Section

1 General

1.1 RELATED REQUIREMENTS

.1 Section 28 46 13 – Fire-Alarm Systems.

1.2 REFERENCES

.1 CAN/ULC-S561:2020 – Installation and Services for Fire Signal Receiving Centres and Systems.

1.3 COORDINATION

.1 Coordinate if the Owner has identified a ULC monitoring company to be used.

.2 Coordinate the installation of the fire alarm monitoring panel with the fire alarm system supplier.

1.4 CLOSEOUT SUBMITTALS

.1 ULC "Fire Protective Signaling Certificate" certificate indicating the monitoring company is in compliance with CAN/ULC-S561.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 In accordance with Section 26 05 00.

2 Products

2.1 ULC FIRE ALARM MONITORING PROVIDER

.1 Provide ULC monitoring transmitter and connect to a monitoring station listed to CAN/ULC-S561.

2.2 TRANSMITTER PANEL

.1 The Fire alarm system shall be provided with a fire alarm monitoring panel that meets ULC-S561 requirements. DSC Fire Alarm Monitoring System or approved equivalent.

.2 The Monitoring System shall be fully redundant cellular / dual internet alarm communication.

.3 Monitoring panel shall be certified for active or passive ULC monitoring and operate on the local cellular 3G networks. System must automatically switch to 2G service should the 3G service fail.

.4 Monitoring Panel shall have an LCD back lit display keypad with AC status indicator. Provide battery back-up for the monitoring panel and energize from a dedicated branch circuit. Provide a red lock-on device for the breaker.

.5 Monitoring shall be provided in a passive configuration to meet ULC S561 requirements. System shall have a dedicated primary telephone line and shall not be shared with any other system in the facility. Provide Cat5 in EMT conduit to the telephone demark in [the telecommunications entrance facility]. Fire alarm system supplier shall be responsible to include a complete system with monitoring for two (2) years after substantial performance.

.6 As part of the fire alarm system shop drawing submission provide information on the monitoring company and confirmation that the monitoring company meets ULC-S561 requirements.

.7 The Monitoring System shall include cellular booster complete with lightning surge protector. Wilson Pro1050 or approved equivalent.

.8 The Contractor is responsible for all wiring from the fire alarm panel to the monitoring panel and from the monitoring panel to the [telecommunications entrance facility]. Cabling shall be as per manufacturer's requirements. All cabling shall be run in conduit.

3 Execution

3.1 INSTALLATION

.1 Provide one dedicated 15A/120 volt circuit for monitoring transmitter at communications entrance facility for use by Monitoring Transmitter and connect fire alarm system outputs to ULC monitoring transmitter.

.2 Post a copy of the ULC certificate at the location of the transmitter.

End of Section

1 General

1.1 SECTION INCLUDES

.1 End-of-Line Devices.

.2 Fault Isolators.

.3 Wire Guards.

.4 Illuminated Signs.

1.2 RELATED REQUIREMENTS

.1 Section 28 46 13 – Fire-Alarm Systems.

.2 Section 28 46 31.31 – Fire Alarm Manual Initiating Devices: manual pull station covers.

1.3 REFERENCES

.1 CAN/ULC-S524-14 – Installation Standard for Fire Alarm Systems.

1.4 UNIT PRICES

.1 Unit price to supply and install wire guard for any fire alarm device.

1.5 CLOSEOUT DOCUMENTS

.1 As-Built Drawings: include location and zone of all End-of-Line devices.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Stock Materials

.1 Provide (supply and install) an additional [five] of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:

.1 Fault Isolators.

.2 End-of-Line devices.

.3 Wire guard.

.2 Spare Parts

.1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.

.1 Supply three of each type of other installed initiating, notification, or controlling devices.

.3 Tools

.1 Supply three of each type of any special tools required for system use and maintenance.

2 Products

2.1 END OF LINE DEVICES

.1 One watt type resistors mounted within outlet boxes separate from those for other devices at the locations indicated. Provide on the cover plate for each such device on approved nameplate, engraved "END-OF-LINE RESISTOR" or with an approved symbol. Provide red lamacoid plate with white 6 mm letters identifying zone.

2.2 FAULT ISOLATORS

.1 Module shall detect and isolate a short-circuited segment of a fault-tolerant loop whilst allowing the rest of the addressing circuit to function normally.

2.3 DEVICE GUARDS

.1 Description: Welded wire mesh of size and shape for the initiation, signaling, or other device requiring protection.

.1 Factory fabricated and furnished by manufacturer of device.

.2 Finish: Paint of color to match the protected device.

.2 Pull station covers: as described in Section 28 46 31.31.

2.4 ILLUMINATED "FIRE DO NOT ENTER" SIGNS

.1 Internally illuminated sign with red LED illuminating text.

.2 Lettering within the sign not visible unless the sign is illuminated.

.3 Display text:

.1 FIRE DO NOT ENTER

.2 Other custom text where specified on drawing.

.4 Designed for 24 VAC/DC with integrated supervisory function.

.5 Manufacturers:

.1 Geographics

.1 GEO-LIS series (indoor use).

.2 GEO-LIS-WP series (outdoor use).

.2 Fire alarm system manufacturer.

3 Execution

3.1 INSTALLATION

.1 Installation to Section 28 46 13 and CAN/ULC-S524.

.2 End-of-Line devices:

ULC-S524-14, Provide End-of-Line devices as directed by the manufacturer. Install 1800 mm above finished floor and provide a label indicating the zone service.

.2 Installation of End-of-Line devices within other field devices: not permitted.

.3 Provide a permanent mark to identify the zone or circuit served by the End-of-Line device.

.3 Fault Isolators:

.1 Provide fault isolators in accordance with CAN/ULC-S524.

.4 Illuminated "Fire Do Not Enter" Signs

.1 Feed illuminated signs from the fire alarm system and provide electrically supervised output circuits.

3.2 FIELD TESTS AND INSPECTIONS

.1 Testing and inspection to Section 28 46 13.

.2 Verification to Section 28 46 13.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Sensors for the detection of Carbon Monoxide (CO) gas.

1.2 RELATED REQUIREMENTS

.1 Section 28 46 13 – Fire-Alarm Systems.

.2 Section 28 46 31.26 – Residential Smoke and Carbon Monoxide Alarms.

1.3 REFERENCES

.1 CSA 6.19-17 – Residential Carbon Monoxide Alarming Devices.

.2 Ontario Building Code.

.3 Underwriter's Laboratories of Canada

.1 CAN/ULC-S529-09 – Smoke Detectors for Fire Alarm Systems.

1.4 CERTIFICATIONS

.1 The CO detector shall be ULC-S529 and CSA 6.19 as Carbon Monoxide alarm device.

2 Products

2.1 MANUFACTURERS

.1 Edwards signature series "SIGA2" devices.

.2 S-Tech.

.3 CO detectors shall be compatible with the system in Section 28 46 13.

2.2 CARBON MONOXIDE SENSORS

.1 The CO element shall be modular and can be replaced when the CO detector reaches end of life, so that the whole detector does not need to be replaced. Detectors that require the complete device to be replaced are not be acceptable.

.2 The CO detector element shall have an integral count-down timer that counts down from 6 years (expected life span of the CO detector component). The detector's processor shall monitor the CO detector component to ensure that if the CO device is out of tolerance before the 6-year time frame, the device will register a trouble condition and identify itself to the control panel.

.3 Devices include, SIGA2-COS, carbon monoxide detector, SIGA2-PCOS, combination Photoelectric/CO detector, SIGA2-PHCOS combination Photo/Thermal/ CO detector as well as SIGA2-HCOS combination Heat/CO detector. The combination devices shall only utilize one detector address and have the ability to separate the device types to a maximum of two different inputs from each addressable detector. It shall be possible to have the smoke detector activate the sounder base only like a smoke alarm and have the heat detector activate the general alarm condition. And if the CO sensor activates, the sounder base must sound the ISO Temporal 4 CO alarm code.

.4 The CO sensor in a sounder base shall be listed as a Carbon Monoxide Alarm to CSA-6.19. Addressable Carbon Monoxide (CO) Detector, EST model SIGA2-COS with audible sounder base. Provide intelligent addressable Carbon Monoxide Detector with Temporal 4 Audible Base.

.5 The CO detection element shall indicate a trouble condition at the FACP signaling end of life and the CO element of the detector shall be field replaceable. It shall be programmed at the main control panel as a supervisory indication and transmit a separate supervisory signal to the central station.

.6 Alternate product for mechanical rooms: S-Tech STCH-1000HW (hard wired alarm, wall mount), and STCH-100HWR (hard wired alarm with relay).

3 Execution

3.1 INSTALLATION

.1 Installation to Section 28 46 13.

.2 Install CO detectors in accordance with 2012 Ontario Building Code, section 6.2.12, and as indicated on the drawings.

3.2 SITE TESTS AND INSPECTIONS

.1 Testing, and inspection to Section 28 46 13.

.2 Verification to Section 28 46 13.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Intelligent Modules.

.2 Fire Alarm Pull Stations for Single Stage Fire Alarm Systems.

1.2 RELATED REQUIREMENTS

.1 Section 21 05 23 - General-Duty Valves for Water-Based Fire Suppression.

.2 Section 26 05 00 – Common Work Results for Electrical.

.3 Section 28 46 13 – Fire-Alarm Systems.

1.3 REFERENCES

.1 CAN/ULC-S528, Manual Stations for Fire Alarm Systems.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Stock Materials

.1 Provide (supply and install) an additional [five] of each manual pull station to be used as directed on site during construction.

.2 Turn over unused surplus in addition to those devices listed below.

.2 Spare Parts

.1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.

.1 Supply 6 keys of each type.

.2 Supply 3 of each type of fire alarm pull station.

.3 Supply 10 manual pull station break-glass rods.

.3 Tools:

.1 Supply three of each type of any special tools required for system use and maintenance.

2 Products

2.1 MICROPROCESSOR BASED INTELLIGENT MODULES

.1 General

.1 Zone Addressable Modules (ZAM) shall be used for the monitoring of water flow, valve tamper, fire suppression control panels, non-addressable detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.

.2 Monitor ZAM's shall monitor any N/O contact device and be capable of powering 2-wire smoke detectors. The ZAM will communicate the zone's status (normal, alarm, trouble) to the transponder. The ZAM's zone address shall be set at the time of installation via a dip switch package.

.3 Control ZAM's shall be able to provide supervised or non-supervised control of any control function. The ZAM will communicate the zone's status (normal, trouble) to the transponder. Each control ZAM shall provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of the relay shall be equipped with a replaceable 2 Amp fuse. The ZAM's zone address shall be set at the time of installation via a dip switch package.

.4 Fire Alarm / Life Safety System shall incorporate microprocessor-based addressable modules for the monitoring and control of system Input and Output functions over a 2-wire electronic communications

loop, using both broadcast and serial polling protocols. All modules shall display communications and alarm status via LED indicators. The function of each connected module shall be determined by the module type, and shall be defined in the system software through the application of a personality code. All addressing of the Microprocessor-based Addressable Modules shall be done electronically, and the electrical location of each module shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the modules will not be dependent on their electrical location on the circuit. All field wiring to the Microprocessor-based Addressable Modules shall be supervised for opens and ground faults and shall be location identified to the module of incidence. Diagnostic circuitry, and their associated indicators, with reviewable Trouble Codes, shall be integral to the Microprocessor-based Addressable Modules to assist in troubleshooting system faults. Each module shall be suitable for operation in the following environment:

.1 Temperature: 0°C to 49°C (32°F to 120°F)

.2 Humidity: 0-93% RH, non-condensing

.2 Single Input Module:

.1 Microprocessor-based Addressable Modules shall be used to provide one (1) supervised Class A input circuit capable of latching operation for use with contact devices, non-damped Waterflow Switches, non-latching supervisory sprinkler switches.

.3 Dual Input Module:

.1 Microprocessor-based Addressable Modules shall be used to provide two (2) independent supervised Class A input circuits capable of operation with contact devices. Both of the input circuits shall be terminated to, and operated from, the same microprocessor-based addressable module.

.2 Modules configured for water flow operation shall have an automatic delay of 15 seconds before reporting the water flow alarm condition to the Fire Alarm Control Panel. The module shall monitor sprinkler supervisory switches and shall automatically report the supervisory function to the Fire Alarm Control Panel each time the associated dry contact closes.

.4 Monitor Module:

.1 The Microprocessor-based Addressable Monitor Module shall be factory set to support one (1) supervised Class A Normally-Open Active Non-Latching Monitor circuit. The module shall automatically report the monitor function to the Fire Alarm Control Panel each time the associated dry contact closes.

.5 Control Relay Module:

.1 Microprocessor-based Addressable Control Relay Modules shall provide one form “C” dry relay contact rated at 2 amps at 24 VDC or 0.5 amps at 120 VAC to, control external appliances or equipment processes. The control relay module shall be rated for pilot duty applications. The position of the relay contact shall be confirmed by the system firmware.

2.2 MICROPROCESSOR BASED ADDRESSABLE MANUAL PULL STATIONS

.1 Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

.2 Stations must be designed such that after an actual activation, they cannot be restored to normal without the use of a special tool.

.3 All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

.4 Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 44 mm (1.75 in) or larger.

.5 All addressing of the Manual Pull Stations shall be done electronically, and the electrical location of each station shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the Manual Pull Station will not be dependent on their electrical location on the circuit.

.6 The manual station shall be suitable for mounting on a North American 38 mm (1-1/2 inch) deep, 100 mm (4 inch) square electrical box with 13 mm (1/2 inch) raised cover.

.7 All Manual Fire Alarm station shall be suitable for operation in the following environment:

.1 Temperature: 0 degrees C to 49 degrees C (32 degrees F to 120 degrees F)

.2 Humidity: 0-93 per cent RH, non-condensing.

.8 Pull Station Cover

.1 All Manual Fire Alarm pull stations shall be provided with a clear, tamperproof, polycarbonate shield and frame that fits over manual pull stations. When lifted to gain access to the actual alarm, it shall sound a 95 dB or 105 dB warning horn.

.2 The cover is connected to the frame by a cable. When the cover is lifted, it hangs off of the frame and the horn will sound until the cover is snapped back onto the frame (or for the life of the battery).

.3 Battery shall be provided for each cover.

.1 Tamper or protecting covers for manual stations shall comply with CAN/ULC-S528, Including Accessories.

.9 Pull stations shall be addressable, single action, non-coded, single stage, semi-flush mounted type.

.10 Provide contacts for connection to magnetic locking devices power supply such that upon activation of the local pull station or first stage fire alarm signal the magnetic locks release.

.11 The approximate location of all initiating devices is shown on the drawings. All existing initiating devices shall not be disturbed unless absolutely necessary to facilitate installation of a new device. No existing devices are to be disturbed without specific authorization by the Project Manager

3 Execution

3.1 INSTALLATION

.1 Installation to Section 28 46 13.

.2 Install manual pull stations at 1200 mm above finished floor.

.3 Where possible, install the manual station on the latch side of a single door at a maximum lateral distance of 1500 mm (59 in) from the door opening.

.4 Install manual pull stations on both sides of a series of doors exceeding 12 m (39 feet) in total width, and within 1500 mm (59 in) of each side of the opening.

3.2 SITE TESTS AND INSPECTIONS

.1 Testing, and inspection to Section 28 46 13.

.2 Verification to Section 28 46 13.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Intelligent Modules.

1.2 RELATED REQUIREMENTS

.1 Section 21 05 13 – Heat Tracing for Fire Suppression Piping.

.2 Section 21 05 23 – General-Duty Valves for Water-Based Fire Suppression.

.3 Section 21 31 00 – Centrifugal Fire Pumps.

.4 Section 23 38 13 – Commercial-Kitchen Hoods.

.5 Section 26 05 00 – Common Work Results for Electrical.

.6 Section 28 46 13 – Fire-Alarm Systems.

1.3 UNIT PRICES

.1 To Section 28 46 13.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Stock Materials

.1 Provide (supply and install) an additional [five] of each of the following fire alarm devices as directed during construction. Turn over unused surplus in addition to those devices listed below:

.1 Zone Addressable Modules (ZAMs).

.2 Spare Parts

.1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.

.1 Supply three of each type of other installed initiating, notification, or controlling devices.

.3 Tools

.1 Supply three of each type of any special tools required for system use and maintenance.

2 Products

2.1 MICROPROCESSOR BASED INTELLIGENT MODULES

.1 General

.1 Zone Addressable Modules (ZAM) shall be used for the monitoring of water flow, valve tamper, fire suppression control panels, non-addressable detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.

.2 Monitor ZAM's shall monitor any N/O contact device and be capable of powering 2-wire smoke detectors. The ZAM will communicate the zone's status (normal, alarm, trouble) to the transponder. The ZAM's zone address shall be set at the time of installation via a dip switch package.

.3 Control ZAM's shall be able to provide supervised or non-supervised control of any control function. The ZAM will communicate the zone's status (normal, trouble) to the transponder. Each control ZAM shall provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of the relay shall be equipped with a replaceable 2 Amp fuse. The ZAM's zone address shall be set at the time of installation via a dip switch package.

.4 Fire Alarm / Life Safety System shall incorporate microprocessor-based addressable modules for the monitoring and control of system Input and Output functions over a 2 wire electronic communications

loop, using both broadcast and serial polling protocols. All modules shall display communications and alarm status via LED indicators. The function of each connected module shall be determined by the module type, and shall be defined in the system software through the application of a personality code. All addressing of the Microprocessor-based Addressable Modules shall be done electronically, and the electrical location of each module shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the modules will not be dependent on their electrical location on the circuit. All field wiring to the Microprocessor-based Addressable Modules shall be supervised for opens and ground faults and shall be location identified to the module of incidence. Diagnostic circuitry, and their associated indicators, with reviewable Trouble Codes, shall be integral to the Microprocessor-based Addressable Modules to assist in troubleshooting system faults. Each module shall be suitable for operation in the following environment:

.1 Temperature: 0°C to 49°C (32°F to 120°F)

.2 Humidity: 0-93% RH, non-condensing

.2 Single Input Module:

.1 Microprocessor-based Addressable Modules shall be used to provide one (1) supervised Class A input circuit capable of latching operation for use with contact devices, non-damped Waterflow Switches, non-latching supervisory sprinkler switches.

.3 Dual Input Module:

.1 Microprocessor-based Addressable Modules shall be used to provide two (2) independent supervised Class A input circuits capable of operation with contact devices. Both of the input circuits shall be terminated to, and operated from, the same microprocessor-based addressable module.

.2 Modules configured for water flow operation shall have an automatic delay of 15 seconds before reporting the water flow alarm condition to the Fire Alarm Control Panel. The module shall monitor sprinkler supervisory switches and shall automatically report the supervisory function to the Fire Alarm Control Panel each time the associated dry contact closes.

.4 Monitor Module:

.1 The Microprocessor-based Addressable Monitor Module shall be factory set to support one (1) supervised Class A Normally-Open Active Non-Latching Monitor circuit. The module shall automatically report the monitor function to the Fire Alarm Control Panel each time the associated dry contact closes.

.5 Control Relay Module:

.1 Microprocessor-based Addressable Control Relay Modules shall provide one form “C” dry relay contact rated at 2 amps @ 24 V DC or 0.5 amps at 120 V AC to, control external appliances or equipment processes. The control relay module shall be rated for pilot duty applications. The position of the relay contact shall be confirmed by the system firmware.

3 Execution

3.1 INSTALLATION

.1 Installation to Section 28 46 13.

3.2 SITE TESTS AND INSPECTIONS

.1 Testing, and inspection to Section 28 46 13.

.2 Verification to Section 28 46 13.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Fire Alarm Horns.

.2 Fire Alarm Strobes.

.3 Combination Horn/Strobes.

1.2 RELATED REQUIREMENTS

.1 Section 26 05 00 – Common Work Results for Electrical.

.2 Section 28 46 13 – Fire-Alarm Systems.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Stock Materials

.1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.

.1 Supply three of each type of signalling device used on the project.

.2 Spare Parts

.1 Provide (supply and install) an additional [five] of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:

.1 Fire alarm horn.

.2 Fire alarm strobes.

.3 Combination horn/strobes.

.3 Tools

.1 Supply three of each type of any special tools required for system use and maintenance.

1.4 CERTIFICATIONS

.1 All appliances which are supplied for the requirements of this specification shall be ULC Listed.

.2 All appliances of the same manufacturer as the Fire Alarm Control Panel specified to ensure absolute compatibility between the appliances and the control panels, and to ensure that the application of the appliances are done in accordance with the single manufacturer's instructions.

.3 Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purpose intended.

2 Products

2.1 HORNS

.1 Vibrating horn: semi-flush mounted, 24 VDC, selectable 94 dBA or 98 dBA, suitable for installation in a standard electrical box.

.2 Red enamel typical, or white enamel as indicated on the drawings, and as confirmed by the Owner.

2.2 HORN-STROBES

.1 Vibrating horn: semi-flush mounted, 24 VDC, selectable 94 dBA or 98 dBA, suitable for installation in a standard electrical box.

.2 Red enamel typical, or white enamel as indicated on the drawings, and as confirmed by the Owner.

.3 Provide horn-strobes where shown on plans and drawings. Strobe output shall be determined as required by its specific location and application from a family of 15/75 cd, 30 cd, and 110 cd devices. Strobes shall provide a synchronized flash.

.4 Strobes shall be 24 VDC and ULC listed.

.5 Strobe circuits shall be coordinated with audible circuits such that activation of an audible circuit results in activation of the companion strobe circuit. The strobe circuits shall be capable of being arranged such that they continue to operate in the event that the audible circuits have been silenced and remain operating until the FACP has been reset. Strobe circuits should also be coordinated with the audible circuits such that they are zoned in the same manner as the audible circuits

.6 All strobes and combination horn strobes shall be mounted such that the bottom of the device is mounted 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower.

2.3 STROBES

.1 Strobes shall be supplied where shown on plans and drawings. Strobe output shall be determined as required by its specific location and application from a family of 15/75 cd, 30 cd, and 110 cd devices. Strobes shall provide a synchronized flash.

.2 Size strobe power supplies based on all strobes set at 75 cd with exact setting determined in the field to provide adequate visual signals in accordance with CAN/ULC-S524.

3 Execution

3.1 INSTALLATION

.1 Installation to Section 28 46 13.

3.2 SITE TESTS AND INSPECTIONS

.1 Testing, and inspection to Section 28 46.21 11.

.2 Verification to Section 28 46 13.

End of Section

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for earthwork Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

.2 ASTM D4253, Test Method for Maximum Index Density and Unit Weight of Soil Using a Vibratory Table.

.3 OPSS, Ontario Provincial Standard Specification.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations of insulation boards, vibration isolator, filter fabric and other specified non-granular items.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Adjacent construction, elevations, sections and details, dimensions, and relationship to adjacent construction.
  - .2 Include design calculations, design concept, construction method, sequence and means by which existing structures, utilities and equipment will be protected; Location of in-use, maintained, re-routed and abandoned underground lines.

.3 Reports:
- .1 Submit written laboratory test reports.
- .2 Submit written field inspection and test report results after each inspection.

.4 Submit dewatering methods 30 days in advance for review by Consultant. If well point system is required, Engineer shall design system and supervise installation.

.5 Submit to Consultant details of locations where surplus soils and other materials are to be disposed of or reused. Include each disposal/reuse Site and type of surplus soil or other material, location of the disposal/reuse Site, operator's name and business address, type of license under which Site operates, and criteria used by Site to access suitability of surplus material for disposal.

.6 Submit to Consultant, within 48 hours of a load of surplus soil or other material leaving the Site, a daily register recording the time and place of disposal/reuse of each load signed by a representative of the disposal site. Such documentation must be submitted before payment for excavation will be made.

1.4 QUALITY ASSURANCE

.1 Have shop drawings signed and sealed by a Professional Engineer licensed in Province of Ontario and having experience in design and inspection of shoring, bracing, underpinning and dewatering (if required) required to complete Work.

1.5 SITE CONDITIONS

.1 Geotechnical conditions: For information on subsurface conditions refer to document appended to Section 02 32 00.

.2 Cultural heritage resources: If Cultural Heritage Resources (such as archaeological sites, artifacts, building and structural remains, and/or human burials) are encountered during performance of Work, contact Consultant immediately and suspend Work in immediate area until assessment has been completed by Ministry of Culture, Tourism and Recreation. Perform required measures to mitigate negative impacts on found resources to acceptance of Consultant.

1.6 PROTECTION

.1 Existing buried utilities and structures:
- .1 Size, depth and location of known existing utilities and structures are indicated for guidance only. Completeness and accuracy is not guaranteed.
- .2 Prior to commencing any excavation Work, have authorities stake out utility locations to prevent disturbance during Work.
- .3 Confirm locations of buried utilities by careful test excavations. Hand dig test excavations as necessary.
- .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain permission of Consultant before moving or otherwise disturbing utilities or structures.

.2 Existing buildings and surface features:
- .1 Conduct with Consultant, a condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by Work.
- .2 Protect existing buildings and surface features which may be affected by Work from damage while Work is in progress and repair damage resulting from Work.
- .3 Where excavation necessitates root or branch cutting, perform Work in accordance with Authorities having Jurisdiction.
- .4 Confirm with Consultant, condition Survey of buildings and structures undertaken by Consultant.

.3 Temporarily cover local existing catch basins and maintenance holes to prevent entry of earth or debris. Ensure adequate surface drainage in affected area is maintained.

.4 Protect Work or work of other Contracts in progress or completed and protect existing properties, stored Products, services, utilities, trees, landscaping and natural features from damage.

.5 Protect excavations against flooding and damage and install and maintain appropriate warning devices during construction and during time when Work is closed down for any cause.

.6 Protect bottom of excavations that will support foundations, slabs, pavements etc. from frost or freezing.

.7 Keep access roads clear of debris and dirt resulting from Work of this Section to acceptance of Authorities having jurisdiction.

.8 Shoring, bracing and underpinning: Comply with local regulations, authorities having jurisdictions and requirements specified.

2 Products

2.1 **MATERIALS**

.1 Select fill: Subject to approval of Consultant consisting of reusable fill excavated from Site or imported fill that is free of organic matter, rubble and material other than soil. Maximum particle size of half thickness of lift specified, moisture content at time of placing 2% maximum over its optimum moisture content and is either non plastic or has a plasticity index of 25% maximum.

.2 Granular A fill: Imported Granular A fill, free of organic matter and, in accordance with OPSS 1010.

.3 Granular B Fill: Imported Granular B fill free of organic matter and in accordance with OPSS 1010.

.4 Clear Stone fill: 19 mm clear stone in accordance with OPSS 1004, free of organic material.

.5 Unshrinkable fill: 0.7 MPa cement stabilized backfill conforming to requirements of CAN/CSA A23.1/A23.2-M.

.6 Dewatering equipment: Equip submersible pumps with filters and/or screens to prevent ground loss. Maintain filters in good operating condition.

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 **LINES AND ELEVATIONS**

.1 Establish lines and elevations from Control Points shown on Contract Drawings.

.2 Have lines and elevations established by Registered Ontario Land Surveyor or qualified Civil Engineer registered in Province of Ontario.

.3 Protect and maintain Control Points and Bench Marks as long as they are required.

3.3 **STRIPPING**

.1 Do not handle topsoil while in wet or frozen condition or in manner in which soil composition is adversely affected.

.2 Strip topsoil from working area in locations shown.

.3 Strip topsoil to depths indicated. Avoid mixing topsoil with subsoil.

.4 Stockpile topsoil in locations directed by Consultant. Stockpile to height not exceeding 2 m. Remove excess topsoil from Site.

3.4 **REMOVAL OF WATER**

.1 Obtain letter of conditional approval from Authorities having Jurisdiction to dispose of ground water into sewer drainage system. Apply for and pay for water disposal permit.

.2 Keep excavations and trenches free of water throughout construction period.

.3 Groundwater removal:

.1 Lower groundwater level and maintain at depth below lowest point of excavation to ensure a dry stable surface.

.2 Dewater to prevent loss of soil and maintain stability of sides and bottom of excavation and of adjacent structures.

.3 Dispose of water in conformance with applicable by-laws and in a manner not detrimental to public and private property, or portion of Work completed or under construction.

.4 Supply and install flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to sewers, water courses or drainage areas in accordance with authorities having jurisdiction. Perform testing on settlement tank discharge to confirm that effluent meets sewer bylaw requirements. Locate tanks to acceptable area determined by Consultant.

.5 Should method of dewatering fail to achieve conditions specified above, Consultant reserves right to revise methods and procedures at no cost to Owner.

.4 Surface water removal:

.1 Remove surface run-off in a manner that will prevent loss of soil and maintain stability of sides and bottom of excavation. Obtain Consultant's approval of dewatering method to be used.

.2 Discharge surface water into existing storm drainage system to acceptance of Consultant and local authorities.

.5 Do not obstruct flow of surface drainage or natural water courses.

3.5 EXCAVATION

.1 Remove concrete, masonry, paving, demolished foundations and rubble and other obstructions encountered during excavation Work.

.2 Do not disturb soil within drip line of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw in a manner acceptable to authorities having jurisdiction.

.3 Excavate to required lines and grades shown on Contract Drawings with allowance for subsequent Work including shoring, bracing and formwork. Make excavation clean and clear of loose material and true to size.

.4 Protect stockpiles of fill against contamination and moisture absorption.

.5 Do not undermine adjacent structures. Where it is necessary to have footings at different levels, found upper footing below imaginary 10-horizontal-to-7 vertical line, or as otherwise indicated, drawn up from base of lower footing. Protect adjacent foundations from frost.

.6 Have excavations in excess of 1200 mm in depth conform to requirements of Occupational Health and Safety Act, and Regulations for Construction Projects.

.7 Do not expose shale at subgrade elevation to drying cycles and in any case, following inspection, cover with minimum 50 mm of lean concrete within 4 hours after exposure.

.8 Fill excavations for foundations which are, through error, carried below elevation shown or approved depth, with 15 MPa concrete, or as directed by Consultant.

.9 Trim, and remove loose material, debris and organic material from excavations. Where material at bottom of excavation is disturbed, remove disturbed material and re-compact to density equal to or better than undisturbed soil or backfill with lean concrete as directed by Consultant.

.10 When excavations are complete, prior to commencement of subsequent Work, request Consultant for inspection of excavation Work.

3.6 TRENCHING

.1 Excavate trenches to lines and grades indicated and to a depth of 75 mm minimum below invert elevation and slope established for pipe, and backfill to invert elevation of pipe with specified granular material.

.2 Unless otherwise authorized by Consultant, 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. Remove unsuitable material from trench bottom to extent and depth as directed by Consultant.

.3 Backfill over-excavation with granular material and compact.

.4 If unstable soil conditions are encountered, excavate trenches to depth directed by Consultant and backfill to correct elevation with backfill material.

.5 Remove loose material from bottom of trenches to ensure granular material is placed against undisturbed soil.

.6 Compact bedding and grade as required for even and uniform support on each length of pipe.

.7 Where excavating is required adjacent to and parallel with and below any footing, submit excavation and backfill procedures to Consultant for review prior to start of excavating.

.8 Keep width of trenches to a minimum to ensure minimum span for pipe to be supported.

.9 Make excavations for fire hydrants of sufficient size and depth to accommodate a minimum 0.75 m^3 of crushed stone. Hand place stone and tamp around and below hydrant elbow to ensure proper drainage of hydrant.

3.7 EXCAVATED MATERIAL DISPOSAL

.1 Except for material to be used as select fill, immediately remove and dispose of excavated material from Site.

.2 Remove and dispose of construction rubble, abandoned gas, water and sewer pipes, valves, valve boxes and fittings, maintenance holes, frames and covers and other material which may be encountered during excavation but not indicated on Contract Drawings.

3.8 **BACKFILLING**

.1 Do not proceed with backfilling operations until walls, slabs, waterproofing and below grade Work has been inspected and accepted by Consultant.

.2 Backfill areas which are free from debris, snow, ice, water and frozen ground.

.3 Do not use backfill material which is frozen or contains ice, snow or debris.

.4 Do not backfill on or against any membrane or protection board covered waterproofing with jagged rock or other sharp objects which might damage waterproofing.

.5 Limit vertical drop of backfill material to 2000 mm.

.6 To avoid pockets and voids, remove sheathing and shoring materials that require removal, as backfilling progresses.

.7 Prior to backfilling or placing concrete on exposed soil subgrade, proof roll subgrade to identify soft or loose areas. Proceed with placing backfill or concrete only after inconsistencies identified by above procedure have been reworked and compacted or excavated, backfilled and compacted as required to eliminate such conditions to acceptance of Consultant.

.8 Place backfill material, grade and compact to levels shown on Contract Drawings.

.9 Place backfill materials in uniform layers 200 mm maximum loose thickness unless specified otherwise.

.10 Ensure each layer is compacted, and accepted by Consultant, before placing succeeding layers.

.11 Unless otherwise indicated, use specified granular material from bottom of trench to 300 mm above top of pipe or 150 mm above top of electrical conduits. Hand place in 150 mm layers and compact carefully to ensure proper backfilling and compaction around bottom quadrants and sides of pipe.

.12 For backfill from 300 mm above top of pipe or 150 mm above electrical conduits to sub-grade level, use select fill unless otherwise noted. Compact either by hand or by machine.

.13 Do not backfill trenches until piping, conduits and cables therein have been inspected, tested, and approved by inspection authorities having jurisdiction and Consultant.

.14 Prior to backfilling of trenches, remove wood block or wedges used to prevent movement of piping during tests.

.15 Where there is a common boundary between select fill and granular fill or unshrinkable fill, place select fill after granular fill has been compacted. Place and compact fill around free standing structures evenly on all sides of structure simultaneously in layers sloping away from structure.

.16 During backfilling, take care to avoid displacing or damaging Utilities Work and Services.

.17 Notify Consultant prior to commencement of backfilling and compacting operations.

3.9 COMPACTION

.1 Compaction densities for select fill, granular fill, and sand fill materials will be determined by ASTM D698. Compaction densities for clear stone and pea gravel will be determined by ASTM D4253.

.2 Add water if necessary to obtain required densities. Correct irregularities or depressions that may develop during compaction by removing or adding material to form a smooth and uniform surface.

.3 Shape and roll alternately to obtain smooth, even and uniformly compacted base.

.4 If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.

.5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers acceptable to Consultant.

.6 Compact backfill materials as follows:
- .1 Imported fill: 98% standard Proctor maximum dry density (SPMDD).
- .2 Under slabs, walks and pavements: 100% (SPMDD).
- .3 All other areas: 95% (SPMDD).

3.10 GRADING

.1 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

.2 Place material only on clean unfrozen surface, properly shaped and compacted and free from snow and ice. Ensure no frozen material is used in placing.

.3 Grade as necessary to bring Work areas to required elevations. Supply additional material required to obtain new grade levels. Place and compact as specified.

.4 Grade drainage ditches to elevations indicated on Contract Drawings.

.5 Maintain positive drainage.

.6 Grade materials using methods which do not lead to segregation or degradation of aggregate.

.7 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.8 Remove and replace that portion of layer in which material becomes segregated during spreading.

.9 Slope grade away from buildings 1:50 minimum.

.10 Make graded areas smooth to profile, free of debris, with local excavations and depressions filled and compacted.

.11 Do not disturb soil within branch spread of trees and shrubs remaining.

.12 Cultivate entire area which is to receive topsoil to a depth of 100 mm. Repeat cultivation in those areas where equipment used for hauling and spreading has compacted soil.

.13 Remove surface debris, roots, vegetation, branches and stones in excess of 50 mm in diameter.

3.11 UNSHRINKABLE FILL

.1 Place unshrinkable fill in locations indicated on Contract Drawings or where Work area is too limited to permit proper placing and compaction. Obtain Consultants approval prior to placing unshrinkable fill. Place in accordance with supplier's written instructions.

.2 If embedded items occur in area being backfilled, coordinate with appropriate trades to ensure that disturbance of embedded items during backfilling is prevented.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 30 00 – Cast-in-Place Concrete.

1.2 REFERENCE STANDARDS

.1 ASTM D698, Standard Proctor Test

.2 ASTM D2321, Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

.3 Occupational Health and Safety Act and Regulations for Construction Projects with respect to trench excavation.

2 Products

2.1 BACKFILL MATERIALS

.1 Primary backfill material:

.1 Granular 'B' material compacted in 150 mm (6") lifts to achieve 95% modified Proctor compaction.

.2 Secondary backfill material:

.1 Granular 'A' material compacted in 150 mm (6") lifts to achieve 95% modified Proctor compaction.

.3 Final backfill material:

.1 Lean course granular material, free of stones larger than 25 mm (1") in size, organics, silt, rubble and clay lumps.

.2 Laid down and compacted in layers of not more than 600 mm (4").

.3 May include native soil, if approved.

2.2 CONCRETE WORK

.1 As specified in Section 03 30 00.

3 Execution

3.1 EXAMINATION

.1 Position and extent of existing underground services and other services shown have been taken from available information. Check field conditions and report any discrepancies before commencing work. Engage services of water supply, drainage, electric supply, telephone, and gas authorities to assist in checking services on and around site.

.2 Perform locates for all existing underground services. Submit report to Owner and Consultant a minimum of five business days prior to commencing excavation.

3.2 EXCAVATION

.1 Saw cut pavements, curbs and sidewalks before proceeding with excavation. Layout cuts for approval before commencing work.

.2 Prepare excavation for underground services of depth and dimensions so that no portion of any pipe bears directly against any rock or other hard surface.

.3 Cut and trim banks of excavations and shore to prevent caving in. Limit width of excavation from "crown" of pipe down to invert to twice outside diameter of pipe for pipe diameters up to 100 mm (12"). For larger sizes limit width of excavation to outside diameter of pipe plus 100 mm (12 inches).

.4 Break up and remove rocks and boulders from excavation. Use drilling and wedging to remove rock encountered in trench. Blasting will not be allowed unless approved and authorized in writing.

.5 Store materials excavated during progress of work to produce minimum of damage or disfigurement of existing ground.

.6 Keep sides and bottoms of excavations from freezing and protect work from damage due to weather conditions. Excavate in limited lengths to enable protective and heating measures to function efficiently during pipe laying, testing and backfilling.

.7 Backfill trenches or provide sheeting, sheet piling or bracing to support trench walls and fence perimeter of work area or cover trench opening with steel plates when work area is not supervised.

3.3 PIPE LAYING AND SUPPORT

.1 Bedding class for buried piping to be as defined in Canadian Pipe Institute, Standard Specification.

.2 Grade bottom of excavations for pipes to achieve specified slope.

.3 Inside building:

.1 Form bottom of trench in earth so that pipe is supported on solid bed of undisturbed earth free from stones or debris exceeding 25 mm (1 inch) in diameter. Shape earth to fit lower one-third segment of pipes and hubs, care being taken to ensure even bearing along barrels.

.4 Outside building:

.1 Form bottom of trench in earth so that pipe is supported on Class "B" bedding.

.2 Support piping installed in unstable or filled ground on Class "A" 15 MPa (2500 lb) concrete bedding.

.5 Grade bottom of excavations for pipes to achieve specified slope. Place pipe and fittings in trench with invert conforming to elevations, slopes and alignment.

.6 On grades exceeding 10 per cent, pipe to be laid uphill with compacted fill "collars" at each joint to prevent line movement in trench.

.7 Support piping, conduits and duct banks passing through backfill at building foundation walls and at manholes and catch basins on 150 mm (6 in) thick reinforced concrete pads. Dowel concrete pads into side of manholes and catchbasins and extend sufficiently to obtain minimum bearing of 600 mm (2 feet) on undisturbed ground.

.8 Where excavation has been carried to greater depth than required, replace with Primary Fill or 10 MPa (1500 lb) concrete, to give bearing value equal to that provided by adjacent undisturbed soil.

.9 Do not lay pipe in standing or running water. Prevent surface run-off from entering trench.

.10 When ground water is present in work area, dewater by bailing or pumping to maintain stability of trench and backfilled areas, and control water level below pipe bedding. Maintain control of water in trench before, during and after pipe installation, and until sufficient backfill has been placed to prevent floatation of pipe.

.11 When pipe laying is interrupted, secure piping against movement and seal open ends to prevent entrance of water, mud, debris or foreign material

3.4 WALL PENETRATIONS

.1 Over excavate trench one and half pipe diameters below invert for distance of 600 mm (2 feet) from face of wall.

.2 Pipe to be fitted through steel sleeve that is minimum 50 mm (2") larger in diameter than pipe.

.3 Fit link seal between sleeve and pipe and tighten.

.4 Backfill over excavated area up to invert of pipe with compacted pea gravel, crushed stone, or crushed gravel with grain size of less than 25 mm (1").

.5 Backfill remainder of trench in accordance with procedures described below.

3.5 BACKFILLING

.1 Do not commence backfilling over services until testing is complete and reviewed and approved by the Building Inspector and/or Consultant.

.2 Do not use frozen material for backfilling nor place any backfilling on or against frozen earth.

.3 Under building floors, roads, curbs, walks, and paved areas:

.1 Backfill trench with Primary Fill brought up to top of trench.

.4 In other locations:

.1 Backfill trench with Primary Fill brought up to level 70% of pipe diameter above invert. Then backfill with Secondary Fill up to height of at least 600 mm (2 ft) above top of pipes. Fill remainder of trench with Final Fill watered and consolidated in one foot layers.

.5 Spaces around manholes, sumps, and catchbasins:

.1 Backfill with Primary Fill brought up to height of at least 600 mm (2 feet) above top of pipes. Fill remainder of trench with Final Fill watered and consolidated in one foot layers. Consolidate material carefully so that walls are not damaged and support provided for piping entering or leaving concrete structure is undisturbed.

.6 Backfill excavation in close proximity to and below any footing level with 10 MPa (1500 lb) concrete to level of top of highest adjacent footing.

.7 Withdraw shoring before backfilling and fill voids left on removal of supports with Primary Fill.

.8 Minimize localized loadings and differential settlement wherever pipe crosses other utilities or subsurface structures, or wherever there are special foundations such as concrete capped piles or sheeting. Provide cushion of Primary Fill bedding between pipe and any subsurface structure.

3.6 RESTORATION OF WORK AREA

.1 Make up settlement of backfill in roads and walks as it occurs so that regular traffic in and around work is not inconvenienced.

.2 After period adequate to reveal settlement has passed fill depressions to restore correct grade.

.3 Remove and dispose of excess excavated material, and leave site clear and unencumbered.

.4 Make good damage to:

.1 Roads, curbs, lawns, walks, and paved areas caused by excavation, backfill, settlement and subsequent restoration.

.2 Existing underground piping, conduit or other services uncovered during excavation.

End of Section

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for concrete curbs and pavements Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A185/A185-M, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

.2 ASTM C260, Specification For Air-Entraining Admixtures For Concrete.

.3 ASTM C309, Specification For Membrane-Forming Compounds for Curing Concrete.

.4 ASTM C494/C494-M, Specification For Chemical Admixtures For Concrete.

.5 ASTM D994, Specification For Preformed Expansion Joint Filler For Concrete (Bituminous Type).

.6 CAN/CSA A23.1/A23.2-M, Concrete Materials and Methods of Concrete Construction/Methods of Tests For Concrete.

.7 CAN/CSA A3000, Cementitious Materials Compendium.

.8 CAN/CSA G30.18-M, Billet-Steel Bars for Concrete Reinforcement.

.9 CSA O121, Douglas Fir Plywood.

.10 CAN/CSA S269.3-M, Concrete Formwork.

1.3 **DESIGN REQUIREMENTS**

.1 Concrete: 30 Mpa unless otherwise indicated on drawings. Exterior concrete to have 5-7% entrained air.

.2 Design concrete so that material will not segregate and excessive bleeding will not occur.

.3 Comply to the MTC Manual of Uniform Traffic Control Devices for signs and flagging when working within existing road ways. Any requirements to restrict local traffic due to the contractors works, must be reviewed and approved by the Consultant.

1.4 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 for each material indicating:
  - .1 Performance criteria, compliance with appropriate reference standard(s), and characteristics.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating elevations, sections, details, materials, joint assemblies, finishes and relationships to adjacent construction.

1.5 **QUALITY ASSURANCE**

.1 Inspection and testing:
- .1 Materials: CAN/CSA A23.1/A23.2-M; Inspect and test for conformance to requirements of this Standard and to Specifications.
- .2 Tests will be made in accordance with CAN/CSA A23.2-M.
- .3 Remove defective materials and completed Work which do not conform to the Contract Documents.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver and store materials on Site in accordance with CAN/CSA A23.1/A23.2-M.

1.7 **SITE CONDITIONS**

.1 Conform to CAN/CSA A23.1/A23.2-M.

.2 Do not deposit concrete on frozen ground. When deposited in forms concrete shall have a temperature between 10°C and 30°C and these limits shall be maintained for 72 hours.

2 Products

2.1 **MATERIALS**

.1 Forms: Plywood to CSA O121, G1S; Douglas Fir plywood, seven ply, exterior grade, waterproof glue, edges sealed with oil based sealer.

.2 Form ties: Adjustable snap ties, formed to break 25 mm or more from surface of concrete after form removal, with a minimum working strength of 1360 kg.

.3 Form release agent: 100% biodegradable, chemically active, VOC compliant, 'Bioform' by Universal Building Product or approved alternative.

.4 Reinforcing steel: CAN/CSA G30.18-M; Billet-steel bars, deformed unless indicated otherwise, Grade 400R.

.5 Welded steel wire fabric: ASTM A185/A185-M; Resistance welded in size and spacing shown for smooth wire fabric, in flat sheets only.

.6 Chairs, bolsters, supports, spacers: CAN/CSA A23.1-M with sufficient strength to rigidly support weight of reinforcement and construction loads. Manufactured by NCA/Acrow - Richmond or Dayton Superior.

.7 Cement: CAN/CSA A3000; Portland, Type 10.

.8 Coarse and fine aggregate: CAN/CSA A23.1/A23.2-M.

.9 Water: CAN/CSA A23.1/A23.2-M.

.10 Water reducing admixture: ASTM C494/C494-M, Type A.

.11 Set retarding admixture: ASTM C494/C494-M, Type D.

.12 Air entraining admixture: CAN/CSA A23.1/A23.2-M and ASTM C260.

.13 Pigmented curing compound: ASTM C309, Type 2, Class B; White pigmented resin based.

.14 Joint filler: ASTM D994, Asphalt impregnated; ‘Asphalt Joint Expansion Joint Filler’ by W. R. Meadows Ltd., in thickness shown on Contract Drawings. Furnish kraft paper or polyethylene sheet as bond breaker between sealant and joint filler

.15 Joint Sealant: Two component, non-tracking, chemically reactive urethane/coal tar modified sealant; ‘Sealtight Gardox’ by W. R. Meadows Ltd. or ‘Vulkem 202' by Tremco.

.16 Bonding Agent: Furnish ‘Sika-Dur’ by Sika, or ‘Intralock’ by W. R. Meadows.

2.2 MIXES

.1 Acceptance of any concrete mix proportion or material, does not preclude its future rejection if it is subsequently found to lack uniformity, or if it fails to conform to requirements specified, or if its field performance is found to be unacceptable.

.2 Mix concrete and concrete proportions in accordance with CAN/CSA A23.1/A23.2-M.

2.3 ADMIXTURES

.1 Use admixtures for concrete from single manufacturer, unless otherwise acceptable to Consultant.

.2 Have manufacturer certify that admixtures are compatible.

.3 Add admixtures to concrete mix in accordance with manufacturer's recommendations.

.4 Except as specified otherwise, comply with requirements of CAN/CSA A23.1/A23.2-M.

.5 Use of calcium chloride or additional admixtures, other than those specified, is not acceptable.

3 Execution

3.1 **GENERAL**

.1 Give Consultant at least 2 working days notice prior to placement of concrete to permit a review of compaction, placement of formwork, reinforcing steel, and associated items embedded in concrete for conformance to reviewed shop drawings and Contract Documents.

.2 Do not place concrete on surfaces which contain frost, water or debris.

.3 Provide concrete curb cuts and sidewalk handicap access ramps as indicated, in accordance with the authorities having jurisdiction.

3.2 **PREPARATION**

.1 Verify grades of items set in paving area for conformity with elevations and sections before placing granular base and subbase material.

.2 Obtain approval of subgrade by Consultant before placing granular subbase and base.

.3 Set out work from lines and levels shown on drawings.

.4 Prevent damage to adjacent and/or existing buildings and/or properties, and existing curbs, sidewalks and asphalt paving.

.5 Accurately saw-cut and modify existing sidewalks to nearest adjacent dummy/expansion joint as directed on site by Consultant.

.6 Remove and dispose of debris from the work of this section in accordance with authorities having jurisdiction.

.7 Fine grade, shape and compact subgrade to minimum of 95% Standard Proctor Density.

.8 Wet base immediately in advance of concreting to ensure a firm moist surface without ponding.

.9 Repair damage to base resulting from hauling or equipment operations.

3.3 **FORMWORK**

.1 Construct formwork in accordance with CAN/CSA S269.3-M to produce finished concrete conforming to shape, dimensions, locations and elevations indicated. Ensure no lumber remains in concrete.

.2 Set forms true to line and grade, join neatly and tightly, and stake securely to resist concrete pressure and impact from tampers without springing.

.3 Apply release agent by spray in accordance with manufacturer's recommendations. Ensure form surfaces receive a uniform coating.

3.4 REINFORCING

.1 Place reinforcing steel as shown on reviewed shop drawings and in accordance with CAN/CSA A23.1-M. Make bars as long as possible.

.2 Make splices in locations shown on Drawings. Lap lengths in accordance with CSA A23.3 unless otherwise shown.

.3 Lap ends and sides of wire fabric not less than 150 mm.

3.5 PLACING OF CONCRETE

.1 Before placing fresh concrete against set or partially set concrete, clean surfaces to remove dirt, scum, shavings, debris, laitance, etc. on set surfaces, brush generously with bonding agent.

.2 Place concrete in accordance with CAN/CSA A23.1/A23.2-M.

.3 Slope concrete to levels shown on Contract Drawings.

.4 Do not place concrete at such a rate as to endanger formwork or to prevent proper compaction.

.5 Place concrete to prevent cold joints and segregation and vibrate sufficiently to ensure thorough compaction, maximum density in accordance to CAN/CSA A23.1/A23.2-M

.6 Check Work frequently with accurate instruments during placing of concrete.

.7 When completing concrete placement for day, carry placement through to a scheduled joint location.

.8 Where concrete placement is stopped for more than 30 minutes due to breakdowns, weather or any other reasons, construct extra bulkhead and construction joint as directed.

3.6 CONCRETE CURBS

.1 Align concrete curbs with curves and tangents indicated on drawings. Concrete curb to be in accordance to details indicated on drawings.

.2 Where existing curb is met, the contractor must make the required transition to style and grade of existing curb to the satisfaction of the Consultant.

.3 Curbs shall have expansion joints at minimum 4500 mm o.c. and in accordance with authorities having jurisdiction. Place reinforcing bars at top and base of curb, with minimum 50 mm concrete cover.

.4 All restoration of the existing road structure for the transition to existing curb is the responsibility of the contractor.

.5 Finish edges of dummy joints and expansion joints with 3 mm radius edging tool.

3.7 CONCRETE PAVEMENTS

.1 Concrete sidewalk to be in accordance with details indicated on drawings.

.2 Concrete for standard sidewalk to be 150 mm thick, except through entrances where the concrete shall be 200 mm thick with wire mesh. The compacted granular 'A' is to be 150 mm thick at all locations.

.3 Where existing sidewalk is met, make the required transition to grade, to the satisfaction of the Consultant. Furthermore, co-ordinate with the City and Consultant, to insure compatibility of existing and or future adjacent works by City forces.

.4 All structural concrete, such as but not limited to, concrete walkway adjacent to building, concrete pads for loading docks, and concrete slabs for loading areas to be constructed in accordance with reviewed shop drawings.

.5 Dummy joints: 6 mm deep at 1500 mm o.c. Tool joints with 6 mm wide steel trowel, radiusing edges 6 mm.

.6 Expansion joints: 6000 mm o.c. maximum.

.7 Tool edges of sidewalk with 50 mm wide steel trowel, radiusing edges 6 mm.

.8 Install sealant in expansion/isolation joints as shown and specified.

3.8 CONSOLIDATING

.1 Consolidate concrete in accordance with CAN/CSA A23.1/A23.2-M

.2 Work concrete into complete contact with forms and embedded items. Consolidate concrete adjacent to side forms and along entire length of forms to ensure a smooth surface finish after stripping of formwork.

3.9 CURING AND PROTECTION

.1 Cure and protect concrete in accordance with CAN/CSA A23.1/A23.2-M.

.2 Apply curing compound after finishing operations have been completed, at rate recommended by compound manufacturer. Ensure compound application is uniform and continuous over entire area being cured.

3.10 CONSTRUCTION JOINTS

.1 Obtain Consultant's acceptance to install construction joints in locations other than those shown.

.2 Construct construction joints to CAN/CSA A23.1-M and as shown. Supply and install dowels in construction joints unless otherwise detailed.

.3 Joints at building face or other abutments: place 12 mm joint filler keeping top 12 mm below concrete surface; apply kraft paper or polyethylene bond over filler and fill with self-levelling sealant applied in accordance with manufacturer's printed instructions.

.4 For sawn joints:

- .1 Do sawn joints in accordance with drawing details. Prepare sample sawn joint for approval by Consultant.
- .2 Ensure joints are straight. Mark alignment with chalk line or other suitable guide. Layout to be approved by Consultant.
- .3 Saw joints using approved equipment and methods to produce joint dimensions indicated.
- .4 Supply sufficient men and equipment including standby equipment, to maintain a satisfactory sawing schedule.
- .5 Schedule sawing operations on 24 hour basis and consistent with concrete placing.
- .6 Make initial saw cuts in a progressive manner and as soon as possible without excessive ravelling.
- .7 If a crack occurs ahead of saw cut, stop immediately. Move ahead several joints and cut one or more joints before returning to saw intermediate joints. Where cracking persists, make 1060 mm saw cut from one edge and complete sawing from opposite edge. Adjust sawing schedule accordingly.
- .8 If uncontrolled cracking or other surface damage results from inadequate or improper sawing techniques suspend further concrete operations until situation is corrected and immediately remove and replace damaged slabs.
- .9 Immediately on completion of sawing, flush joints with water to remove laitance.

3.11 FINISHING

.1 When striking off concrete surface, maintain a uniform roll of concrete ahead of first screed for it's full length when finishing machine is on first pass.

.2 Where joints are formed rather than sawn, form longitudinal and transverse joints after final pass of finishing machine.

.3 Hand finish areas inaccessible to finishing machine to same quality and surface characteristics as machine finished surfaces.

.4 Finish concrete surface with an approved float at proper time. Operate from edge to edge with a wiping motion while advancing , with each succeeding pass overlapping previous one.

.5 Check surface with approved straightedge 4500 mm long. Correct irregularities exceeding 5 mm before concrete takes initial set.

.6 Finish edges of slabs with edging tool to form a smooth squared surface. Do not patch with cement paste.

3.12 IDENTIFICATION STAMP

.1 For sidewalks in the public right-of-way, mark concrete at each end of the work and at least every 18000 mm or such other places as the Consultant may select.

.2 The stamp shall be located on the centre of the bay of walk, next to and parallel to a transverse joint.

.3 The size and shape of the stamp shall be as shown on City of Brampton Drawings.

.4 The imprint shall be clear and legible and satisfactory to the Consultant.

3.13 BROOM FINISH

.1 Commence texturing immediately after float finishing.

.2 Use soft bristled broom to produce an approved light, non-slip concrete surface finish with fine granular or sandy texture free from disfigurations. Finishes to be approved by Consultant.

.3 Apply broom finish at right angles to curb and parallel to joints. All trowel and tool marks to be removed with broom. Do not contaminate joints by over-brooming.

3.14 REMOVAL OF FORMS

.1 Do not disturb forms until concrete has hardened and developed sufficient strength to safely support its own weight and load on it.

.2 Strip formwork in accordance with CAN/CSA A23.1-M.

3.15 DEFECTIVE CONCRETE

.1 Concrete is defective when:
- .1 Containing excessive honeycombing or embedded debris.
- .2 Concrete damaged by freezing or which is unsatisfactory due to placement at too high a temperature.
- .3 Average 28 day strength of any three consecutive strength tests is less than specified minimum 28 day strength.
- .4 Any 28 day strength test result is less than 80% of specified minimum 28 day strength.
- .5 Surface texturing, joint type and placement and tolerances are unacceptable in the opinion of the Consultant.

.2 Repair of defective concrete work:
- .1 Repair defective areas while concrete is still plastic, otherwise wait until curing is completed. Use repair methods approved by Consultant.
- .2 Grind off high surface variations where directed.

.3 Remove and replace defective concrete where directed.
- .1 Remove minimum 3000 mm of pavement by sawing through concrete across full lane width.
- .2 Replace with new concrete to this specification.
- .3 Construct dummy contraction joint between sawn face of existing concrete and face of new concrete.

3.16 PROTECTION

.1 Do not open concrete pavement to traffic or construction equipment until concrete reaches 70% of specified strength or until approved by Consultant.

END OF SECTION

TREE & SHRUB PRESERVATION

PART 1 GENERAL

1.1 Description of Work

.1 This section specifies the preservation of existing vegetation on the site.

1.2 Related Work

.1	All Division 1	Specification Sections
.2	Section 01561	Environmental Protection
.3	Section 02231	Clearing & Grubbing
.4	Section 02232	Tree Pruning
.5	Section 02311	Site Grading
.6	Section 02315	Excavating, Trenching & Backfilling
.7	Section 02911	Site Topsoil & Finish Grading

1.3 Quality Control (Specific)

.1 Contractor shall have a thorough knowledge of horticulture, being able to identify trees, shrubs and ground covers by both common and botanical nomenclature. All persons overseeing tree work must be trained according to the tree care standards accepted by the International Society of Arboriculture.

1.4 Product Delivery, Storage, and Handling (Specific)

.1 Roots of existing trees to be preserved are not to be driven on.

.2 Surplus soil, equipment, vehicles, debris or materials shall not be placed over root systems of the trees within the protective fencing. No contaminants will be dumped or flushed where feeder roots of trees exist, that is within 1.5 times the diameter of the tree's canopy. No cables of any type shall be wrapped around or installed in trees.

PART 2 PRODUCTS

2.1 Temporary Tree Protective Fencing (Specific)

.1 Existing trees shall be properly protected beyond the drip line with minimum 1.2m high temporary fencing as per City of Brampton standard until Substantial Performance.

.2 Maintain existing grade within drip line of all trees to be preserved.

.3 The area within the protecting fencing shall remain undisturbed and free of debris, building materials and equipment.

.4 Prune dead wood only unless directed otherwise by the Consultant. Do not prune leaders, all cuts greater than 25mm diameter shall be treated with approved dressing as per Section **02232 Tree Pruning**.

.5 Silt control fabric as per layout and extent on drawings.

2.2 Fertilizing Existing Trees

.1 The Work will be carried out between October 15th and November 14th of the fiscal year.

.2 The Contractor will provide 2.7 kg of actual nitrogen in an organic or synthetic organic form or 9 kg of product 30-10-7 per 100 square meters of area or to a 40 cm diameter tree suspended in 225 litres of water. (6 lbs. of nitrogen or 20 lbs. of product in 50 gallons of water).

.3 The Consultant reserves the right to take samples of the mixture used, for analysis.

.4 The Contractor will be responsible for any damage caused to turf, walkways, trees or structures.

PART 3 EXECUTION

3.1 Layout

.1 Stake out and locate any major root systems from existing trees.

.2 All proposed construction Works that may intersect with root systems of existing trees are to be identified and staked out using yellow flags.

.3 Protective fencing location(s) are to be staked out as directed by the Consultant.

3.2 Execution

.1 **Through Existing Root Systems:** Excavation required through existing root systems due to proposed Works is to be excavated by hand. Roots are to be cut with a sharp axe, and all cuts to be sealed with approved Tree Surgeons paint.

.2 **Pruning:** Prune vegetation, loose bark, hazardous wood removal and all dead and broken branches. Prune branches to compensate for root loss then treat with tree paint.

.3 **Grade Change Higher Around Trees:** Place 100mm diameter perforated pipe on the existing grade, radiating a minimum of 8 spokes out from the trunk, to the spread of branches, sloping away from the trunk. Connect tiles and place tiles at the end of each slope. The upright spokes shall be extended to reach the new grade to allow for aeration and watering. Tiles are to be covered with clean crushed rock and fill area covered with the tile system with sandy gravel fill.

.4 **Grade Change Lower Around Trees:** A 1:3 downward slope is be constructed to the new grade. Water is to be applied at least three (3) times during dry summer periods and once prior to freeze-up, until the tree has adapted to the new conditions, or until the project has been certified Substantially Performed.

.5 **Fencing:** Maintain Temporary Tree Protective Fencing until removal which is directed by the Consultant.

.6 **Fertilize**: Fertilize in accordance with good horticulture practises to ensure promotion of root growth for two (2) years after acceptance. Where trees whose roots have been disturbed, within the drip line, drill holes 20mm in dia. and 40mm deep at 1000mm intervals on a square grid pattern under the trees drip line, fill holes with topsoil, and water.

3.3 Trees To Be Replaced

.1 Existing trees to remain as per the Contract Documents that have been severely damage or die as a result of the construction shall be replaced with the same species or as approved by the Consultant. Trees to be removed shall be cut completely flush to ground or as otherwise directed by the Consultant.

3.4 Damage

.1 Contractor to repair or make good any damage to trees or other vegetation, at no additional cost to the Owner.

END OF SECTION - 02901

PLANTING OF TREES, SHRUBS, GROUNDCOVERS & TRANSPLANTING

PART 1 GENERAL

1.1 Description of Work

.1 This section describes the labour, all materials and installation requirements necessary to complete the tree, shrub, and groundcover planting and transplanting as indicated or specified herein.

1.2 Examination

.1 Contractor to report to the Consultant, in writing of any conditions or defects encountered on the site during or before construction upon which Work of this section depends and which may adversely affect its performance.

.2 Do not commence Work until such conditions or defects have been investigated and corrected.

.3 Commencement of Work shall imply acceptance of surfaces and conditions and no claim for damages or extras resulting from such conditions or defects will be accepted thereafter, except in cases where such conditions cannot be known prior to or during the course of construction.

1.3 Testing

.1 Test stockpiled topsoil as specified in Section **02911 Site Topsoil & Finish Grading,** and as noted on the Contract Document drawings, and submit results to the Consultant for review, prior to starting Work on site.

1.4 Related Work

.1 **Establishing Sub-Grade for Planting Beds**
Section 02311 .....Site Grading

.2 **Preparation of Planting Beds**
Section 02911 .....Site Topsoil & Finish Grading

1.5 Submittals

.1 Topsoil: Before delivery of topsoil, provide Contractor with a written statement giving location of properties from which soil is to be obtained, names and addresses of owners, depth to be stripped, and crops during the past two (2) years.

1.6 Reference Standards

.1 Trees, shrubs and ground covers are to be supplied and installed in accordance with the Metric Guide Specification for Nursery Stock Current Edition of the Canadian Nursery Trades Association except where specified otherwise.

1.7 Source Quality Control

.1 Contractor to ensure the all plant material at source is acceptable prior to digging operations;

.2 Imported plant materials must be accompanied with necessary permits and import licenses. Conform to federal and provincial regulations.

1.8 Samples

.1 Provide samples for: Mulch - Canada Red Mulch or Gro-Bark.

1.9 Qualifications

.1 All planting Work described in the Section shall be executed by experienced personnel under the direction of the Contractor.

1.10 Substitutions

.1 All plants shall be supplied as specified in the Contract Documents. Alternates will not be allowed unless approved in writing from the Consultant.

.2 Give timely notice in writing to the Consultant when applying for substitutions.

.3 The Contractor must verify to the Consultant, the lack of availability and source of the specified plant material.

1.11 Delivery, Storage and Protection

.1 Protect plant material from frost, excessive heat, wind and sun during delivery.

.2 Immediately store and protect plant material which will not be installed within one (1) hour after arrival at site in storage location approved by the Consultant.

.3 Protect plant material from damage during transportation:

.1 When delivery distance is less than 30 km and vehicle travels at speeds under 80 km/h, tie tarpaulins around plants or over vehicle box.
.2 When delivery distance exceeds 30 km or vehicle travels at speeds over 80 km/h, use enclosed vehicle.

.4 Protect stored plant material from frost, wind and sun and as follows:

.1 For bare root plant material, preserve moisture around roots by heeling-in or burying roots in sand or topsoil and watering to full depth of root zone.
.2 For pots and containers, maintain moisture level in containers. Heel-in fibre pots.
.3 For balled and burlapped and wire basket root balls, place to protect branches from damage. Maintain moisture level in root zones.

1.12 Warranty

1. The Contractor hereby warrants that plant material as itemized on plant list will remain free of defects for two (2) years from the date of Substantial Performance of the Work.

.2 End-of-warranty inspection will be conducted by the Consultant and Owner.

.3 Consultant reserves the right to extend Contractor's warranty responsibilities for an additional one (1) year if, at end of initial warranty period, plant development and growth is not sufficient to ensure future survival.

1.13 Job Conditions

.1 The Contractor shall receive the site with the planting areas free of waste or debris developed by other trades. Any discrepancy shall be reported to the Contractor prior to planting.

PART 2 PRODUCTS

2.1 Plant Material and Accessories

.1 Type of root preparation, sizing grading and quality: comply with Metric Guide Specification for Nursery Stock, latest addition of the Canadian Nursery Trades Association.

.2 Plant material: free of disease, insects, defects or injuries and structurally sound with strong fibrous root system.

.3 Plant material: root pruned regularly, but not later than one growing season prior to arrival on site.

.4 Trees: with straight trunks, with no bark damage or stump wounds, well and characteristically branched for species except where specified otherwise.

.5 Bare root stock: nursery grown, in dormant stage, not balled and burlapped or container grown.

.6 Collected stock: maximum 40 mm in calliper, with well developed crowns and characteristically branched; no more than 40% of overall height may be free of branches.

.7 Water: potable and free of minerals which may be detrimental to plant growth.

.8 Stakes: T-bar steel stakes 40 x 40 x 5 x 2440 mm drilled to receive # 10 wire and pine or fir wood 38 x 38 x 2400 mm, treated with Pentox preservative.

.9 Black Rubber Hose: 12 mm outside diameter.

.10 Cables and accessories: factory galvanized cables, wire tighteners, eyebolts and turnbuckles. Use turnbuckles with 150 mm long eyebolts and 10 mm diam. threaded opening for tightening.

.11 Guy wires: steel wire strand to CSA G4-M1977 at following sizes:
- .1 Shrubs and trees under 70 mm calliper use l.5 mm diameter wire.
- .2 Trees 70 to l50 mm caliper use 3 mm diameter wire.

.12 Eyebolts: coarse threaded galvanized steel at following sizes:
- .1 Trees l50-500 mm calliper use 10 mm dia.

.13 Flagging: High visibility plastic flagging ribbon 12mm to 25mm width, affixed to midpoint of guy wires.

.14 Tree rings: fabricated from 3 mm galvanized wire encased in two ply reinforced 12 mm dia. rubber garden hose or equivalent.

.15 Wire mesh: galvanized, electrically welded.
- .1 For tree guards use 1.4 mm wire with 25 x 50 mm mesh.

.2 For gunite reinforcing use l.4 mm wire with 50 x 50 mm mesh.

.16 Reinforcing rod: 10 mm bars to CSA G30.12 - Ml977.

.17 Gunite concrete: to ACI 506-66.

.18 Fibreglass fabric: tight woven, min 2.5 kg/m2 mass, 1 m wide.

.19 Root ball burlap: 150 g Hessian burlap.

.20 Tree wrapping material: new, clean, plain burlap strips minimum 2.5 kg/m2 mass 150 mm wide.

2.2 Mulch

.1 Shredded bark wood: varying in size from 25 to 75 mm in length, from coniferous trees or approved alternate, and free of chemicals. "Gro-Bark" or "Canada Red Mulch" is acceptable. Approval of substitutions must be requested in writing prior to commencement of Work.

2.3 Fertilizer

.1 Where topsoil is supplied by the Contractor, the quantities of fertilizers required shall be based on the following minimum rates.

10-6-4 @ 36g/1 mm cal. for trees
12-6-4 @ 890g/m3 of topsoil for shrubs

.2 Fertilizers shall be complete, commercial fertilizers containing not less than 60% urea formaldehyde and the following percentages by weight.

Nitrogen	Phosphoric Acid	Potash
10	6	4
12	6	6

.3 Synthetic commercial type, ratio 5:3:2.

2.4 Anti-Dessicant

.1 Anti-desiccants: wax-like emulsion to provide film over plant surfaces reducing evaporation but permeable enough to permit transpiration.

PART 3 EXECUTION

3.1 Pre-Planting Operations

.1 Ensure plant materials acceptable to the Consultant.

.2 Remove damaged roots and branches from plant material.

.3 Apply anti-desiccant to conifers and deciduous trees in leaf in accordance with manufacturer's instructions.

.4 Remove burlap trunk wrap and notify the Consultant to inspect and accept trees. Re-wrap immediately after inspection.

3.2 Excavation and Preparation of Planting Beds

.1 Establishment of sub-grade for planting beds is specified in Section **02311 Site Grading**.

.2 Preparation of planting beds is specified in Section **02911 Site Topsoil & Finish Grading.**

.3 For individual planting holes:

.1 Stake out location and obtain approval from Consultant prior to excavating.

.2 Stake-out all plant material to be approved prior to planting.

.4 If planting drainage is required:

.1 Excavate to depth and width as indicated.

.2 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.

.3 Scarify subgrade sides of planting hole.

.4 Remove water which enters excavations prior to planting. Notify Consultant if water source is ground water.

3.3 Digging for Plants

.1 All plants shall be dug and delivered to the site as specified on the Plant List, or in the case of relocation of existing plant material on the site, dug according to the following specification.

.2 Plants specified "B/R" shall be moved with bare roots. They shall be dug and moved while dormant, with the major portion of the fibrous root system provided.

.3 Immediately after digging, the root system shall be wrapped or puddle and shall be kept moist to prevent drying out until planted on the site.

.4 All plants specified "B&B" shall be moved with solid balls wrapped in burlap.

.5 No plant shall be used when the ball of earth surrounding the roots has been cracked or broken preparatory to or during the process of planting, or when the burlap and ropes holding the soil ball have been removed prior to planting.

.6 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, and shall be sufficiently large to contain at least 75% of the fibrous root system.

Deciduous Trees

Caliper	Root Ball Diameter
25mm – 40mm	0.60m
50mm	0.75m
75mm	0.90m
100mm	1.05m
125mm	1.35m
150mm	1.50m
200mm	1.80m
250mm	2.50m

Coniferous Trees

Height	Root Ball Diameter
1.8m-2.4m	0.75m
2.4m-3.0m	0.90m
3.0m-3.6m	1.05m
3.6m-4.6m	1.20m
4.6m-5.4m	1.35m

3.4 Handling of Plants

.1 All plants shall be well protected against damage and drying out from the time of digging until they are planted on the site.

.2 All roots shall be cleanly cut; split roots are not acceptable. Where combing is not practised, the roots shall be evenly cut at the edges of the ball. The cut ends of all roots 25 mm in diameter and larger shall be painted with asphalt emulsion.

.3 Plants shall be transported with care taken to prevent damage. Branches shall be carefully tied in such a manner so as not to break or damage trunks. Points of contact with equipment shall be padded.

.4 Plants with broken or abraded trunks or branches are not acceptable.

.5 Root balls, trunks, branches and leaves shall be protected from sun and wind desiccation.

3.5 Planting

.1 For bare root stock, place 50 mm backfill soil in bottom of hole. Plant trees and shrubs with roots placed straight out in hole.

.2 For burlapped root balls, ensure the wire basket is sitting 100mm + below finished grade. Cut away top one-third 1/3 or of wrapping and wire basket without damaging root ball. Do not pull burlap or rope from under root ball. Cut and remove all nylon rope around tree trunks.

.3 For container stock or root balls in non-degradable wrapping, remove entire container or wrapping without damaging root ball.

.4 Plant vertically in locations staked and approved. Orient plant material to give best appearance in relation to structure, roads and walks.

.5 For trees and shrubs:

.1 Backfill soil in 150 mm lifts. Tamp each lift to eliminate air pockets. When two thirds of depth of planting pit has been backfilled, fill remaining space with water. After water has penetrated into soil, backfill to finish grade.

.2 Form watering saucer as indicated on detail.

.6 For ground covers, backfill soil evenly to finish grade and tamp to eliminate air pockets.

.7 Water plant material thoroughly.

.8 After soil settlement has occurred, fill with soil to finish grade.

.9 Dispose of burlap, wire and container material off site.

3.6 Trunk Protection

.1 Install trunk protection on deciduous trees as indicated.

.2 Install trunk protection after trees have been inspected and accepted by Consultant.

3.7 Tree Supports

.1 Install tree supports as indicated on detail(s) Deciduous Tree Planting and Coniferous Tree Planting, unless otherwise specified.

3.8 Mulching

.1 Mulch shall be free from deleterious materials and shall be stored as to prevent inclusion of foreign materials.

.2 For fall plantings placing of mulch to occur in following spring after soil thaws and warms up.

.3 Ensure soil settlement has been corrected prior to mulching.

.4 Spread mulch as indicated, minimum 100 mm thick.

3.9 Acceptance

.1 Plant material will be accepted by the Consultant after planting operation is completed provided that plant material exhibits healthy growing condition and is free from disease, insects and fungal organisms after the warranty period.

.2 Plant material installed less than ninety (90) days prior to frost will be accepted in the following spring, thirty (30) days after start of growing season provided that acceptance conditions are fulfilled.

.3 A preliminary inspection will be held sixty (60) days from day of acceptance to determine plant health and overall acceptability. All plants that are not healthy will be noted and shall be removed from the site and replaced with plants of the same species and size as originally specified. The Consultant may extend the warranty period for replacement plants if highly unsatisfactory conditions exists, two

(2) years after acceptance of the replacement planting.

.4 A final inspection of the replacement plants will be conducted at the end of extended warranty period, if any, to determine acceptance or rejection. This will be the final replacement.

3.10 Replacements

.1 All plant materials found dead, or not in a healthy, satisfactory growing condition or which, in any other way, do not meet the requirements of the Specifications, shall be replaced by the Contractor. All costs shall be borne by the Contractor.

.2 All required replacement shall be plants of the same size and species as specified in the Plant List and shall be supplied and planted in accordance with the Contract Document drawings and specifications.

3.11 Maintenance

.1 Perform following maintenance operations from time of planting to Substantial Performance of the work.

.1 Water to maintain soil, moisture conditions for optimum establishment, growth and health of plant material without causing erosion. For all plant material, water thoroughly in late Fall prior to freeze-up to saturated soil around root system.

.2 Remove weeds monthly from planting beds and tree pits to ensure healthy and vigorous plant growth.

.3 Replace or respread damaged, missing or disturbed mulch.

.4 For non-mulched areas, cultivate as required to keep top layer of soil friable.

.5 Ensure plant material is in a healthy, vigorous state at time of Final Acceptance.

.2 Apply pesticides in accordance with Federal, Provincial and Municipal regulations as and when required to control insects, fungus and disease. Obtain product approval from the Consultant prior to application.

.1 Remove dead or broken branches from plant material.

.2 Keep trunk protection and guy wires in proper repair and adjustment. Remove trunk protection, tree supports and level watering saucers at end of two (2) year warranty period, unless sooner as directed by the Consultant.

.3 Remove and replace dead plants and plants not in healthy growing condition. Make replacements in same manner as specified for original plantings.

.4 Submit semi-annual written reports to Consultant identifying:

.1 Maintenance Work carried out.

.2 Development and condition of plant material.

.3 Preventative or corrective measures required which are outside Contractor's responsibility.

END OF SECTION - 02906

SITE TOPSOIL & FINISH GRADING

PART 1 GENERAL

1.1 Related Work

.1	Section 02311	Site Grading
.2	Section 02315	Excavating, Trenching, & Backfilling
.3	Section 02906	Planting of Trees, Shrubs, Ground Covers & Transplanting
.4	Section 02924	Seeding
.5	Section 02938	Sodding

1.2 Source Quality Control

.1 **Testing of Topsoil**

.1 All topsoil to be used on park sites, sports fields, planting beds, trees etc. must be tested by an approved testing in accordance with General Requirements:

Section 01600 **Materials, Equipment and Workmanship Quality**
Section 01450 **Quality Control & Inspection**

.2 Test topsoil from source prior to stripping and stockpiling for :

.1 Particle size analysis (percentage of sand, silt and clay by Hydrometer Method).

.2 Organic matter, phosphorus (sodium bicarb), potassium, magnesium, calcium, soil pH, buffer pH, percent base saturation and calculated CEC. (Cation Exchange Capacity)

.3 Test for Sulphur, Zinc, Manganese, Iron, Copper, Boron and soluble salts content, and Atrazine.

.3 Use 25mm diameter sampling tube or spade and in the presence of the Consultant, take twenty-five (25) samples per hectare to full depth of topsoil at random across entire area to be stripped. Mix samples together thoroughly before submitting for testing.

.4 Submit 0.5 kg sample of topsoil to testing laboratory and indicate present use, intended use, type of subsoil and quality of drainage. Prepare and ship sample in accordance with provincial regulations and testing laboratory requirements.

.5 The Contractor shall arrange for and assume all costs for such testing of topsoil imported to the site and the amendment

recommendation report. For onsite topsoil stockpiles, unless otherwise provided for in this document, the tests and report shall be arranged and paid for by the Contractor. A City of Brampton Representative must be present for the sample selection. Submit two (2) copies of soil analysis and recommendations for corrections to sustain vigorous plant growth including recommended fertilizer applications to the Consultant prior to commencing of topsoil spreading and topsoil delivery.

.6 Stockpiled topsoil will be amended by shredder as per the recommendations for corrections in the presence of the Consultant.

.7 When the source of such topsoil is exhausted, topsoil from a new source shall not be used until tested and approved.

.8 The Contractor has one (1) growing season from the time of soil testing to implementation on site. Any test result that is older than one (1) growing season may be asked to be retested at the discretion of the Consultant.

1.3 Scheduling of Work

.1 Schedule placing of topsoil and finish grading to permit sodding or seeding operations under optimum conditions.

PART 2 PRODUCTS

2.1 Materials

.1 Topsoil: friable, neither heavy clay nor of very light sandy nature consisting of the following, within 5% +/-: 45% sand, 35% silt, 20% clay and pH of 6.2 to 7.2. Free from subsoil, roots, vegetation, debris, toxic materials, stones over 50 mm diameter, containing four percent (4%) **minimum** organic matter for clay loams and two percent (2%) **minimum** organic matter for sandy loams and must be capable of sustaining vigorous plant growth.

.2 All topsoil whether existing or imported topsoil for use under sodded areas shall be screened topsoil having passed through a 25mm size screen and ensure that it is free from:

.1 Debris and stones over 25 mm diameter.

.2 Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.

.3 Planting Soil for planting of trees, shrubs and ground covers from the stockpile shall be mechanically shredded and amended as per the soil analysis recommendations for corrections. Rototilling or mixing by other means is not acceptable.

.4 Manure: Well-rotted, unleached cattle manure, free from harmful chemicals and other injurious substances and saw dust, shavings, or similar refuse, at least eight (8) months old, but not more than two (2) years old, and with no more than 25% straw, leaves or **other unacceptable materials** for planting use.

.5 Peat Moss: Shall be partially decomposed fibrous or cellular stems and leaves of Sphagnum Mosses with a texture varying from porous fibrous to spongy fibrous, fairly elastic and substantially homogeneous with a pH value of not less than 4.5 and not greater than 6.0. It shall be baled and free of decomposed colloidal residue, wood, sulphur and iron, be brown in colour and finely shredded, suitable for horticultural purposes. Shredded particles shall not exceed 5 mm in size.

.6 Fertilizer: All fertilizer and soil amendment materials and quality to meet recommendations and standards outlined in the soil testing report.

PART 3 EXECUTION

3.1 Soil Preparation of Existing Grade

.1 Grade soil, eliminating uneven areas and depressions, ensuring positive drainage. Remove soil contaminated with toxic materials. Dispose of removed materials as directed by Consultant.

.2 Cultivate entire area which is to receive topsoil to following depths:

.1	Sod:	150mm boulevard areas; 200mm building lots
.2	Seed:	150mm
.3	Flower beds:	300mm
.4	Shrub beds:	450mm
.5	Trees:	as specified or as directed by the Consultant.

.3 Repeat cultivation in those areas where equipment used for hauling and spreading has compacted soil.

.4 Remove surface debris, roots, vegetation branches and stones in excess of 50 mm diameter.

.5 Special Conditions:

1. Environmentally sensitive areas, wetlands, or natural heritage sites where existing soil conditions are sufficient to sustain additional plantings, the Consultant may request that plantings be installed in native, undisturbed soil.

3.2 Soil Amendment Preparation

.1 The Consultant will accept three (3) means of soil amendment preparation for areas seeded, sodded, or planted. These means are as follows:

.1 Mixed and prepared by a mechanical shredder on site.
.2 Mixed and amended on the site.
.3 Pre-mixed soils imported to the site.

.2 The Consultant will be responsible for reviewing soils during the preparation process and clarify in writing to the Owner that the final soil product(s) and installation conforms to the specification.

3.3 Spreading of Topsoil or Planting Soil

.1 Spread topsoil after the Consultant has inspected and certified rough grading.

.2 Spread topsoil with adequate moisture in uniform layers over approved, unfrozen subgrade, where, sodding or seeding is indicated. Irregularities in the surface resulting from topsoiling or other operations shall be corrected to avoid the formation of depressions causing standing water.

.3 Apply topsoil to following minimum depths: 150mm for seeded areas, 100mm for sodded areas.

.4 Apply planting soil to following **minimum** depths:

.1	Sod:	150mm boulevard areas; 200mm building lots.
.2	Seed:	150mm
.3	Flower beds:	300mm
.4	Shrub beds:	450mm
.5	Trees:	as specified or as directed by the Consultant.

5. Manually spread topsoil or planting soil around existing trees, shrubs and obstacles.

6. Where any portion of the surface becomes gullied or similarly damaged,
the Contractor will repair affected area adding topsoil as necessary to restore to the satisfaction of the Consultant.

7. Contractor is to install and maintain erosion control fencing to prevent soil erosion.

3.4 Soil Amendments

.1 Apply soil amendments at rate and number of applications as specified and as determined from soil test and report, including any maintenance recommendations.

.2 Mix soil amendments into full depth of topsoil prior to application of fertilizer.

3.5 Application for Fertilizer

.1 Spread fertilizer uniformly over entire area of topsoil at manufacturer's recommended timing and rate of application.

.2 Mix fertilizer thoroughly to full depth of topsoil.

3.6 Finish Grading

.1 Fine grade and loosen top soil. Eliminate rough spots and low areas to ensure positive drainage. Prepare loose friable bed by means of cultivation and subsequent raking.

.2 Roll to consolidate topsoil for areas to be sodded leaving surface smooth, uniform, firm against deep foot printing, and with a fine loose, texture to approval of Consultant.

3.7 Restoration of Stockpile Sites

.1 Restore stockpile sites to a ‘rake clean' condition acceptable to the Consultant.

3.8 Surplus Material

.1 Dispose of materials not required off site or as directed by the Consultant.

END OF SECTION - 02911

SEEDING

PART 1 GENERAL

1.1 Description of Work

.1 This section describes the labour, materials, and installation requirements necessary to complete the seeded turf planting related items as indicated or specified.

1.2 Related Work

.1	All Division 1	Specification Sections
.2	Section 01600	Material, Equipment & Workmanship Quality
.3	Section 02311	Site Grading
.4	Section 02911	Site Topsoil & Finish Grading

1.3 Product Data

.1 Submit product data in accordance with Section **01330 Submittals**.

.2 Provide product data for:

.1 Seed
.2 Mulch
.3 Fertilizer

1.4 Delivery, Storage and Acceptability

.1 All grass seed hydraulic mulch, fertilizers and other related materials, where required, shall be stored in a dry, weatherproof area and shall be protected from damage by heat, moisture, rodents, or other elements until the time of seeding or use. All material shall be labelled by grower or manufacturer as separate items and shall not be removed or defaced.

.2 Bulk deliveries of seed shall be accompanied with delivery tickets specifying percentage germination, purity, and noxious weed seed content.

1.5 Measurement for Payment

.1 Seeding will be measured as per square metre unless otherwise stipulated in the Bid Document – Price Schedule.

1.6 Job Conditions

.1 The turf areas will be free of waste or debris developed by other trades. Any discrepancy from such conditions shall be reported to

the Contractor before beginning construction.

1.7 Grading

.1 The Contractor shall grade all turf areas as noted on the Contract Document drawings;

.2 Fine grade all turf areas eliminating rough or low areas to ensure positive drain age.

PART 2 PRODUCTS

2.1 Grass Seed Mixture

.1 Consult the Consultant to determine specific requirements for seed mixture application. Fertilizer application rates are to be as recommended in the soils test report.

.2 Grass Seed shall be Certified Canada No. 1 Grade to Government of Canada, Seeds Regulations and having minimum germination of 85% and minimum purity of 97%.

.3 Seed mixtures shall be suited to the climate, soil conditions and type, orientation, sun exposure, terrain, establishment and maintenance conditions under which they are to be grown.

.4 The mixture shall be mixed and supplied by a recognized certified seed supplier.

2.2 Seed Labelling

.1 All seed and seed mixes shall be in the original sealed package with the original legible label securely attached.

.2 Labelling shall conform to the requirements of the Canadian Seeds Act and Regulations. Each package shall be labelled to show:

1. The name and address of the seed supplier.
2. The seed species, or the name of the seed mix and the various individual seed species that comprise the seed mix and the percentage by mass.
3. The grade of the seed or seed mix.
4. The supplier’s name and lot designation number.
5. Mass in kilograms
6. Date and location of bagging
7. Year of production

.3 Seeding mix specification for **Upland Naturalization Seed Mix**.

40% Elymus riparius (Riverbank Wild Rye)
25% Oenethera biennis (Evening Primrose)
10% Rudbeckia hirta (Black Eyed Susan)
5% Euthamnia graminifolia (Grass Leaf Goldenrod)
5% Carex granularis (Open Field Sedge)
2% Solidago Canadensis (Canada Goldenrod)
2% Asclepsis syriaca (Common Milkweed)
1% Aster cordifolius (Heart Leaved Aster)
1% Aster novae-angliae (New England Aster)
1% Anenome canadensis (Canada Anenome)
1% Clematis virginiana (Virgins Bower)
1% Monarda fistulosa (Wild Bergamot)

Seed rate to be 26 kg/Ha.

To be spread with Lolium multiflorum cover crop. Cover crop seed rate to be 22 kg/Ha. Ideally seed in Fall.

.4 Seeding mix specification for **Tableland parks**:

48% Creeping Red Fescue
15% Majestic Kentucky Bluegrass
13% Palmer Perennial Rye Grass
11% Gator Perennial Rye Grass
7% Fortress Creeping Red Fescue
6% Yorktown II Perennial Rye Grass

.5 Seed mix specification for **Valleylands**:

10% White Clover
15% Fiesta Perennial Rye Grass
10% Mustang Tall Fescue
10% Creeping Red Fescue
15% Timothy
10% 'Dormie' Kentucky Blue Grass
30% Bird’s Foot Trefoil

.6 Seed mix specification for **Road Buffers:**

25% RFT Tall Fescue (Festuca arundiancea ‘Rhizomatous’)
30% Perennial Rye Grass (Lolium perenne)
25% Creeping Red Fescue (Festuca rubra)
5% Kentucky Blue Grass (Poa pratensis)
5% White Clove (Tripofolium repens)
10% Bird’s Foot Trefoil (Lotus corniculatus)

.7 Seed rate as per manufacturer's recommendation.

.8 Seed will be shipped in containers with original tags from recognized supplier

.

2.3 Mechanical Seeding

.1 Use equipment suitable for specified area to approval of Consultant. Where area allows, the "Brillion" type equipment is recommended.

.2 Use manually operated broadcast seeder only for small specific locations and areas inaccessible to "Brillion" seeding.

.3 Sow at the rate of as per manufacturer's recommendation during calm weather and when soil moisture content is adequate for germination.

.4 Sow seed in two directions, 50% of seed in one direction and remaining 50% of seed at right angles to first seeding pattern, using same method of seeding.

.5 Cover broadcasted seed by raking and chain harrowing.

.6 Hydro-Mulching:

.1 Mix fibre mulch with water according to manufacturer's recommendations, and apply to seeded areas at a minimum rate of 1600 kg/ha (16kg/100m2). Apply 2250 kg/ha (22.5 kg/100m2) on areas subject to wind and water erosion.

.2 Add and mix tackifier into slurry of water and fibre mulch and apply as required according to manufacturer's instructions and recommendations.

.3 Using hydro-mulching equipment, apply fibre mulch slurry mixture within twenty-four (24) hours of mechanical seeding. Achieve uniform coverage after application.

.7 Roll seeded grass with roller not exceeding 50 kg where uneven soil conditions warrant.

.8 Water entire area with fine spray after each area has been sown. Apply water only where application of water is practical and will not interfere with other Work.

.9 Apply enough water to ensure penetration of at least 50 mm, avoid

washing out seeds.

2.4 Hydro-Seeding and Mulching

.1 Proceed with hydro-seeding only after final grade has been approved by Contractor.

.2 No Hydro-seeding shall be performed when wind speeds exceed 10 km/h, over frozen soil, or on ground covered in snow, ice or standing water. Hydro-seed only when conditions are favourable for successful seed germination.

.3 Do not spray onto structures, signs guardrails fences, plant material, utilities and other than surfaces intended. Clean-up immediately, any material sprayed where not intended to the satisfaction of the Consultant.

.4 One- Step Hydraulic Seeding and Mulching

.1 Thoroughly mix grass seed, fertilizer, fibre mulch and water to obtain following slurry mixture and application rates per hectare.

1. Grass Seed – 300 kg/ha.
2. Fertilizer – (12-51-0) at 300 kg/ha.
3. Fibre Mulch – minimum 1600 kg/ha or 2250 kg/ha on areas subject to wind and water erosion.
4. Water – minimum 32,000 litres and to fibre mulch manufacturer's recommendations.

.2 Add tackifier directly into slurry mixture and thoroughly mix at rate recommended by manufacturer. Apply tackifier as required according to manufacturer's instructions.

.3 Using appropriate hydraulic hydro-mulching equipment, apply slurry mixture uniformly at optimum angle of application.

.4 Use proper nozzles for application and provide hose extensions to propel mulch slurry to inaccessible areas.

.5 Agitate slurry mix consistently during spraying to keep it homogeneous and avoid blockage to pipes.

2.5 Terra Seeding

.1 Terra Seeding Installation contractor must have three (3) years proven experience in the application of Terra Seeding using a

Blower Truck.

.2 A legible, valid Seed Analysis Certificate from a Seed Testing Laboratory approved by the Canadian Food Inspection Agency (CFIA) for all single seed species and all seed mixtures shall be provided to the Consultant twenty-four (24) hours prior to any seeding operations. The Seed Analysis Report shall stipulate the seed supplier's lot designation numbers.

.3 Test Results from the Seed Analysis Certificate shall specify germination and purity for each seed species of the mix as well as the seed mix composition expressed as a percentage of each see species by mass for each seed mix specified in the contract. Test results shall meet or exceed the value for the various seed mixes as specified by the consultant.

.4 Materials:

.1 Permanent Seed Mixes: Use permanent seed mixes as specified on drawings.

.2 Annual Nurse Crop Seed: Nurse crop seed shall be a cereal grain such as Annual Ryegrass, Fall Rye Grain or Winter Wheat Grain unless otherwise approved by the Consultant.

.3 Fertilizer: Shall comply with the provisions of the Canadian Fertilizers Act and Fertilizer Regulations. Fertilizer shall be supplied in original bags bearing the manufacturer's original label indicating mass and analysis. All fertilizer shall be in granular form, dry, free flowing and free from lumps, and applied at rates specified by the Consultant.

.4 Composted Topsoil: Shall be pre-mixed and shall consist of a minimum 60% compost material. The composted topsoil may be amended by the additional of concrete sand and peat loam. Concrete sand shall be added to improve aeration and soil structure. Peat loam shall be added to adjust the pH of the compost and to make the composted topsoil lighter and easier to blow. Both amendments shall be added at the discretion of the Contractor to ensure that the composted topsoil meets the material specification and is suited for distribution by a pneumatic blower. Once mixed, composted topsoil material shall consist of particles where 100% of the material is able to pass through a 25 mm sieve.

.5 Compost: Shall be derived from a well-composted green organic waste matter from an approved source. All compost

material shall meet the Ontario Ministry of the Environment's Interim Guidelines for the production and Use of Aerobic Compost in Ontario definition for Type A compost and shall be supplied from composting sites certified to meet the Ontario Ministry of the Environment's Compost Regulation 101.

.6 Concrete sand shall have a pH range from 7.7 to 8.0 with a mid-range of 7.8 and shall meet gradation requirements for concrete sand as described in OPSS.

.7 Peat loam shall consist of a minimum 50% organic matter and equal parts sand, silt and clay. Peat loam shall be suitable for horticultural purposes. Shredded particles shall not exceed 16 mm in size.

.5 Equipment:

.1 Pneumatic Blower Truck: Shall be a custom manufactured, fully integrated, truck mounted unit. The blower truck shall be equipped with a computer-calibrated seed injection system and shall be capable of uniformly applying composted topsoil and seed at a rate greater than 0.25 cubic meters of material per minute. The blower truck shall also be equipped with an application hose capable of extended 90 meters from the blower truck unit.

.6 Operational Constraints :

.1 The composted topsoil and seeding operation shall not commence until a legible, valid Seed Analysis Certificate and a legible, valid signed declaration from the compost supplier has been approved by the Consultant.

.2 The composted topsoil and seeding operation shall not commence until the Consultant has approved the surface preparation and the layout of permanent seed mixes.

.3 The composted topsoil and seeding application and or the re-application shall not be carried out under adverse field conditions such as high wind, frozen soil or soil covered with snow, ice or in areas of standing water to a concentrated flow of water.

.4 The Contractor shall maintain the site and control erosion until conditions permit application or re-application of seed and compost topsoil.

.5 The surface shall be prepared not more than seven (7) calendar days before the seeding operation. No seeding or composted topsoil application shall come in contact with the foliage of any trees, shrubs, or other vegetation. No seed or composted soil application shall come in contact with water bodies.

.7 Application Rates for Composted Topsoil:

1. Depending of the slope gradation, depth and composted soil, seed shall be as follows:

0- 5% slope:	10-15 mm. depth
5- 10% slope:	15-20 mm. depth
10-25% slope:	(4:1) 20-25 mm. depth.
25-35% slope:	(3:1) 25-40 mm. depth
35-45% slope	(40-50 mm. depth

2. Composted Topsoil and Seed Application

1. Prior to the application of the composted topsoil and seeding, the Contractor shall ensure that the pneumatic blower has been properly calibrated to provide the specified amounts of seed and that the blower can adequately uniformly apply composted topsoil and seed at a rate greater than .025 cubic meters of material per minute.

2. Once the blower has been calibrated, the Contractor shall apply composted topsoil and seeding uniformly ay specified depths to all areas identified for cover in the contract drawings or as directed by the Consultant.

2.6 Water

.1 Water used should be potable and shall be free of impurities that would inhibit germination and growth or may be harmful to the environment.

2.7 Seed Protection on Slopes and Ditches

.1 Erosion Control Blanket: where applicable, refer to plans for extent.

.1 Bonterra S1 Erosion Control Blanket or approved alternate: 100% weed free wheat straw .50 lb./yd^2. Netting on top side made of photo-degradable polypropylene or alternate with

mesh openings of approximately (13 mm x 13 mm). Blanket sewn with biodegradable or photo-degradable thread on 50 mm centres or approved alternate.

.2 Cover all prepared and seeded slopes 3:1 or steeper with erosion control blanket.

.3 Unroll blanket either horizontally or vertically to the slope without stretching or pulling.

.4 Lay blanket smoothly on soil surface. Overlap adjacent sections of blanket minimum 100 mm and use metal staples.

.5 Secure blanket to ground with staples in accordance with the erosion control blanket manufacturer's instructions.

.6 Minimize damage to seedbed during installation of blanket. Re-grade by hand raking as required, to correct any damage.

.7 In ditches and swales, unroll blanket in the direction of flow. Overlap adjacent sections of blanket minimum of 100 mm with upstream section on top and stapled. Follow manufacturer's installation recommendations.

2.8 Protection of Seeded Areas - General

.1 Immediately after seeding provide adequate protection against erosion, pedestrian and vehicular traffic damages. Protect newly seeded areas along walkways using bright coloured ribbon or fencing when necessary. Remove protection after seeded areas become established or when directed by the Consultant.

.2 Keep site well drained and landscape excavations dry.

PART 3 EXECUTION

3.1 Workmanship

.1 Do not perform Work under adverse field conditions such as frozen ground or ground covered with snow, ice or standing water.

3.2 Preparation of Surfaces

.1 At the time of seeding, all top soiled areas designated for seeding shall be free from erosion and shall have a fine graded, uniform surface free of humps and hollows. The surface shall be uniformly

cultivated with agricultural implements to a minimum depth of 50mm and shall not have surface stones greater than 50mm in diameter, weeds or other unwanted vegetation. Ensure areas are free of deleterious and refuse materials.

.2 Soil to be loose, friable and suitable as a seedbed to germinate seed, free of humps and hollows and deleterious materials.

.3 Obtain approval of topsoil grade and depth from the Consultant before starting seeding.

3.3 Area and Layout

.1 The locations of the different, permanent seed mixtures and composted topsoil shall be staked out on the ground surface in accordance with the contract documents. Stakes shall be used to indicate the limits of each type of seed mix.

3.4 Seeding

.1 Schedule seeding to be carried out when seasonal conditions are likely to ensure successful germination and a continued growth of all species of seed in the grass mixture establishment. All seeding shall be done during calm weather and on soil that is free of frost, snow and standing water.

.2 Seed shall be applied by Mechanical Dry Seeding, Terra Seeding, or Hydraulic Seeding unless otherwise specified.

.3 Sow seed uniformly at the rate as per manufacturer's recommendations.

.4 Seed between August 15th and September 15th, and between April 15th and May 1st unless otherwise directed by the Consultant.

.5 Blend applications into adjacent grass areas or sodded areas previous applications to form uniform surfaces.

.6 Embed seed into soil to depth of 5 mm within one hour of sowing.

.7 Roll area immediately with water ballast type idler prior to watering.

.8 Install Erosion Control Material as per manufactured instructions in areas as shown on plans and details.

.9 Protect seeded areas against damage by using temporary protective hoarding and signage to protect newly seeded areas from damage

including erosion, pedestrian and vehicular traffic or wild life. Remove this protection after lawn areas have been accepted by the Consultant.

3.5 Establishment

.1 Perform following operations from time of seed application until Preliminary Acceptance:

.1 Repair and reseed dead or bare spots to allow establishment of seed prior to Preliminary Acceptance.

.2 Cut grass to 40 mm whenever it reaches height of 60 mm. Remove clippings which will smother grass.

.3 Fertilize seeded areas after first cutting at the recommended rate per hectare as per testing agency. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well. Postpone fertilizing until following spring if application falls within four week period prior to expected end of local growing season.

.4 Eliminate weeds by mechanical means.

3.6 Maintenance

Perform the following operations from time of installation to acceptance and until the end of warranty period:

.1 Apply water in sufficient quantities to maintain optimum soil moisture level for germination and continued healthy growth of grass. Promptly repair and reseed any damage that occurs through washout of soil.

.2 Areas with no irrigation system: supply labour, hoses and attachments necessary to provide adequate watering to prevent grass and underlying soil from drying out.

.3 Provide clean water and water hauling vehicle with proper attachments to provide efficient and adequate watering of seeded areas when necessary.

.4 Provide weed control in newly seeded areas by mowing when required or directed by the Consultant. Cut and maintain weed growth to height of 100 mm. Remove all weed and grass clippings.

.5 Control and eliminate turf damaging pests that appear in newly seeded areas.

.6 Cut lawn grass at regular intervals and maintain minimum height of 60 mm. Cut forage or native type grass at 80 to 100 mm or as directed by the Consultant. Do not cut more than 30% of blade at any one mowing. Remove clippings that will smother grass.

.7 Re-seed areas which show root growth failure, deterioration, bare or thin spots, or which have been damaged by any means or cause, including replacement operations. Overseed areas that show inadequate or improper sowing of seed from Brillion or other methods.

.8 Fertilize seeded areas during establishment period, minimum six (6) weeks after seeding, with 27-14-0 fertilizer or as directed by the Consultant. Spread evenly at rate of 3 kg/100 m^2, water in well.

.9 Maintain daily maintenance log throughout Contract. Submit copy of log data to the Consultant each week for verification. Record all maintenance activities performed on site.

.10 The Consultant may extend maintenance period at no additional cost when Contractor fails to: maintain an accurate log; submit log when required; or when unsatisfactory and inadequate maintenance occurs.

3.7 Preliminary Acceptance

.1 Seeded areas will be accepted by the Consultant provided that:

.1 Areas are uniformly established to minimum of 95% and turf is free of rutted, eroded, bare or dead spots and free of weeds.

.2 Areas have been cut at least twice.

.3 Areas have been fertilized.

.2 Areas seeded in fall which have not received two (2) cuts will be reviewed for Preliminary Acceptance the following spring, one (1) month after start of growing season provided Preliminary Acceptance conditions are fulfilled.

3.8 Restoration

.1 Upon completion of Work, remove all or any surplus materials and

debris off site.

.2 Reinstate pavement and sidewalks, all amenities, etc., at elevation which existed before excavation.

.3 Clean and reinstate areas affected by Work as directed by the Consultant.

.4 Correct any or all deficiencies previously recorded.

3.9 Warranty

.1 Guarantee seeded areas due to faulty material and workmanship for a period of two (2) years from the issue date of the Substantial Performance of the work. Refer to Section **01700** **Contract Closeout, Takeover & Warranties** for submittal requirements.

END OF SECTION - 02924

SODDING

PART 1 GENERAL

1.1 Description of Work

.1 This section describes the labour, materials, and installation requirements necessary to complete the sodding turf planting related items as indicated or specified.

1.2 Related Work

.1	All Division 1	Specification Sections
.2	Section 02906	Planting of Trees, Shrubs, Groundcovers & Transplanting
.3	Section 02911	Site Topsoil & Finish Grading
.4	Section 02924	Seeding

1.3 Scheduling

.1 Scheduled sod laying to coincide with topsoil operations.

.2 Do not lay sod until topsoil finished grade. Obtain approval of topsoil fine grade prior to sodding.

1.4 Certification

.1 The supplier shall provide, upon request of the Contractor, a label or statement certifying the quality of grade, location of sod source and species of grass in the sod, and that the sod meets the specifications or requirements.

1.5 Delivery, Storage, And Acceptability

.1 All sod shall be reviewed by the Contractor at the job site prior to installation. The Contractor reserves the right to refuse the sod if it is deemed unacceptable.

.2 Schedule delivery in order to keep storage on the job site to a minimum without causing delays.

.3 Each palette, flat, or specified group of sod shall be labelled by the grower or manufacturer as separate items.

.4 During delivery, sod materials shall be protected from any drying or contamination by detrimental material.

.5 Deliver sod to site within twenty-four (24) hours of being lifted and lay sod within thirty-six (36) hours of being lifted.

.6 Do not deliver small, irregular, or broken pieces of sod.

.7 Turf materials shall be sprinkled with water and covered with moist burlap, straw, or other approved covering and protected from sun exposure to wind and direct sunlight. Covering shall be such that air can circulate and heating will not develop.

.8 During dry weather protect sod from drying and water sod as necessary to ensure its vitality. Dry sod is to be rejected by the Contractor.

.9 Deliver fertilizers and similar material to the site packed in standard containers, clearly marked with contents, weight, analysis, and name of manufacturer.

.10 Store fertilizer in dry, weatherproof storage areas.

1.6 Alternatives

.1 Should the Contractor proceed to use material not previously approved or materials contrary to the specifications, the Consultant will proceed to have such works rectified at the Contractor's expense.

1.7 Handling

.1 Sod shall not be dropped or dumped from vehicles.

1.8 Source Quality Control

.1 The Contractor shall:

.1 Supervise all work in this section including implementation and all maintenance until Substantial Performance of the Works.

.2 Shall obtain approvals for suppliers, Sub-Contractors, and materials to be used in this section of Work;

.3 Ensure the sod supplier meets the standards and requirements of the "Nursery Sod Growers Association of Ontario"

.4 Shall obtain approvals from Consultant of sod at source and submit proof to the Consultant that the sod delivered to the site was obtained from the approved source and is #1 Nursery Sod.

PART 2 PRODUCTS

2.1 Materials

.1 Turf Grass Nursery Sod: specifically sown and cultivated in a nursery field all in compliance with the specifications published by Nursery Sod Growers Association of Ontario, Number One Grade Turfgrass Nursery Sod.

.1 Broken, dry, discoloured pieces will be rejected by the Consultant.

.2 Size of Sections: Turfgrass shall be cut by able methods by machines designed for that purpose, to the suppliers length and width, plus or minus 12mm in width and plus or minus 5% in length. Broken pieces and torn or uneven ends are not acceptable.

.3 Thickness of cut: Turfgrass sod shall be cut at a uniform soil thickness (excluding top growth and thatch) of 15mm plus or minus 5 min.

.4 Strength of sod: Minimum age of twelve (12) months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.

.1 Sod shall be strong enough that a nominal sized section can be grasped at one end, picked up and handled without damage.

.2 Sod shall have strong fibrous root system, free of stones, burned or bare spots.

.5 Moisture Content: Turfgrass sod shall not be harvested or transplanted when its moisture content is too low or too high, resulting in potential damage to the sod.

.6 Grass height: The height of the grass in the sod at the time of harvesting shall be between 40mm and 60mm.

.7 Thatch: Turfgrass sod shall be reasonably free from thatch. Up to 10 mm of thatch (uncompressed) is acceptable.

.8 Diseases, Fungi, Nematodes, Insects: Turfgrass sod shall be reasonably free from diseases, fungi, nematodes and soil-born insects, to the extent that with proper installation methods and initial maintenance new turf will not deteriorate due to such causes.

.9 Wire mesh: 40 mm, plastic.

.10 Wooden pegs, 25 x 25 x 250 mm.

.11 Water used should be potable and shall be free of impurities that would inhibit germination and growth or may be harmful to the environment.

.12 Fertilizer: As recommended by testing agency as per topsoil sample.

.13 Herbicide: type, rate, and method of application subject to approval by Consultant.

PART 3 EXECUTION

3.1 Laying of Sod

.1 Prior to sodding, the Contractor is to verify that the finished grade and depth of topsoil is satisfactory.

.2 Fertilizer as per recommendation by testing agency as per topsoil sample. Refer to Topsoil Section **02911, Subsection 3.5 Application for Fertilizer**.

.3 Sodding during excessively wet conditions, at freezing temperatures or over frozen soil is not acceptable.

.4 Lay sod in rows, perpendicular to slope, and with joints staggered. Butt sections closely without over-lapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.

.5 Where new sod abuts existing sodded areas/seeded areas, new sod must be knitted to existing with finish grade of new sod same as existing.

.6 Provide close contact between sod and soil by light rolling. Use of heavy roller to correct irregularities in grade is not permitted.

.7 Water sod immediately after laying to obtain moisture penetration into top 100 mm of topsoil.

3.2 Laying of Pegged Sod

.1 Place approved mesh on top of topsoil of slopes steeper than 3:1. Secure mesh in place with wooden pegs or staples at maximum intervals of 1000 mm. Cover mesh lightly with topsoil.

.2 Lay sod sections perpendicular to slopes greater than 3:1 (run/rise) and secure with wooden pegs. Place pegs 3 per m2, 100 mm below to edge to prevent shifting of sod and drive pegs flush with top of sod soil.

3.3 Maintenance

.1 Maintain sodded area from the time of installation until the second cut has been completed AND until Substantial Performance of the Work.

.2 Maintenance shall include all necessary measures to establish and maintain grass in a healthy, vigorous growing condition. Maintenance shall include, but not be limited to the following work until Substantial Performance of the Work

.1 Watering: When required in sufficient quantities and at a frequency to prevent sod from drying out and to maintain topsoil under sod continuously moist to a depth of 75 to100 mm. Water sufficiently to ensure that sod has become firmly rooted in the topsoil.

.2 Mowing: Regular intervals to maintain a maximum height of 50 mm. Do not cut more than 1/3 of the grass height at any one mowing. Trim and clip edges. Remove clippings.

.3 Fertilizing: If instructed by the Consultant, sodded areas may be fertilized based on mixtures and rates as per supplier's and manufacturer's instructions and soil test results. Postpone fertilizing until the spring following a fall installation.

.4 Make good any erosion that results from faulty workmanship or material at no extra cost.

.5 Replace any deteriorated or bare spots with new sod.

3.4 Sod Acceptance

.1 Prior to Substantial Performance of the works, the sodded areas shall meet the following criteria:

.1 Sodded areas are properly established and are self-sustaining.

.2 Sod is free of bare and dead spots and without weeds.

.3 No surface soil is visible when grass has been cut to height of 40 mm.

.4 Sodded areas have been cut minimum two (2) times prior to acceptance review.

.2 The Contractor is responsible to arrange review of sod for acceptance review within one (1) week after second cut. Additional cuts will be required if acceptance review meeting doesn't occur in a timely matter.

.3 Areas sodded in fall will be accepted in following spring one (1) month after start of growing season provided acceptance conditions are fulfilled.

.4 The Owner will take over the cutting of the sod following a successful acceptance review.

3.5 Cleaning

.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION - 02938

SITE FURNISHINGS

PART 1 GENERAL

1.1 Related Work

.1 All Division 1 Specification Sections

1.2 Source Quality Control

.1 Supply manufacturer's samples of finishes and anchoring systems and Shop Drawings for approval by the Consultant.

.2 **All furniture to be a City of Brampton approved standard unless otherwise noted in this section.** Refer to the Planning and Infrastructure Services Department website link indicated below for all Streetscape & Parks Construction Standard Details**:** **http://www.brampton.ca/en/Business/planningdevelopment/guidelines-manuals/Pages/Streetscape-Parks-Construction-Standard-Detail.aspx**

.3 Refer to **Section 01095 Referenced Guidelines** for a list of all Streetscape & Parks Construction Standard Details.

1.3 Inspection

.1 Refer to Section **01450 Quality Control & Inspection**

1.4 Shop Drawings and Product Literature

.1 Submit Shop Drawings and product data as requested by the Consultant.

.2 Indicate dimensions, sizes, assembly, anchorage and installation details for each furnishing specified

1.5 Maintenance Data

.1 Provide maintenance data for care and cleaning of site furnishings at the time of project close out as specified in Section **01700 Contract Closeout, Takeover & Warranties**.

PART 2 PRODUCTS

2.1 Site Furnishings

.1	Bench:	Maglin MLB1200W Black powder coat finish Surface mount 1-800-716-5506
.2	Picnic Table:	Maglin MLPT721W Black powder coat Direct burial Umbrella hole 1-800-716-5506
.3	River Pebble Mulch:	Install as per detail on L2

PART 3 – EXECUTION

3.1 Installation

.1 Install site furniture square and plumb as shown on the Contract Document drawings.

.2 Assemble furnishings in accordance with manufacturer's instructions and details as shown on L2.

.3 Touch up damaged finished to the satisfaction of the Consultant.

.4 Anchoring: All site furniture is to be surface mounted to concrete (as per manufacturer's specifications) or into unit paving. Anchoring system is to be drilled and secured with expansion epoxy grout as supplied by approved manufacturer.

.5 Use tamper-proof nuts.

END OF SECTION - 12500

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for foundation drainage Work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

.2 ASTM F449, Standard Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control.

.3 ASTM F667, Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 30 00:
  - .1 Two 300 x 300 mm samples of drainage board.
  - .2 Two 300 mm long samples of perimeter drainage and/or pipe.

2 Products

2.1 **MATERIALS**

.1 Perimeter drainage:
- .1 ASTM D3350 and ASTM F667, 100 mm diameter HDPE, perforated with fittings prewrapped with filter cloth by Ideal Pipe or approved alternative or ‘TREMDrain Total Drain’ by Tremco Inc.
- .2 Perimeter drainage system to be complete with accessories as required for complete installation including but not limited to corner guard pieces and outlet pipe connections.

.2 Drainage board: Three-dimensional dimpled core and geotextile fabric complete with adhesive or fasteners as required for installation. ‘Miradrain 6000’ by Carlisle Coatings and Waterproofing, ‘Delta-Drain 6000’ by Dorken Systems Inc., ‘TREMDrain’ by Tremco Inc. or ‘Mel-Drain 5035' by W. R. Meadows.

.3 Drainage pipe: ASTM D3350 and ASTM F667, 100 mm diameter HDPE by Ideal Pipe or approved alternative, unperforated with fittings, and perforated with fittings prewrapped with filter cloth in locations as indicated on drawings or as specified herein.

.4 Clean outs: 100 mm HDPE outlets , tees, extension pipes, reducers, flush plugs, etc. suitable for use with drainage pipe as manufactured by Canron Inc, Ideal Pipe, or approved alterative.

.5 Foundation drainage Pipe Fill: 19 mm clear stone in accordance with OPSS 1004.

.6 Granular fill: Free draining, sharp, hard, durable, granular material conforming to OPSS 1010, Type A.

.7 Filter cloth: Terrafix 270R as manufactured by Terrafix Geosynthetics Inc. or approved equivalent.

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 PREPARATION

.1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to installation.

3.3 INSTALLATION

.1 Install perimeter drainage around perimeter of basement and where indicated on Drawings.

.2 Install drainage board in accordance with ASTM F449 and manufacturer's recommendations. Drainage board shall extend full height of foundation wall to top of footing where indicated on Drawings. Install drainage board after installation of waterproofing membrane is complete. Position panel with flat side against wall and filter fabric toward soil/drainage side and attach to foundation wall using manufacturer approved fastening system.

.3 Provide unperforated drainage pipe between perforated drainage pipe and drain connection installed by Division 22 and 23.

.4 Install drainage pipe on a bed of foundation drainage fill, minimum 100 mm deep where pipe is not placed over footing, and surround with same fill 150 mm thick at sides and over top of pipe and for under floor drainage extend fill to under side of slab.

.5 Provide cleanouts on non-perforated pipe at all changes of direction and in pipe runs greater than 15 metres. Provide flush cleanouts where indicated.

.6 Cover foundation drainage fill with filter cloth. Cover filter cloth with sand 300 mm thick at top and sides.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 26 – Grounding and Bonding for Electrical Systems.

1.2 REFERENCES

.1 American Society for Testing and Materials (ASTM)

.1 ASTM A497/A497M-07, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

.2 ASTM D1056-07, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

.2 Canadian Standards Association (CSA)

.1 CAN/CSA-A3000-08, Cementitious Materials Compendium. Includes:

.1 CAN/CSA-A3001-08, Cementitious Materials for Use in Concrete.

.2 CSA-A23.1-09/A23.2-09, Concrete materials and methods of concrete construction/Test methods and standard practices for concrete.

.3 CSA G30.3-M1983(R1998), Cold-Drawn Steel Wire for Concrete Reinforcement.

.4 CSA G30.5-M1983(R1998), Welded Steel Wire Fabric for Concrete Reinforcement.

.5 CAN/CSA-G30.18-92(R2007), Billet-Steel Bars for Concrete Reinforcement.

.3 Ontario Provincial Standard Drawings (OPSD):

.1 OPSD 2100.06, December 1992, Rigid Ducts Encased in Concrete.

.2 OPSD 2101.02, December 1992, Extension of Existing Rigid Ducts Encased in Concrete.

.3 OPSD 2102.01, January 1990, Underground Rigid Duct Connection at Concrete Substructure.

.4 OPSD 2103.030, March 1998, Duct Installation in Existing Paved Area, Unshrinkable Backfill Method.

.5 OPSD 2110.010, February 1996, Electrical Maintenance Hole Cast in Place, 1200 mm x 1200 mm.

.6 OPSD 2110.050, February 1996, Electrical Maintenance Hole Cast in Place, 600 mm x 1450 mm.

.7 OPSD 2110.060, February 1996, Electrical Maintenance Hole Cast in Place, 1800 mm x 2440 mm.

.8 OPSD 2110.070, February 1996, Electrical Maintenance Hole Cast in Place, 1200 mm x 1650 mm.

.9 OPSD 2111.020, February 1996, Electrical Maintenance Hole Precast Concrete, 600 mm x 1450 mm.

.10 OPSD 2111.030, February 1996, Electrical Maintenance Hole Precast Concrete, 1200 mm dia.

.11 OPSD 2111.040, February 1996, Electrical Maintenance Hole Precast Concrete, 1200 mm x 1650 mm.

.12 OPSD 2111.050, February 1996, Electrical Maintenance Hole Precast Concrete, 1800 mm x 2400 mm.

.13 OPSD 2116.01, December 1992, Drainage Facilities for Electrical Maintenance Holes.

1.3 SUBMITTALS

.1 Submit shop drawings for precast maintenance holes in accordance with Section 26 05 00.

2 Products

2.1 PVC DUCTS

.1 PVC ducts, type EB1, encased in reinforced concrete.

2.2 PVC DUCT FITTINGS

.1 Rigid PVC opaque solvent welded translucent pushfit type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.

.2 Expansion joints.

.3 Rigid PVC 5 degree angle couplings.

2.3 PRECAST CONCRETE MAINTENANCE HOLES

.1 Precast concrete maintenance holes and auxiliary sections fabricated in steel forms.

.2 Aggregates: to CAN/CSA-A23.1/A23.2.

.3 Portland cement with 40% Fly ash10 GU HE HS.

.4 Steel welded wire fabric mesh reinforcing: to ASTM A497/A497M, CAN/CSA-G30.18.

.5 Neoprene gasket seals between maintenance hole sections: to ASTM D1056.

.6 Size: 762 mm clear diameter.

2.4 DRAINAGE

.1 Floor drain fittings in each maintenance hole consisting of floor drain, back water valve, trap and pipe connection to drainage system. Dry sump.

.2 Storm sewer connection: cast iron service saddle consisting of oil resistant gasket, stainless steel clamp and oil resistant O-ring.

.3 Sump pit: 300 mm x 300 mm x 125 mm.

2.5 MAINTENANCE HOLE NECKS

.1 Concrete brick and mortar.

2.6 MAINTENANCE HOLE FRAMES AND COVERS

.1 Cast iron maintenance hole frames and covers.

.2 Bolted on covers to prevent unauthorized entry.

.3 Size: 762 mm clear diameter.

2.7 GROUNDING

.1 Ground rods: in accordance with Section 26 05 26 for cable rack grounding.

2.8 CABLE RACKS

.1 Hot dipped galvanized cable racks and supports.

.2 12 mm x 100 mm preset inserts for rack mounting.

2.9 CABLE PULLING EQUIPMENT

.1 Pulling iron: galvanized steel rods, size and shape as indicated.

.2 Pull rope: 6 mm stranded nylon polypropylene, tensile strength 5 kN, continuous throughout each duct run with 3 m spare rope at each end.

2.10 MARKERS

.1 Concrete type cable markers: 600 mm x 600 mm x 100 mm, with words: "Cable", "Joint", "Conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.

.2 Cedar post type markers: 89 mm x 89 mm square, 1.5 m long, pressure treated with clear coloured, copper napthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing duct.

.1 Nameplate: aluminum anodized 89 mm x 125 mm, 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with words "Cable", "Joint", "Conduit" with arrows to indicate change in direction.

3 Execution

3.1 INSTALLATION GENERAL

.1 Install underground duct banks and maintenance holes including formwork.

.2 Build duct bank and maintenance holes on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density.

.3 Open trench completely between maintenance holes to be connected before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.

.4 Prior to laying ducts, construct "mud slab" not less than 75 mm thick.

.5 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.

.6 Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.

.7 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than [40] [75] mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with 75 mm thick concrete cover. Use galvanized steel conduit for sections extending above finished grade level.

.8 Make transpositions, offsets and changes in direction using 5 degree bend sections, do not exceed a total of 20 degree with duct offset.

.9 Use bell ends at duct terminations in maintenance holes or buildings.

.10 Use conduit to duct adapters when connecting to conduits.

.11 Terminate duct runs with duct coupling set flush with end of concrete envelope when dead ending duct bank for future extension.

.12 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.

.13 Allow concrete to attain 50% of its specified strength before backfilling.

.14 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.

.15 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.

.16 Immediately after placing of concrete, pull through each duct steel wooden mandrel not less than 300 mm long and of diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Pull stiff bristle brush through each duct immediately before pulling-in cables.

.17 Install four 3 m lengths of 15M 10M reinforcing rods, one in each corner of duct bank when connecting duct to maintenance holes or buildings. Wire rods to 15M 10M dowels at maintenance or building and support from duct spacers. Protect existing cables and equipment when breaking into existing maintenance holes. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.

.18 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.

3.2 MAINTENANCE HOLES

.1 Build cast-in-place maintenance holes.

.2 Install precast maintenance holes.

.3 Place concrete in two lifts with slab and sump in first, walls, roof and neck in second lift. Provide key in walls to slab. Place 100 mm x 6 mm PVC water bar vertically in key. Install ground rod before placing slab and place reinforcing steel, inserts for cable rack, pulling irons, drain, duct outlets, duct run dowels before casting walls. Make maintenance hole to duct connection as indicated.

.4 Provide 115 mm deep window to facilitate cable bends in wall at each duct connection. Terminate ducts in bell-end fitting flush with window face. Provide four 10M steel dowels at each duct run connection to anchor duct run. On runs of 16 ducts and greater, support concrete duct encasement on a 700 mm wide by 75 mm thick concrete pier poured against maintenance hole wall between slab and bottom of duct run, provide dowels for anchoring.

.5 Alternately connect large duct runs by leaving square opening in wall, later pouring duct run and wall opening in one pour, and install 10M x 3 m reinforcing rods in duct run at maintenance hole connection.

.6 Build up concrete maintenance hole neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas.

.7 Install maintenance hole frames and covers for each maintenance hole. Set frames in concrete grout onto maintenance hole neck.

.8 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.

.9 Install cable racks, anchor bolts and pulling irons as indicated.

.10 Grout frames of maintenance holes. Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic slurry.

.11 Ensure filling of voids in joint being sealed. Plaster with cement grout, walls, ceiling and neck.

.12 Spray paint "X" on ceiling of maintenance hole above floor drain or sump pit.

3.3 MARKERS

.1 Mark location of duct runs under hard surfaced areas not terminating in maintenance hole with railway spike driven flush in edge of pavement, directly over run. Place concrete duct marker at ends of such duct runs. Construct markers and install flush with grade.

.2 Mark ducts every 150 m along straight runs and changes in direction.

.3 Where markers are removed to permit installation of additional duct, reinstall existing markers.

.4 Lay concrete markers flat and centered over duct with top 25 mm above earth surface.

.5 Provide drawings showing locations of markers.

3.4 SITE TESTS AND INSPECTIONS

.1 Inspection of duct will be carried out by Consultant prior to placing.

.2 Placement of concrete and duct cleanout to be done when Consultant present.

3.5 WASTE MANAGEMENT

.1 Separate and recycle waste materials in accordance with Section 26 05 00.

.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 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant.

.5 Divert unused and broken concrete materials from landfill to local quarry facility as approved by Consultant.

.6 Divert unused aggregate materials from landfill to quarry facility for reuse as approved by Consultant.

.7 Fold up metal banding, flatten and place in designated area for recycling.

End of Section

1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.2 No. 211.1-M1984(R1999), Rigid Types EBI and DB2/ES2 PVC Conduit.

.2 CSA C22.2 No. 211.3-96(R2000), Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Bi-national standard, with UL 1684).

1.2 SUBMITTALS

.1 In accordance with Section 26 05 00.

.2 Submit WHMIS MSDS - Material Safety Data Sheets acceptable to Labour Canada and Health and Welfare Canada for solvent cement. Indicate VOC content.

2 Products

2.1 PVC DUCTS AND FITTINGS

.1 Rigid PVC duct: to CSA C22.2 No. 211.1, Type DB2/ES2, with fabricated moulded fittings, for direct burial expanded flange ends, Trade size 5. Nominal length: 6 m plus or minus 12 mm.

.2 Rigid PVC split ducts.

.3 Rigid PVC bends, couplings, reducers, bell end fittings, plugs, caps, adaptors same product material as duct, to make complete installation.

.4 Rigid PVC 90° and 45° bends.

.5 Rigid PVC 5° angle couplings.

2.2 SOLVENT WELD COMPOUND

.1 Solvent cement for PVC duct joints.

2.3 CABLE PULLING EQUIPMENT

.1 6 mm stranded nylon pull rope tensile strength 5 kN.

3 Execution

3.1 EXAMINATION

.1 Verification of Conditions:

.1 Before commencing work establish locations of buried services on and adjacent to site.

.2 Evaluation and Assessment:

.1 Arrange with appropriate authority for relocation of buried services that interfere with execution of work. Pay costs of relocating services.

.2 Before commencing work, conduct, with Departmental Representative, condition survey of existing structures, trees and plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by work.

3.2 PREPARATION

.1 Temporary Erosion and Sedimentation Control:

.1 Use 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, in accordance with 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.

.2 Protection of in-place conditions:

.1 Protect excavations from freezing.

.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 Departmental Representative's 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 to remain undisturbed.

.3 Removal:

.1 Remove obsolete buried services within 2 m of foundations. Cap cut-offs.

.2 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

.3 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

.4 Remove trees, stumps, logs, brush, shrubs, bushes, vines, undergrowth, rotten wood, dead plant material, exposed boulders and debris within areas designated on drawings.

.5 Remove stumps and tree roots below footings, slabs, and paving, and to 600 mm below finished grade elsewhere.

3.3 EXCAVATION

.1 Shore and brace excavations, protect slopes and banks and perform work in accordance with Provincial and Municipal regulations.

.2 Do blasting in accordance with Provincial and Municipal regulations. Repair damage to approval of Departmental Representative. No blasting will be permitted within 3 m of any building and where damage would result.

.3 Topsoil stripping:

.1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected.

.2 Strip topsoil to depths as directed by Departmental Representative. Avoid mixing topsoil with subsoil.

.3 Strip topsoil over areas to be covered by new construction, over areas where grade changes are required, and so that excavated material may be stockpiled without covering topsoil.

.4 Stockpile in locations as directed by Owner.

.4 Excavate as required to carry out work, in all materials met.

.1 Do not disturb soil or rock below bearing surfaces. Notify Departmental Representative when excavations are complete.

.2 If bearings are unsatisfactory, additional excavation will be authorized in writing and paid for as additional work.

.3 Fill excavation taken below depths shown without Owner's written authorization with concrete of same strength as for footings.

3.4 INSTALLATION

.1 Install duct in accordance with manufacturer's instructions.

.2 Clean inside of ducts before laying.

.3 Ensure full, even support every 1.5 m throughout duct length.

.4 Slope ducts with 1 to 400 minimum slope.

.5 During construction, cap ends of ducts to prevent entrance of foreign materials.

.6 Pull through each duct steel mandrel not less than 300 mm long and of diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling-in cables.

.7 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.

.8 Install markers as required.

.9 Arrange for inspection of installation by Electrical Inspector prior to commencing backfill.

3.5 BACKFILLING

.1 Reinstate existing conditions.

.2 Start backfilling only after inspection and receipt of written approval of fill material and spaces to be filled from Departmental Representative.

.3 Remove snow, ice, construction debris, organic soil and standing water from spaces to be filled.

.4 Lateral support: maintain even levels of backfill around structures as work progresses, to equalize earth pressures.

.5 Under seeded and sodded areas: use site excavated material to bottom of topsoil except in trenches and within 600 mm of foundations.

.6 Blown rock material, not capable of fine grading, is not acceptable, imported material is to be placed on this type of material.

.7 Against foundations (except as applicable to trenches and under slabs and paving): excavated material or imported material with no stones larger than 200 mm diameter within 600 mm of structures.

.8 Underground tanks: use sand to bottom of granular base courses or to bottom of topsoil, as applicable.

3.6 GRADING

.1 Grade to ensure that water will drain away from buildings, walls and paved areas, to catch basins and other disposal areas approved by Owner. Grade to be gradual between finished spot elevations as indicated.

3.7 WASTE MANAGEMENT

.1 Separate and recycle waste materials in accordance with Section 26 05 00.

.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 preservative treated wood through incineration.

.7 Do not dispose of preservative treated wood with other materials destined for recycling or reuse. Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill as approved by Departmental Representative.

.8 Dispose of unused wood preservative material at official hazardous material collections site. Do not dispose of unused preservative material into sewer system, into streams, lakes, onto ground or in other location where they will pose health or environmental hazard.

.9 Dispose of unused solvent cement at an official hazardous material collections sites as approved by Departmental Representative. Do not dispose of unused solvent cement into sewer system, into streams, lakes, onto ground or in other location where they will pose health or environmental hazard.

End of Section

1 General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 – Common Work Results for Electrical.

.2 Section 31 23 00 – Excavation and Fill.

1.2 REFERENCES

.1 Canadian Standards Association (CSA),

.1 CAN/CSA-A3000, Cementitious Materials Compendium. Includes:

.1 CAN/CSA-A5, Portland Cement

.2 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.

.3 CSA G30.3, Cold-Drawn Steel Wire for Concrete Reinforcement.

.4 CSA G30.5, Welded Steel Wire Fabric for Concrete Reinforcement.

.5 CSA-G30.18, Billet-Steel Bars for Concrete Reinforcement.

.2 American Society for Testing and Materials (ASTM),

.1 ASTM D1056, Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.

1.3 SUBMITTALS

.1 Submit manufacturer's test data and certification at least 2 weeks prior to commencing work.

.2 Submit manufacturer's information data sheets and instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section 26 05 00.

1.5 CLOSEOUT SUBMITTALS

.1 Record documentation: provide record drawings, including details of pipe and duct bank materials, maintenance and operating instructions.

2 Products

2.1 MANHOLES

.1 Pre-cast or cast-in-place

.2 Designed for heavy traffic (buses) area

.3 Concrete neck between manhole and cover frame

.4 Cast iron covers and frames flush with finished grade

.5 Hot-dipped galvanized steel cable racks and supports

.6 Hot-dipped galvanized steel pulling loops opposite each conduit bank opening

.7 Copper-clad steel ground rod connected to the building perimeter grounding loop

2.2 HANDHOLES

.1 Precast concrete

.2 Designed for heavy traffic areas

.3 Bolt down cast iron covers

.4 Ground all metal components except the cover

3 Execution

3.1 INSTALLATION

.1 Manholes:

.1 Ground all metal components except the cover

.2 Ground incoming as per Alectra/ESA requirements

.3 Provide manholes in conduit banks where the conduit bank changes direction more that 30º and such that no one section of the conduit bank exceeds 50 m.

.2 Handholes

.1 Maximum spacing 45 m.

.2 Separate handholes for power and communications systems. Different communications systems may be combined into single handhole. Power supply for different system of the same voltage may be combined into single handhole.

End of Section

CITY OF BRAMPTON FIRE STATION #201

27 Rutherford Road South, Brampton, Ontario

salter pilon architecture inc.

Appendix

- Door Schedule
- Colour and Material Schedule
- March Alert Station Controller Installation Guide

BFES Station 201
25 Rutherford Road S, Brampton, Ontario

Job No. 22625

Architect
Salter Pilon Architecture
151 Ferris Lane
Suite 400
Barrie, Ontario

Coordinator
Jennifer Fleming - UCSH Barrie
Tel: 705-733-3507
Fax: 705-739-5169
E-Mail: jenf@ucsh.com

Consultant

Steve Robinson - UCSH Barrie
Tel: 705-733-3507
Fax: 705-739-5169
E-Mail: stever@ucsh.com

Submittal Date: **June 16, 2021**

Openings Schedule

Hardware Group	Qty	Opening Number(s)	Location 1	To/ From	Location 2	Hand	Nominal Width	Nominal Height	Door Thickness	Door Mat'l	Frame Mat'l	Label
001	1	101A	EXTERIOR	FROM	VESTIBULE 101B	RHR	1100	2150	57	AL	AL	
002	1	101B	VESTIBULE 101	FROM	CORRIDOR 106	LHR	1050	2150	45	HM	HM	
003	1	102	VESTIBULE 101	TO	UNIVERSAL WASHROOM 102	LH	1050	2150	45	HM	HM	
004	1	103	CORRIDOR 106	TO	DC DORM/OFFICE 103	RH	950	2150	45	HM	HM	45 MIN
005	1	104	CORRIDOR 106	TO	PC DORM/OFFICE 104	RH	950	2150	45	HM	HM	45 MIN
006	1	105	CORRIDOR 106	TO	OPEN ADMIN OFFICE 105	LH	950	2150	45	AL	AL	
007	1	106	CORRIDOR 106	FROM	FITNESS ROOM 117	LHR	950	2150	45	HM	HM	
008	1	107	CORRIDOR 106	FROM	DORMS 107	RHR	950	2150	45	HM	HM	45 MIN
009	1	108	CORRIDOR 106	TO	ELECTRICAL 108	LH	950	2150	45	HM	HM	45 MIN
009	1	110	CORRIDOR 106	TO	IT ROOM 110	LH	950	2150	45	HM	HM	45 MIN
009	1	111	CORRIDOR 106	TO	MECHANICAL 111	RH	950	2150	45	HM	HM	45 MIN
010	1	109	CORRIDOR 106	TO	JANITOR 109	RH	950	2150	45	HM	HM	45 MIN
011	1	112	CORRIDOR 106	TO	LOCKER ROOM 112	LH	950	2150	45	HM	HM	
012	1	113	LOCKER ROOM 112	TO	WASHROOM 113	RH	950	2150	45	HM	HM	
012	1	114	LOCKER ROOM 112	TO	WASHROOM 114	LH	950	2150	45	HM	HM	
012	1	115	LOCKER ROOM 112	TO	WASHROOM 115	RH	950	2150	45	HM	HM	
013	1	116	LOCKER ROOM 112	TO	WASHROOM 116	LH	950	2150	45	HM	HM	
014	1	117	CORRIDOR 106	FROM	LOCKER ROOM 112	RHR	950	2150	45	HM	HM	
015	1	118	EXTERIOR PATIO AREA	TO	KITCHEN/MEETING 118	RH	1000	2150	57	AL	AL	
016	1	120A	CORRIDOR 106	TO	OUTDOOR STORAGE 120	RH	950	2150	45	HM	HM	45 MIN
017	1	120B	EXTERIOR PATIO AREA	FROM	OUTDOOR STORAGE 120	LHR	1200	2150	45	HM	HM	
018	1	121A	STAFF ENTRANCE 121	FROM	CORRIDOR 122	RHR	1050	2150	45	HM	HM	
019	1	121B	EXTERIOR	FROM	STAFF ENTRANCE 121	LHR	1100	2150	57	AL	AL	
020	1	123	CORRIDOR 122	TO	MED. STOR 123	RH	950	2150	45	HM	HM	45 MIN
021	1	124A	APPARATUS BAY 131	TO	DECON. 124	RH	950	2150	45	HM	HM	60 MIN
022	1	124B	CORRIDOR 122	TO	DECON. 124	RH	950	2150	45	HM	HM	
023	1	125A	APPARATUS BAY 131	TO	GEAR LAUNDRY 126	RH	950	2150	45	HM	HM	60 MIN
024	1	125B	CORRIDOR 106	TO	CLEAN/LAUNDRY 125	RH	950	2150	45	HM	HM	
025	1	126	APPARATUS BAY 131	TO	GEAR LAUNDRY 126	RH	1050	2150	45	HM	HM	
025	1	127B	GEAR LAUNDRY 126	TO	BUNKER GEAR 127	LH	1050	2150	45	HM	HM	
026	1	127A	APPARATUS BAY 131	TO	BUNKER GEAR 127	SLIDER	2500	2350	45	AL	AL	
027	1	128	APPARATUS BAY 131	TO	TOOL 128	RH	950	2150	45	HM	HM	
027	1	130	APPARATUS BAY 131	TO	HOSE TOWER 130	RH	950	2150	45	HM	HM	
028	1	129	APPARATUS BAY 131	TO	COMPR 129	LH	950	2150	45	HM	HM	
029	1	131A	CORRIDOR 122	TO	APPARATUS BAY 131		950	2150	45	HM	HM	60 MIN
030	1	131B	EXTERIOR	FROM	APPARATUS BAY 131	LHR	950	2150	45	HM	HM	
031	1	FD-1	EXTERIOR	FROM	APPARATUS BAY 131	FOLD	4270	4270		-	-	
031	1	FD-2	EXTERIOR	FROM	APPARATUS BAY 131	FOLD	4270	4270		-	-	
031	1	FD-3	EXTERIOR	FROM	APPARATUS BAY 131	FOLD	4270	4270		-	-	

Hardware Group	Qty	Opening Number(s)	Location 1	To/ From	Location 2	Hand	Nominal Width	Nominal Height	Door Thickness	Door Mat'l	Frame Mat'l	Label
031	1	FD-4	EXTERIOR	FROM	APPARATUS BAY 131	FOLD	4270	4270		-	-	
032	1	OH-1	EXTERIOR	FROM	APPARATUS BAY 131	OH	4270	4270	35	-	-	
032	1	OH-2	EXTERIOR	FROM	APPARATUS BAY 131	OH	4270	4270	35	-	-	
032	1	OH-3	EXTERIOR	FROM	APPARATUS BAY 131	OH	4270	4270	35	-	-	
032	1	OH-4	EXTERIOR	FROM	APPARATUS BAY 131	OH	4270	4270	35	-	-	
033	1	MISC-1								-	-	

Hardware Schedule

Heading #001

1 Single door 101A, EXTERIOR FROM VESTIBULE 101B RHR

1100 x 2150 x 57 - AL DR x AL FR

1	Continuous Hinge	SL27 HD CL LL x 2111	
1	Electric Strike	9600-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Dead Lock	28-4875 C26D RHR LC	C26D
1	Mortise Housing	320275 26 Z20 N	626
2	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Exit Device	31-AD8504 J L/Trim RHR LC C32D 1100	C32D
2	Rim Housing	320475 H 26 Y0ZN 626	626
3	Permanent Core	Permanent Core - By City of Brampton	
1	Door Pull	GSH 1180-2 #4B Mtg (57mm Dr) C32D	C32D
1	Auto Operator	4000 628 (Push)	628
2	Push Button	CM-46/4 C32D	C32D
1	Relay	CX-33	
1	Overhead Door Stop	699S C26D RHR (110°)	C26D
1	Threshold	CT-46 x 1100	
1	Weatherstripping	Weatherstrip - By Aluminum Door Supplier	
1	Door Sweep	W-24S-CA x 1100	CA
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

NOTE:
- DEADLOCK ONLY TO BE USED IN THE EVENT OF AN EMERGENCY. CONFIRM ACCEPTANCE WITH LOCAL JIRISDICTION HAVING AUTHORITY.
- CONFIRM MODE OF OPERATION WITH CLIENT.

Heading #002

1 Single door 101B, VESTIBULE 101 FROM CORRIDOR 106 LHR

1050 x 2150 x 45 - HM DR x HM FR

1	Continuous Hinge	SL24 HD CL LL x 2111	
1	Electric Strike	9400-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Rim Housing	320475 H 26 Y0ZN 626	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Exit Device	31-8804 J L/Trim LHR LC C32D 1050	C26D/US32D
1	Permanent Core	Permanent Core - By City of Brampton	
1	Door Pull	GSH 1180-2 TB C32D	C32D
1	Auto Operator	7000 628 (Push)	628
2	Push Button	CM-46/4 C32D	C32D
1	Relay	CX-33	
1	Kick Plate	GSH 80A C32D (200 x 1010) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #003

1 Single door 102, VESTIBULE 101 TO UNIVERSAL WASHROOM 102 LH

1050 x 2150 x 45 - HM DR x HM FR

3	Standard Hinge	LH1368CB 127 x 114 C26D	C26D
1	Lockset	8204 LNL C32D LH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-F-630-LBM- 2005M3	630-LBM
1	Power Supply	CX-PS13V3	
1	Auto Operator	7000 628 (Pull)	628
2	Push Button	CM-46/4 C32D	C32D
1	Restroom Control Kit	CX-WC13FM (Less Door Contact)	
1	Emergency Call Kit	CX-WEC10	
1	Kick Plate	GSH 80A C32D (305 x 1010) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Opening Schematic	Opening Schematic - By UC Access	

MODE OF OPERATION:
1. TO OPEN DOOR ACTIVATE THE DOOR BY THE EXTERIOR BARRIER FREE PUSH PLATE AND DOOR WILL SLOWLY POWER OPEN. TIME OUT AND SLOWLY CLOSE.
2. TO LOCK DOOR FOR PRIVACY ACTIVATE PUSH TO LOCK SWITCH, POWER WILL BE CUT TO EXTERIOR BARRIER PUSH PLATE CREATING PRIVACY.
3. ALSO ON ACTIVATION OF THE INTERIOR PUSH TO LOCK SWITCH (#2).
4. TO EXIT WASHROOM ACTIVATE INTERIOR BARRIER FREE PUSH PLATE AND THE DOOR WILL SLOWLY OPEN (#3).
5. MANUAL NON B/FREE.
6. IN NON FIRE RATED APPLICATION, IF THE WASHROOM IS VACANT THE DOOR CAN BE MANUALLY PUSHED OPEN AS THE ELECTRIC STRIKE WILL NOT ENGAGED.
7. IN A FIRE RATED APPLICATION A KEY WILL BE REQUIRED TO OPERATE THE DOOR MANUALLY (#1). THE KEY WILL UNLOCK THE STOREROOM FUNCTION LOCKSET AS THE ELECTRIC STRIKE MUST BE ENGAGED TO MEET THE FIRE CODE REQUIREMENT FOR SELF LATCHING.
#1 - DOOR CAN ALSO BE OPENED IN A FIRE RATED APPLICATION BY EXTERIOR ACTUATOR IF ROOM IS NOT OCCUPIED.
#2 - THE EXTERIOR "AURA" PUSH PLATE WILL CHANGE ILLUMINATION FROM GREEN TO RED ADVISING THAT THE DOOR IS LOCKED AND THE ROOM IS OCCUPIED. AS WELL THE ILLUMINATED PUSH TO LOCK BUTTON. THE INTERIOR PUSH PLATE IS NOT ILLUMINATED.
#3 - THE SYSTEM WILL ALSO RESET IF THE DOOR IS OPENED MANUALLY WITH THE DOOR LEVER.

NOTE:
- DO NOT USE DOOR CONTACT - UTILIZE LBM IN ELECTRIC STRIKE.
- 120V & LOW VOLTAGE WIRING BY ELECTRICAL CONTRACTOR.
- OCCUPIED & EMERG KIT TO BE INSTALLED TO CONTROL. THE PRIVACY OF THE OCCUPANT, IN CONJUNCTION WITH AUTO DOOR OPERATOR AS WELL AS PROVIDED EMERGENCY RESPONSE CAPABILITIES, INCLUDING ALARMS INSIDE & OUTSIDE OF WASHROOM.
- ELECTIRC STRIKE TO BE TIED INTO AUTOMATIC DOOR OPERATOR AS WELL AS BOTH INTERIOR ACTUATORS & EXTERIOR ACTUATOR.
- DOOR OPERATOR TO BE INSTALLED BY A FACTORY TRAINED INSTALLER AS PART OF THE FINISHING HARDWARE CONTRACT. ALL WIRES TO BE RUN BY THE ELECTRICAL CONTRACTOR.

Heading #004

1 Single door 103, CORRIDOR 106 TO DC DORM/OFFICE 103 RH

950 x 2150 x 45 - HM DR x HM FR - 45 MIN

CONFIRM HARDWARE & LOCK FUNCTION

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Privacy Set	8265 LNL C32D RH	C32D
1	Surface Closer	1431 OT EN TB RH	EN
1	Drop Plate	1431D EN	EN
1	Overhead Door Stop	698S C26D RH (95°)	C26D
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA

Heading #005

1 Single door 104, CORRIDOR 106 TO PC DORM/OFFICE 104 RH

950 x 2150 x 45 - HM DR x HM FR - 45 MIN

CONFIRM HARDWARE & LOCK FUNCTION

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Privacy Set	8265 LNL C32D RH	C32D
1	Surface Closer	1431 OT EN TB RH	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA

Heading #006

1 Single door 105, CORRIDOR 106 TO OPEN ADMIN OFFICE 105 LH

950 x 2150 x 45 - AL DR x AL FR

1	Continuous Hinge	SL24 HD CL LL x 2111	
1	Latchset	8215 LNL C32D LH	C32D
1	Wall Door Stop	GSH 250B C32D	C32D

Heading #007

1 Single door 106, CORRIDOR 106 FROM FITNESS ROOM 117 LHR

950 x 2150 x 45 - HM DR x HM FR

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Door Pull	GSH 4209-2 TB C32D	C32D
1	Push Plate	GSH 81A C32D (101 x 406) TM	C32D
1	Surface Closer	1431 CPS TB EN LHR	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D

Heading #008

1 Single door 107, CORRIDOR 106 FROM DORMS 107 RHR

950 x 2150 x 45 - HM DR x HM FR - 45 MIN

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Latchset	8215 LNL C32D RHR	C32D
1	Surface Closer	1431 CPS TB EN RHR	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA

Heading #009

1 Single door 108, CORRIDOR 106 TO ELECTRICAL 108	LH
1 Single door 110, CORRIDOR 106 TO IT ROOM 110	LH
1 Single door 111, CORRIDOR 106 TO MECHANICAL 111	RH

950 x 2150 x 45 - HM DR x HM FR - 45 MIN

9	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
2	Lockset	8204 LNL C32D LH	C32D
1	Lockset	8204 LNL C32D RH	C32D
3	Mortise Housing	320275 26 Z20 N	626
3	Cylinder Collar	94-0188 626	626
3	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
3	Permanent Core	Permanent Core - By City of Brampton	
3	Electric Strike	1006CLB-630-LBM- 2005M3	630-LBM
3	Power Supply	Power Supply - By Security Contractor	
3	Proximity Reader	Proximity Reader - By Security Contractor	
2	Surface Closer	1431 O TB EN LH (Pull)	EN
1	Surface Closer	1431 O TB EN RH (Pull)	EN
3	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
3	Wall Door Stop	GSH 250B C32D	C32D
3	Weatherstripping	W-66-BL x 5300	BL
3	Door Sweep	W-24S-CA x 950	CA
3	Door Contact	Door Contact - By Security Contractor	
3	Opening Schematic	Opening Schematic - By UC Access	

Heading #010

1 Single door 109, CORRIDOR 106 TO JANITOR 109 RH

950 x 2150 x 45 - HM DR x HM FR - 45 MIN

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Lockset	8204 LNL C32D RH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Surface Closer	1431 O TB EN RH (Pull)	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA

Heading #011

1 Single door 112, CORRIDOR 106 TO LOCKER ROOM 112 LH

950 x 2150 x 45 - HM DR x HM FR

CONFIRM HARDWARE

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Door Pull	GSH 4209-2 TB C32D	C32D
1	Push Plate	GSH 81A C32D (101 x 406) TM	C32D
1	Surface Closer	1431 OT EN TB LH	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D

Heading #012

1 Single door 113, LOCKER ROOM 112 TO WASHROOM 113 RH
1 Single door 114, LOCKER ROOM 112 TO WASHROOM 114 LH
1 Single door 115, LOCKER ROOM 112 TO WASHROOM 115 RH

950 x 2150 x 45 - HM DR x HM FR

9	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Privacy Set	8265 LNL C32D LH	C32D
2	Privacy Set	8265 LNL C32D RH	C32D
3	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
3	Floor Door Stop	GSH 209 C26D	C26D

Heading #013

1 Single door 116, LOCKER ROOM 112 TO WASHROOM 116 LH

950 x 2150 x 45 - HM DR x HM FR

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Privacy Set	8265 LNL C32D LH	C32D
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D

Heading #014

1 Single door 117, CORRIDOR 106 FROM LOCKER ROOM 112 RHR

950 x 2150 x 45 - HM DR x HM FR

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Door Pull	GSH 4209-2 TB C32D	C32D
1	Push Plate	GSH 81A C32D (101 x 406) TM	C32D
1	Surface Closer	1431 CPS TB EN RHR	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D

Heading #015

1 Single door 118, EXTERIOR PATIO AREA TO KITCHEN/MEETING 118 RH

1000 x 2150 x 57 - AL DR x AL FR

CONFIRM DOOR WILL ACCEPT MORTISE LOCK

1	Continuous Hinge	SL27 HD CL LL x 2111	
1	Lockset	8204 LNL (57mm Door) C32D RH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Surface Closer	351 OT TB EN RH (Pull)	EN
1	Drop Plate	351D EN	EN
1	Overhead Door Stop	699S C26D RH (110°)	C26D
1	Threshold	CT-46 x 1000	
1	Weatherstripping	Weatherstrip - By Aluminum Door Supplier	
1	Door Sweep	W-24S-CA x 1000	CA
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #016

1 Single door 120A, CORRIDOR 106 TO OUTDOOR STORAGE 120 RH

950 x 2150 x 45 - HM DR x HM FR - 45 MIN

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Lockset	8204 LNL C32D RH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Surface Closer	1431 O TB EN RH (Pull)	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #017

1 Single door 120B, EXTERIOR PATIO AREA FROM OUTDOOR STORAGE 120 LHR

1200 x 2150 x 45 - HM DR x HM FR

1	Continuous Hinge	SL24 HD CL LL x 2111	
1	Lockset	8204 LNL C32D LHR	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Surface Closer	351 CPS TB EN RH	EN
1	Armor Plate	GSH 80A C32D (838 x 1150) TM	C32D
1	Threshold	CT-46 x 1200	
1	Head Seal	W-20N-CA x 1200 (Install Prior To Closer)	CA
2	Jamb Seal	W-16N-CA x 2150	CA
1	Door Sweep	W-24S-CA x 1200	CA
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #018

1 Single door 121A, STAFF ENTRANCE 121 FROM CORRIDOR 122 RHR

1050 x 2150 x 45 - HM DR x HM FR

1	Continuous Hinge	SL24 HD CL LL x 2111	
1	Door Pull	GSH 1180-2 TB C32D	C32D
1	Push Plate	GSH 81A C32D (101 x 406) TM	C32D
1	Surface Closer	351 CPS TB EN LH	EN
1	Kick Plate	GSH 80A C32D (200 x 1010) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D

Heading #019

1 Single door 121B, EXTERIOR FROM STAFF ENTRANCE 121 LHR

1100 x 2150 x 57 - AL DR x AL FR

1	Continuous Hinge	SL27 HD CL LL x 2111	
1	Electric Strike	9600-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Rim Housing	320475 H 26 Y0ZN 626	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Exit Device	31-AD8504 J L/Trim LHR LC C32D 1100	C32D
1	Permanent Core	Permanent Core - By City of Brampton	
1	Door Pull	GSH 1180-2 #4B Mtg (57mm Dr) C32D	C32D
1	Surface Closer	351 P10 TB EN RH	EN
1	Drop Plate	351D EN	EN
1	Blade Stop	581-2 EN	EN
1	Overhead Door Stop	698S C26D LHR (90°)	C26D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Threshold	CT-46 x 1100	
1	Weatherstripping	Weatherstrip - By Aluminum Door Supplier	
1	Door Sweep	W-24S-CA x 1100	CA
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #020

1 Single door 123, CORRIDOR 122 TO MED. STOR 123 RH

950 x 2150 x 45 - HM DR x HM FR - 45 MIN

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Lockset	8204 LNL C32D RH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Surface Closer	1431 O TB EN RH (Pull)	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #021

1 Single door 124A, APPARATUS BAY 131 TO DECON. 124 RH

950 x 2150 x 45 - HM DR x HM FR - 60 MIN

CONFIRM HARDWARE & MODE OF OPERATION

3	Standard Hinge	LH1399CB 114 x 101 C32D	C32D
1	Lockset	8204 LNL C32D RH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Auto Door Operator Supplier	
1	Auto Operator	7000 628 (Pull)	628
2	Push Button	CM-46/4 C32D	C32D
1	Relay	CX-33	
1	Push To Lock	CM-45/85SSE1 4 1/2"	
1	Push For Assistance	CM-450R/12	
1	Assistance Requested Light	CM-AF50/SO	
1	Assistance Required Light	CM-AF141SO	
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA

Heading #022

1 Single door 124B, CORRIDOR 122 TO DECON. 124 RH

950 x 2150 x 45 - HM DR x HM FR

CONFIRM HARDWARE & MODE OF OPERATION

3	Standard Hinge	LH1399CB 114 x 101 C32D	C32D
1	Lockset	8204 LNL C32D RH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-F-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Auto Door Operator Supplier	
1	Auto Operator	7000 628 (Pull)	628
2	Push Button	CM-46/4 C32D	C32D
1	Relay	CX-33	
1	Push To Lock	CM-45/85SSE1 4 1/2"	
1	Push For Assistance	CM-450R/12	
1	Assistance Requested Light	CM-AF50/SO	
1	Assistance Required Light	CM-AF141SO	
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D

Heading #023

1 Single door 125A, APPARATUS BAY 131 TO GEAR LAUNDRY 126 RH

950 x 2150 x 45 - HM DR x HM FR - 60 MIN

3	Standard Hinge	LH1399CB 114 x 101 C32D	C32D
1	Latchset	8215 LNL C32D RH	C32D
1	Surface Closer	1431 O TB EN RH (Pull)	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA

Heading #024

1 Single door 125B, CORRIDOR 106 TO CLEAN/LAUNDRY 125 RH

950 x 2150 x 45 - HM DR x HM FR

3	Standard Hinge	LH1399CB 114 x 101 C32D	C32D
1	Latchset	8215 LNL C32D RH	C32D
1	Surface Closer	1431 O TB EN RH (Pull)	EN
1	Drop Plate	1431D EN	EN
1	Overhead Door Stop	698S C26D RH (90°)	C26D
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D

Heading #025

1 Single door 126, APPARATUS BAY 131 TO GEAR LAUNDRY 126 RH

1 Single door 127B, GEAR LAUNDRY 126 TO BUNKER GEAR 127 LH

1050 x 2150 x 45 - HM DR x HM FR

2	Continuous Hinge	SL24 HD CL LL x 2111	
1	Latchset	8215 LNL C32D LH	C32D
1	Latchset	8215 LNL C32D RH	C32D
1	Surface Closer	351 O TB EN LH (Pull)	EN
1	Surface Closer	351 O TB EN RH (Pull)	EN
2	Armor Plate	GSH 80A C32D (838 x 1010) TM - Confirm Plate Size	C32D
2	Wall Door Stop	GSH 250B C32D	C32D

Heading #026

1 Single door 127A, APPARATUS BAY 131 TO BUNKER GEAR 127 SLIDER

2500 x 2350 x 45 - AL DR x AL FR

POWER OPERATED SLIDING DOOR

HARDWARE COMPLETE BY ALUMINUM DOOR SUPPLIER

Heading #027

1 Single door 128, APPARATUS BAY 131 TO TOOL 128 RH
1 Single door 130, APPARATUS BAY 131 TO HOSE TOWER 130 RH

950 x 2150 x 45 - HM DR x HM FR

CONFIRM HARDWARE

6	Standard Hinge	LH1399CB 114 x 101 C32D	C32D
2	Latchset	8215 LNL C32D RH	C32D
2	Surface Closer	1431 O TB EN RH (Pull)	EN
2	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
2	Wall Door Stop	GSH 250B C32D	C32D

Heading #028

1 Single door 129, APPARATUS BAY 131 TO COMPR 129 LH

950 x 2150 x 45 - HM DR x HM FR

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Lockset	8204 LNL C32D LH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Surface Closer	1431 O TB EN LH (Pull)	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #029

1 Single door 131A, CORRIDOR 122 TO APPARATUS BAY 131

950 x 2150 x 45 - HM DR x HM FR - 60 MIN

CONFIRM HARDWARE

3	Standard Hinge	LH1368CB 114 x 101 C26D	C26D
1	Lockset	8204 LNL C32D LH	C32D
1	Mortise Housing	320275 26 Z20 N	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Electric Strike	1006CLB-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Surface Closer	1431 O TB EN LH (Pull)	EN
1	Kick Plate	GSH 80A C32D (200 x 910) TM	C32D
1	Wall Door Stop	GSH 250B C32D	C32D
1	Weatherstripping	W-66-BL x 5300	BL
1	Door Sweep	W-24S-CA x 950	CA
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #030

1 Single door 131B, EXTERIOR FROM APPARATUS BAY 131 LHR

950 x 2150 x 45 - HM DR x HM FR

CONFIRM HARDWARE

1	Continuous Hinge	SL24 HD CL LL x 2111	
1	Rim Housing	320475 H 26 Y0ZN 626	626
1	Cylinder Collar	94-0188 626	626
1	Construction Core	3201CCW B1 R1 P UN 6 PIN 626	
1	Permanent Core	Permanent Core - By City of Brampton	
1	Exit Device	31-8804 J L/Trim LHR LC C32D 950	C26D/US32D
1	Electric Strike	9600-630-LBM- 2005M3	630-LBM
1	Power Supply	Power Supply - By Security Contractor	
1	Proximity Reader	Proximity Reader - By Security Contractor	
1	Door Pull	GSH 1180-2 TB C32D	C32D
1	Surface Closer	351 P10 TB EN RH	EN
1	Overhead Door Stop	698S C26D LHR (110°)	C26D
1	Kick Plate	GSH 80A C32D (200 x 900) TM	C32D
1	Threshold	CT-46 x 950	
1	Head Seal	W-20N-CA x 950 (Install Prior To Closer)	CA
2	Jamb Seal	W-16N-CA x 2150	CA
1	Door Sweep	W-24S-CA x 950	CA
1	Door Contact	Door Contact - By Security Contractor	
1	Opening Schematic	Opening Schematic - By UC Access	

Heading #031

1 Single door FD-1, EXTERIOR FROM APPARATUS BAY 131 FOLD
1 Single door FD-2, EXTERIOR FROM APPARATUS BAY 131 FOLD
1 Single door FD-3, EXTERIOR FROM APPARATUS BAY 131 FOLD
1 Single door FD-4, EXTERIOR FROM APPARATUS BAY 131 FOLD

4270 x 4270 x __ - - DR x - FR

FOUR FOLD FIRE STATION DOOR

HARDWARE COMPLETE BY DOOR SUPPLIER

Heading #032

1 Single door OH-1, EXTERIOR FROM APPARATUS BAY 131	OH
1 Single door OH-2, EXTERIOR FROM APPARATUS BAY 131	OH
1 Single door OH-3, EXTERIOR FROM APPARATUS BAY 131	OH
1 Single door OH-4, EXTERIOR FROM APPARATUS BAY 131	OH

4270 x 4270 x 35 - - DR x - FR

HIGH SPEED OVERHEAD DOOR

HARDWARE COMPLETE BY DOOR SUPPLIER

Heading #033

1 Elevation MISC-1

__ x __ x __ - - DR x - FR

MISCELLANEOUS

1	Key Cabinet	LD1200 (30 Key Capacity)
6	Cut Key	Operating Key
3	Cut Key	Control Key

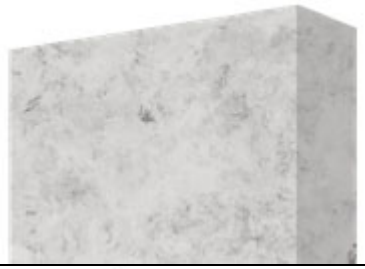
NOTES:

1. Read Colour Schedule in conjunction with full project documentation. See drawing A600 for Room Finish Schedule.
2. Abbreviations are located after the main body of this schedule.
3. See drawing A600 for Floor Finish, wall paint & tile accents and locations of wall protection.
4. It is the sub trades' responsibility to review Colour & Material Schedule in conjunction with full project documentation and bring to the attention of the consultant any discrepancies, errors or inconsistencies. Those proceeding with work are responsible to correct mistakes.
5. Typical walls and painted ceilings are PT-1.
6. Painted interior doors and frames are PT-2 unless otherwise noted.
7. SPS window stools are SPS-1 Refer to details.
8. North and East walls in Janitor room are clad in FRP to a height of approx. 1500 mm.
9. Tile setting materials are Kiesel as per specifications. Grout colours selected from manufacturer's full colour range.

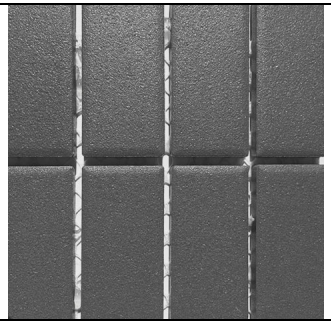
2 SCHEDULE

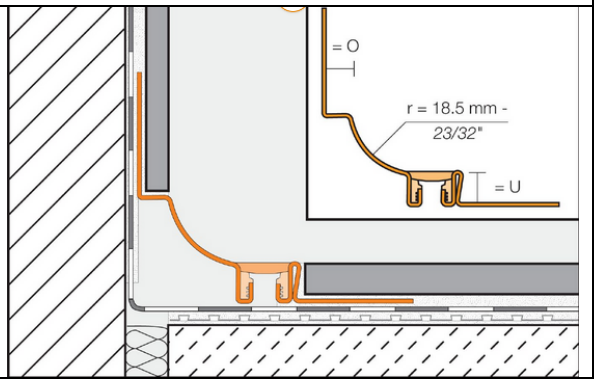
06 20 00 Finish Carpentry & Architectural Woodwork

Wood – Bench Seats (Locker Room 142) **WD-1**	**WD-1 –** Wood bench seat Species: Eastern white cedar Dimensions: Refer to details. Finish: ST-1	
Plastic Laminate Millwork (Kitchen/Meeting 117 cabinets) **PL-1**	**PL-1 –** Lamitech HPL & Compact Laminate Colour: 1465 (LG) Grey Cedar Finish: LG (Grain Texture) Grain Direction: Vertical Doors & Drawer fronts on Cabinets to be Lamitech Compact Laminate (Dunleavy Cordun), double faced board 12mm thick.	
Plastic Laminate Millwork (Dorms 107 cubbies, Laundry 125 cabinets & base, Kitchen cabinets base) **PL-2**	**PL-2 -** Lamitech HPL & Compact Laminate Colour: 2297 Fossil Finish: MT (Matte) Grain Direction: Vertical Doors & Drawer fronts on Cabinets as well as cabinet base to be Lamitech Compact Laminate (Dunleavy Cordun), double faced board 12mm thick.	

Quartz Countertop (Community Café counters, island and banquette cap) **QTZ-1**	**QTZ-1** – Cambria Colour: Montana Midnight Thickness: 20mm Edge Profile: Square – 40mm Finish: Matte	
Solid Polymer Surfacing (Window Stools, Counter in 125 Clean Laundry) **SPS-1**	**SPS-1** – Avonite Colour: Summit 8905 Thickness: 12mm Finish: Satin	
Cabinet/Drawer Pull (Kitchen/Meeting 117) **H-1**	**H-1**– Richelieu Contemporary Stainless Steel Cabinet Pull Model: BP500160195 Finish: Brushed Nickel Dimensions: Centre to centre 160mm (185 mm overall)	
Drawer/Cabinet Pull (Clean Laundry 125) **H-2**	**H-2**– Richelieu Contemporary Metal Cabinet Pull Model: BP228804900 Finish: Matte Black Dimensions: Centre to centre 4”(110 mm overall)	

09 30 00 Tile

Porcelain Floor Tile	**T-1** – Reserved	
Porcelain Floor Tile (L1 corridors, Universal washroom) **T-2**	**T-2** – Stone Tile Series: MATIERES DE REX Colour: GRIS (Texture: Matte) Size: 300 mm x 600 mm & 600 x 600 mm; Thickness: 10mm Installation pattern: Stacked, refer to drawings Dynamic Coefficient of Friction (wet) .74 Keisel grout colour: TBD	
Ceramic Wall Tile (Shower and washroom walls) **T-3**	**T-3** – Stone Tile Series: Progetto Ceramiche Colour: Perla (gloss finish) Size: 100mm x 400mm Installation pattern: Stacked, horizontal orientation Grout width: 3mm Keisel grout colour: TBD	
Porcelain Mosaic Floor tile (shower floors, fixture walls in washrooms & showers) **T-4**	**T-4** – Stone Tile Series: STI Mosaico Colour: Mid Grey (unglazed/matte) Size: 23mm x 48mm (300 x300 mesh) For shower floor w/ Schluter cove profile	

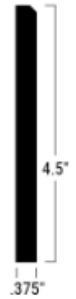
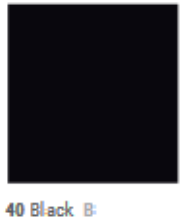
Accessory Trims (Edge Protection profile for floor & wall tile) **TT-1**	**TT-1 -** Edge Protection - Schluter Model for floors: Schiene Finish: E - Stainless 304 Model for walls: Jolly Finish: AE – Satin Anodized Aluminum Use at transitions, corners & exposed edges/terminations of all tile finishes.	
Accessory Trims (Cove-shaped profile for floor/wall transition in shower) **TT-2**	**TT-2** – Stainless steel cove-shaped profile – Schluter Model: Dilex-HKS Finish: E - Stainless 304 with Thermoplastic movement zone G = Grey Use at junction of floor tile and wall tile within showers.	

09 51 00 Acoustical Ceiling Tiles

Suspended Acoustic Ceiling (Typical ceilings) **ACT-1**	**ACT-1** – CGC Halcyon ClimaPlus Panel Size: 610mm x 1220mm Edge: Square; Colour: Flat White Suspension Grid: 15/16” Tee, white OR **ACT-1** – Armstrong Optima Panel	SQ

	Size: 610mm x 1220mm Edge: Square; Colour: Flat White Suspension Grid: 15/16” Tee, white	

09 65 13 Resilient Base and Accessories

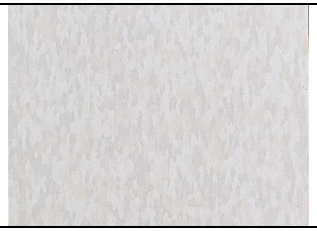
Resilient Wall Base (with LINO) **RB-1**	**RB-1** Tarkett/Johnsonite Millwork Wall Base Profile: Mandalay MW-TB1-H Colour: Peppercorn Height: 114 mm (4.5”) Thickness: 9.5 mm (.375”)	
Rubber Wall Base (with SDT, sealed concrete) **RB-2**	**RB-2** Tarkett/Johnsonite Traditional Wall Base with Toe Colour: 40 Black Height: 4” H X 0.125” Thick	

Rubber Wall Base (with RSF) **RB-3**	**RB-3** Tarkett/Johnsonite Millwork Wall Base Profile: Mandalay MW-40-H6 Colour: 40 Black Height: 152 mm (6”) Thickness: 9.5 mm (.375”)	
Accessories (Transitions under resilient flooring as required)	Tarkett Subfloor Leveler System LS-40 Reducer – height and width to suit Length: 1200 mm	No image

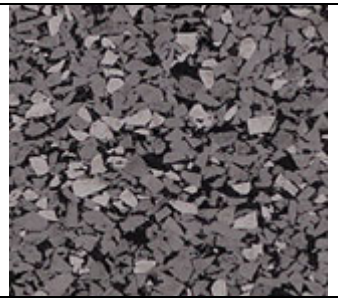
09 65 16 Resilient Sheet Flooring

Linoleum (Dorms 107) **LINO-1**	**LINO-1** – Forbo Marmoleum Style: Striato 2.5mm thick linoleum sheet (2m wide roll) Colour: 3573 Trace of Nature Surface Finish: Topshield (factory applied) Slip resistance: R9	

09 65 19 Resilient Tile Flooring

Static Dissipative Tile (IT room) **SDT-1**	**SDT-1** - Armstrong Excelon Static Dissipative Tile (SDT), 305 x 305 mm Colour: Armor Gray 51951 Installed as per manufacturers directions c/w grounds and conductive adhesive.	

09 65 66 Resilient Sports Flooring

Resilient Sports Flooring (Fitness Room 116) **RSF-1**	**RSF-1 –** Ecore Athletic Everlast UltraTile Rubber floor tile with high density wear layer. Size: 24” x 24” x 1” thick Colour: EL15A Steel Appeal 2	

09 67 23 Epoxy Flooring

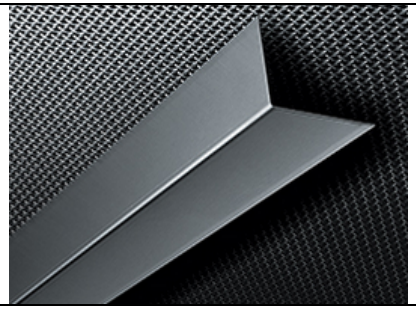
Epoxy Flooring (Locker Room, Decon, Janitor, Clean Laundry) **EPX-1**	**EPX-1** Colour to be selected from Manufacture’s full range	

09 91 00 Painting

Painting (Typical walls) **PT-1** **EP-1**	**PT-1 /EP-1** – Dulux Colour: DLX1007-1 Willow Springs Finish: Eggshell for walls; Flat for ceilings Epoxy paint as per schedule.	
Painting (Typical metal door frames) **PT-2**	**PT-2** – Dulux Colour: DLX1007-7 Bark Finish: semi-gloss for metal frames	
Painting (Painted bulkheads and ceilings) **PT-3**	**PT-3** – Dulux Colour: DLX1025-1 Commercial White Finish: Flat	
Painting (Accent Walls as noted) **PT-4**	**PT-4** – Dulux Colour: DLX1158-6 Blue Oasis Finish: Eggshell for walls	
Painting (Painted Doors) **PT-5**	**PT-5** – Dulux Colour: DLX1007-4 Hot Stone Finish: semi-gloss for metal doors	
Painting (Accent Walls in Dorm 107) **PT-6**	**PT-6** – Dulux Colour: DLX1122-5 Dill Finish: Eggshell for walls	

Painting (Accent walls in Fitness) **PT-7**	**PT-7**– Dulux Colour: DLX1222-5 Lime Green Finish: Eggshell for walls	
Painting (Accent walls in Locker Room) **PT-8**	**PT-8** – Dulux Colour: DLX1158-5 Cosmopolitan Finish: Eggshell for walls	
Painting (Wood Benches) **ST-1**	**ST-1 –** Sansin Interior Stain Colour: Buttermilk 3406 Note: Submit colour sample on specified wood species	 BUTTERMILK 3406

10 80 00 Miscellaneous Specialties

Corner Guards (as noted) **CG-1**	**CG-1** – Construction Specialties CO-8 Stainless steel corner guard Size: 3 ½" x 3 ½" Finish: #4 Satin finish	

10 51 00 Lockers

Lockers	ASM (Anthony Steel Manufacturing) Lockers Type 1 (Tactical Gear Locker within Locker Rm): A124 Pearl Grey body with A385 Ocean doors	
	Bunker Gear Lockers (racks and mesh lockers) Ready Rack by Groves Incorporated Colour: Red (Standard)	

12 21 23 Window Coverings

Roller Shades	Refer to specifications. Shade cloth colour to be selected from Manufacturer's standard range for solar shades and black-out shades.	No image

3 ABBREVIATIONS

*	Refer to Remarks	C.T.C.	Centre to Centre	FIN.	Finish
ACT	Acoustic Ceiling Tile	C/W	Complete With	FLR	Floor
AFF	Above Finished Floor	CP	Composite Panels	FR	Fire Retardant
ALUM	Aluminum			FRP	Fiberglass Reinforced
ARCH	Architectural	DIA	Diameter		Panels
A/V	Audio Visual	DIM	Dimensions		
		DM	Decorative Metals	GALV.	Galvanized
BF	Barrier Free	DN	Down	GB	Grab Bar
BLK	Block	DTL	Detail	GL	Glazing
BLKG	Blocking	DWGS	Drawings	GWB	Gypsum Wall Board
BLKHD	Bulkhead				
BN	Bullnose	E.J.	Expansion Joint	H	Hardware
B/O	Black-out (blind)	ELECT	Electrical	HD	Hand Dryer
CBD	Cement Board	ELEV	Elevator	HDR	Hand Rail
CG	Corner Guard	EP	Epoxy Paint	HDWD	Hardwood
CH	Coat Hook	EPX	Epoxy Flooring System	HM	Hollow Metal
C/L	Centre Line	EQ.	Equal	HORIZ.	Horizontal
CLG	Ceiling	EXP	Exposed	HR	Hour
COL.	Column	EXIST.	Existing	HT	Height
CONC	Concrete	EXT	Exterior		
CONC-POL	Concrete, polished			INSUL.	Insulation
CONC-S	Concrete, sealed	FD	Floor Drain	JT	Joint
CONT.	Continuous	FE	Fire Extinguisher	L	Lighting
CPT	Carpet	FEC	Fire Extinguisher Cabinet	LVT	Luxury Vinyl Tile
CRS	Course	FF	Factory Finish		
M	Mirror	REQ'D	Required	U.N.O.	Unless Noted Otherwise

MAT	Material	RH	Robe Hook	UR	Urinal
MAX.	Maximum	RF	Resilient Flooring	U/S	Underside
MECH	Mechanical	RSF	Resilient Sports Flooring	URETH	Urethane
MG	Mirror	RT	Rubber Tile		
MIN.	Minimum			V.B.	Vapour Barrier
MM	Millimeters	SDT	Static Dissipative Tile	VCT	Vinyl Composite Tile
MS	Metal Stud	SEAL	Sealer	VERT.	Vertical
MTL	Metal	S/L	Sidelight	VEST	Vestibule
		SPEC'D	Specified	VP	Veneer Panel
N.I.C.	Not In Contract	SPS	Solid Polymer Surfacing		
N.T.S.	Not To Scale	S.S.	Stainless Steel	W/	With
		ST	Stain	WB	Wood Base
O.C.	On Centre	STN	Stone	WC	Wallcovering
O.H.	Overhead	STRUCT.	Structural	WD	Wood
OWSJ	Open Web Steel Joist	SUSP.	Suspended	WD SLT	Wood Slat
				WR	Washroom
P.WD	Plywood	T	Tile	WT	Wood Trim
PL	Plastic Laminate	T-C	Tile – Ceramic wall tile	WV	Wood Veneer
PREFIN.	Prefinished	T-P	Tile – Porcelain		
PREMNUF	Premanufactured	T-M	Tile – Mosaic		
PT	Paint	TBC	To be confirmed		
PU	Polyurethane Sealer	TBB	Tile Backer Board		
		TC	Toilet Compartments		
R	Radius	TRANSP.	Transparent		
RB	Resilient Base	TYP	Typical		
RBB	Rubber Base				

END OF SCHEDULE

APPENDIX A1

MACH ALERT STATION CONTROLLER INSTALLATION GUIDE

Mach Alert, Inc.
503 E. Jackson Street, Suite 149
Tampa, FL 33602

Station Controller
Installation Guide

The following installation guideline is for typical Fire Station Alerting Systems utilizing Mach Alert, Inc. (MAI) equipment.

- **Station Controller**
- **Lighting Controller**
- **Audio Interface**
- **Other MAI-Supplied Equipment**

Refer to the particular system configuration diagrams applicable to the type of FSA system for the target location. This manual provides a general guideline.

Since all Fire Station Alerting systems are customized to some extent, this guide will serve as a general set of instructions for the various components such as the FSA Station Controller (SC) rack, audio, lighting, zone switches and other system equipment.

Rev. Date: 2018-11-12 v023

Mach Alert, Inc.
503 E. Jackson Street, Suite 149
Tampa, FL 33602

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Warnings and Hazards Caution - Lethal Voltages. The Station Controller and other FSA equipment operate with voltages which can be lethal. This is not restricted to only 110/120 Voltage AC feeds, but also includes 70 Volt audio systems used for Public Address (PA) systems and other possible lethal voltages within racks and cabinets. MAI does not assume responsibility for any damage to property or injury to persons as the result of lack of precautions and proper installation techniques to avoid electrocution and other injuries.

Caution - Falling and Tripping Hazards. Many installation sites include working on ladders, scaffolds, or near locations where loss of balance can cause serious or lethal injuries. Observe all precautions for maintaining balance with safety-approved ladders appropriate for the installation work being conducted.

Installation Planning and Staging

Since almost all Fire Station Alerting systems are customized to some extent, this guide will serve as a general set of instructions for the various components such as the ***MACH Alert FSAA*** Station Controller enclosure, audio connections, lighting setup, zone selection switches and other system equipment.

Prior to commencing and installation of FSA equipment such as the Station Controller (SC), there are a number of planning steps and review of systems information before commencing.

- Bill of Materials (BOM) specific to the installation.
- Reference Documents, Manuals and Data Sheets for specific equipment or sub-assemblies.
- Location Plan for equipment and general interconnection schemes.
- Wiring, cable routing and connection termination information for devices and equipment used in the installation process.
- Pertinent information include SC panel installation location, radio connections, PA amplifier connections, speaker locations and zones (room or areas), alerting lights and zone selection switches, network connections and auxiliary electrical devices.

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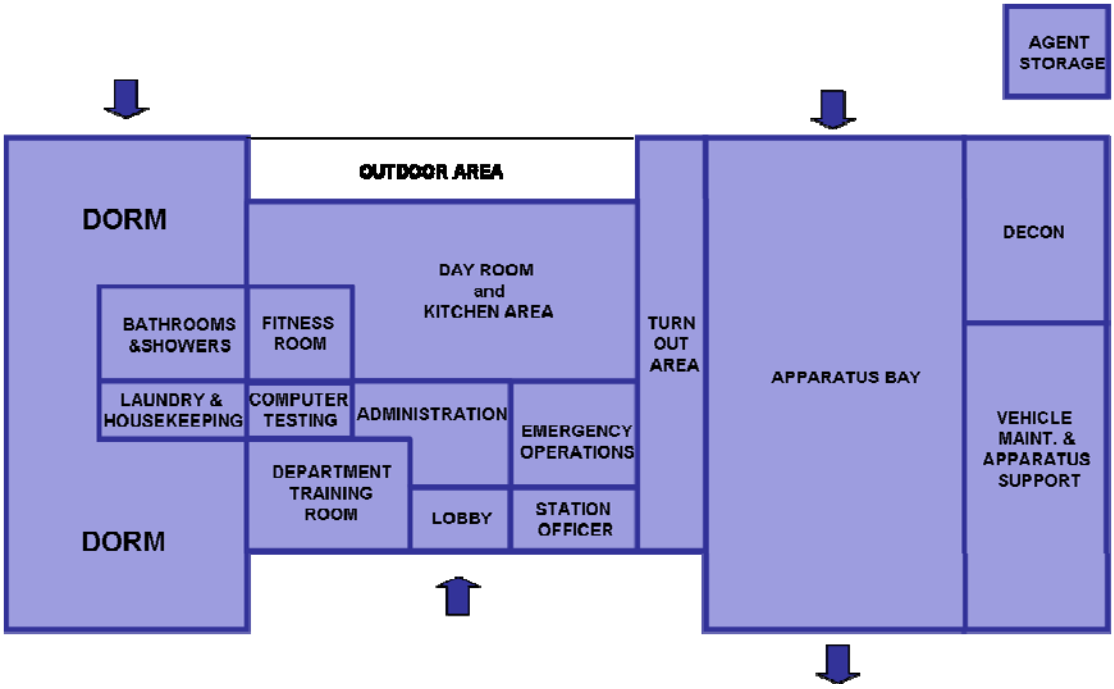
Installation Guideline

The following installation guideline is for typical installations. Refer to the particular system configuration diagrams applicable to the type of ***MACH Alert FSAA*** system for the target location and connections required.

1. Typical Fire Station Layout

The diagram below shows the typical areas of a fire station.



Primary Features of the typical fire station include:

- **Apparatus Bay** - where fire trucks, EMT ambulances, and other vehicles are stored.
- **Day Room and kitchen area** - where firefighters spend much of the day when not dispatched.
- **Turn Out area** - where firefighters have lockers and protective gear and outfits.
- **Training room, Offices** - where responders may need to acknowledge vital alerts calls.
- **Dormitory Area** ("dorm") is also referred to as "**Bunk Rooms**" or "**Sleeping Quarters**"
- **Outside building areas** - where vehicle maintenance or other responders may be occupying.
- Other support areas

These primary areas are where the audio alerts and visual alert displays are placed to notify firefighters and EMT personnel of a needed incident response.

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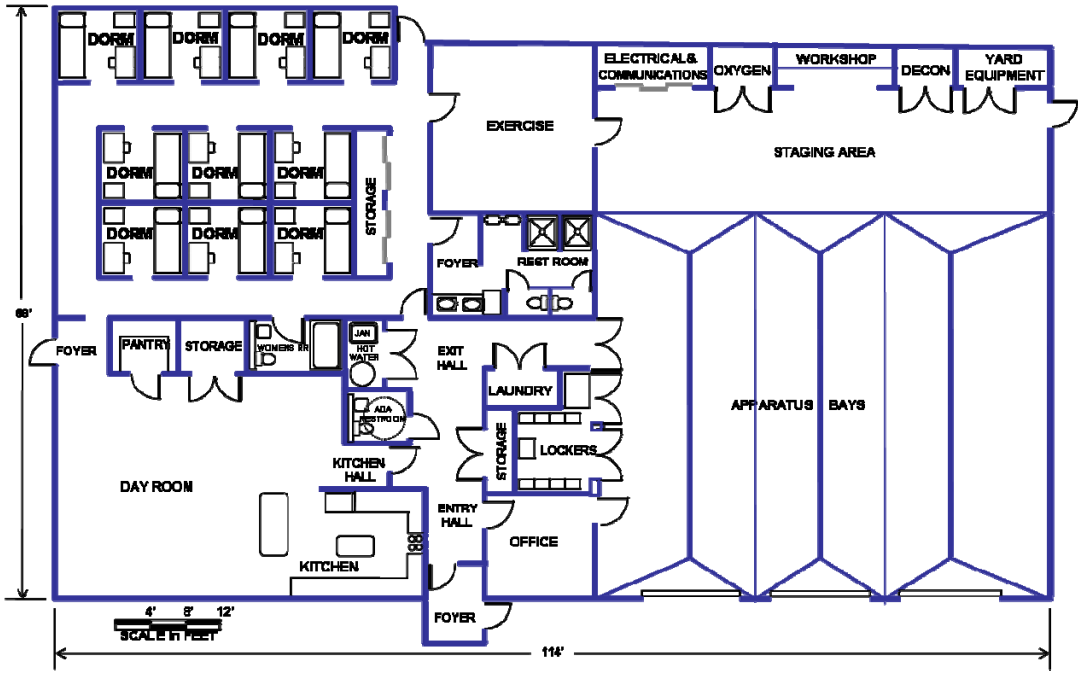
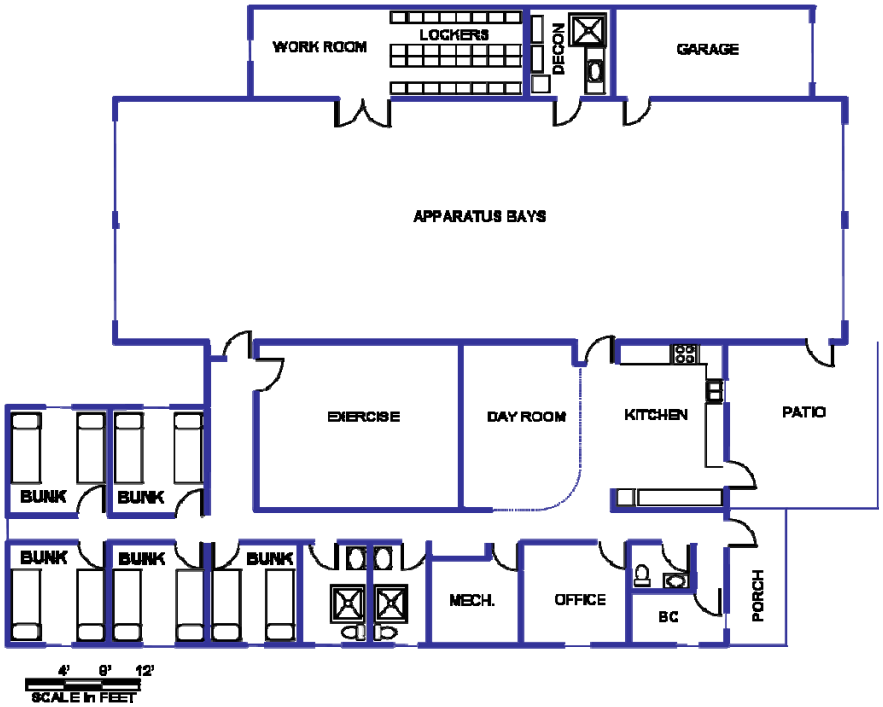
2. Actual Fire Station Floor Plan Samples

The following two diagrams show examples of actual fire station floor plans. Note the size and variation in layouts.



Fire Station Sample Floor Plan #1



Fire Station Sample Floor Plan #2

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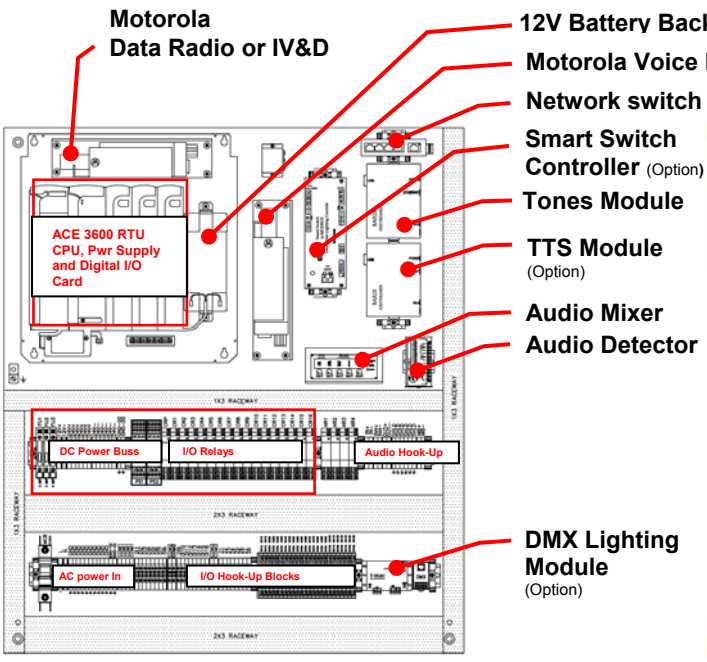
3. Installation Preparation - Identify Equipment

The *MACH Alert FSAA* - Fire Station Alerting and Automation installation typically consists of the following System Components.

SC - Station Controller

The Station Controller (SC) is a Motorola ACE3600-based high-performance RTU installed in a UL 508A certified NEMA-1 wall-mount industrial panel. The SC is located at each fire station typically in a communications utility room. The SC processes information to and from the AIC and FSAA Server, generates alert tones, and provides station audio control including an optional text-to-speech decoding. The Station Controller (SC) is a modular unit containing a Power Supply Modules, CPU Module, Barix audio Module, 32 DI/DO Module, 6.5 Ah Backup Battery, Motorola FM two-way radio, audio mixer with balanced line output. Optional zone selector switches, LED lighting controllers are available as options that connect to the Station Controller. Below is a Mechanical design view of the Station controller.

Station Controller



Mechanical Design Concept

Sample Installed Custom SC System

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Installation of the Station Controller Equipment Cabinet

You must be a MR (Motorola Service Representative) field technician to interface to the FSAA system and terminal blocks to avoid damage to the Station Controller. Qualified Electrician may also be required to assist where needed.

The ***MACH Alert FSAA*** Station Controller will come pre-configured by MAI and supplied by Motorola or the FSAA contractor as part of the system equipment delivered to the installation site. Every Station Controller is factory wired and completely tested.

Physical installation requires solidly mounting the enclosure and connecting the 120VAC branch circuit and auxiliary circuits (PA audio, Alerting light and/or control circuits). Specific Job name and number Station Controller wiring diagrams are enclose inside each cabinet door. Please review these diagrams before installing the Station Controller.

⚠ CAUTION

Protect the cabinet from construction grit and metal chips to prevent malfunction or shortened life of the *MACH Alert FSAA* Station Controller.

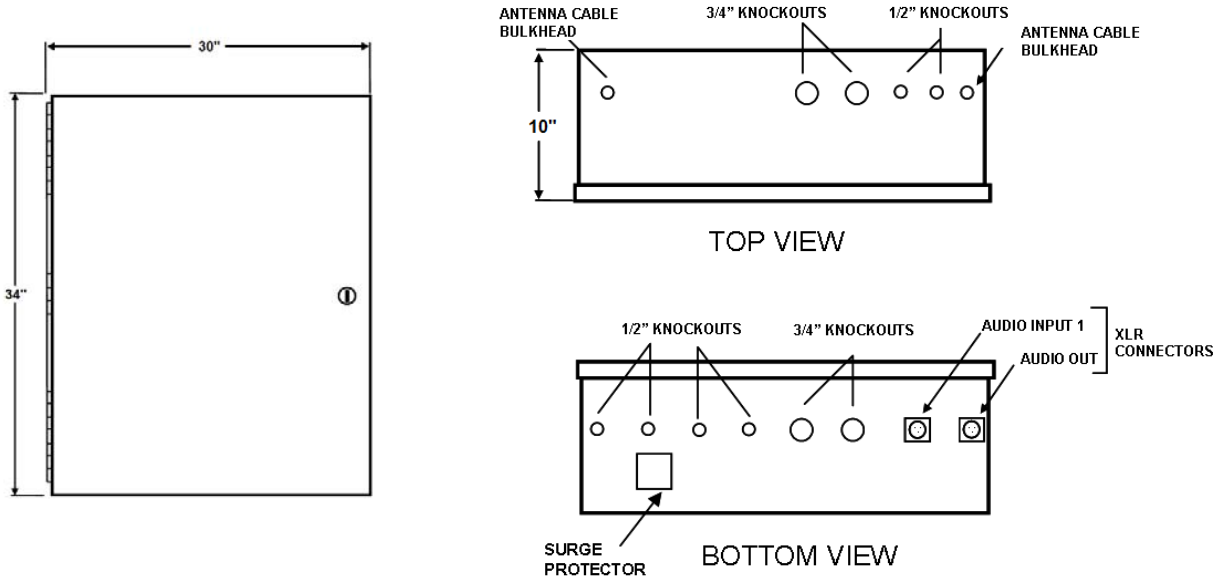
The dimensions of the *MACH Alert FSAA* Station Controller are an important consideration in determining proper location selection. Choose a location that offers a flat, rigid mounting surface capable of supporting the weight of the enclosed transfer switch equipment. Avoid locations that are moist, hot, or dusty. Mount the Station Controller vertically to a rigid supporting wall structure. Level all mounting points by using flat washers behind the holes to avoid distortion of the cabinet. It is recommended that Unistrut or similar mounting hardware be use to secure the FSAA cabinet to a wall. Check to make certain that there are no obstructions to allow clear opening access to the Station Controller door, or other hazards in the immediate area that could create a problem. If there are any doubts as to the suitability of the location, discuss it with your MAI / Motorola Project Manager Representative during the DDR (Detailed Design Review) process.

⚠ CAUTION

SINCE THE STATION CONTROLLER CABINET MUST BE LIFTED INTO PLACE FOR MOUNTING, BE CERTAIN THAT ADEQUATE RESOURCES ARE AVAILABLE FOR LISTING TO AVOID PERSONNEL INJURIES OR EQUIPMENT DAMAGE.

Mount the cabinet using Unistrut™ horizontally across the top and bottom of the enclosure for concrete or cinder block walls use ¼ inch drop anchors, three for each strut. For drywall, use toggle bolts, use 4 for each strut if location of wooden studs cannot be discovered.

Installation of the Station Controller Equipment Cabinet



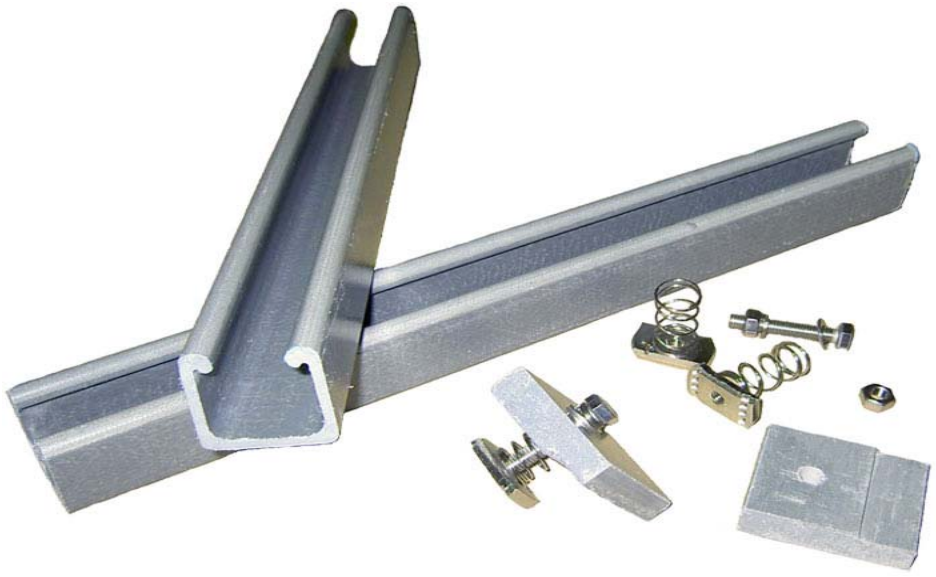


Fig. 1 – Station Controller Cabinet with Dimensions and Sample Unistrut Hardware

Examine the Station Controller (SC) configuration to discover the sub-assemblies and terminal blocks installed in the enclosure. In particular, note the following in the enclosure:

- AC Power requirements.
- Radios installed (option) - Antenna connections.
- Enhanced Audio Mixer (option)
- Station Alert lights requirements. (AC or DC)
- Station PA audio "Zone" connections.(optional)
- Bunk Room Speakers, Lights and Zone switch (option) connections and placement
- Note the Terminal block configuration as shown below (typical). Wiring to lighting, sensors, and other equipment will terminate on these blocks.

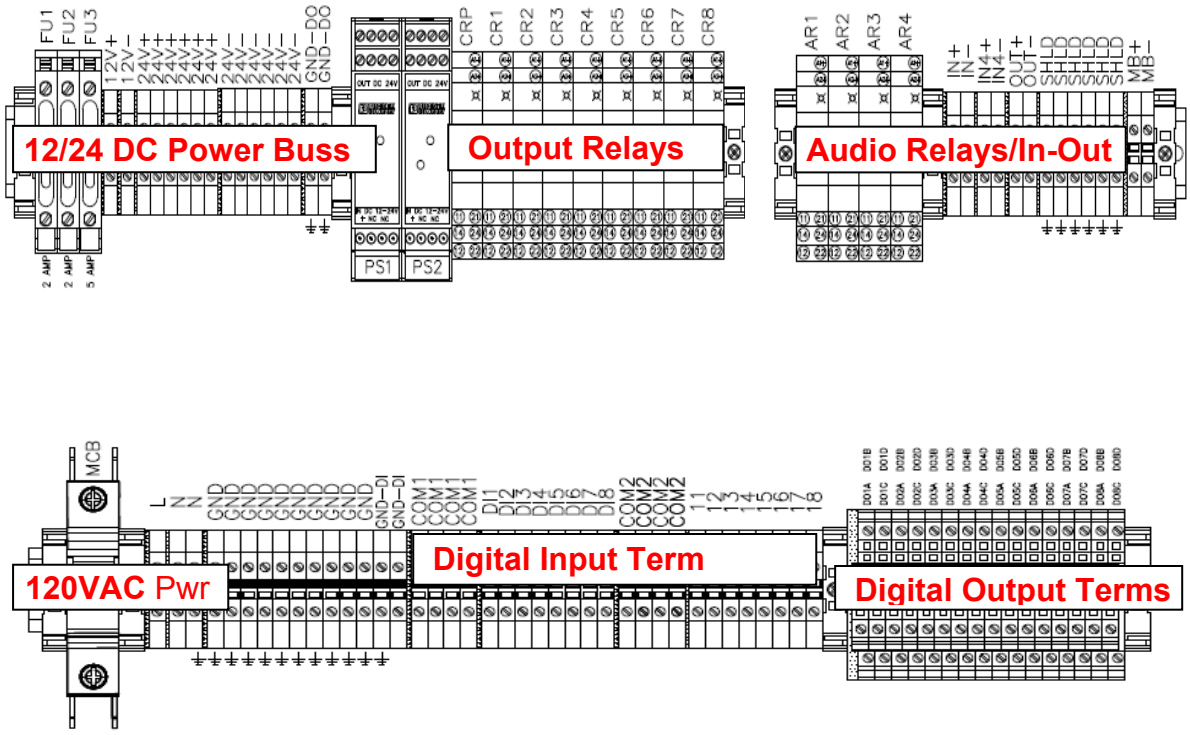


Fig. 2 - Typical Station Controller Terminal Block configuration (May vary with Options purchased)

Station Controller Line power connections.

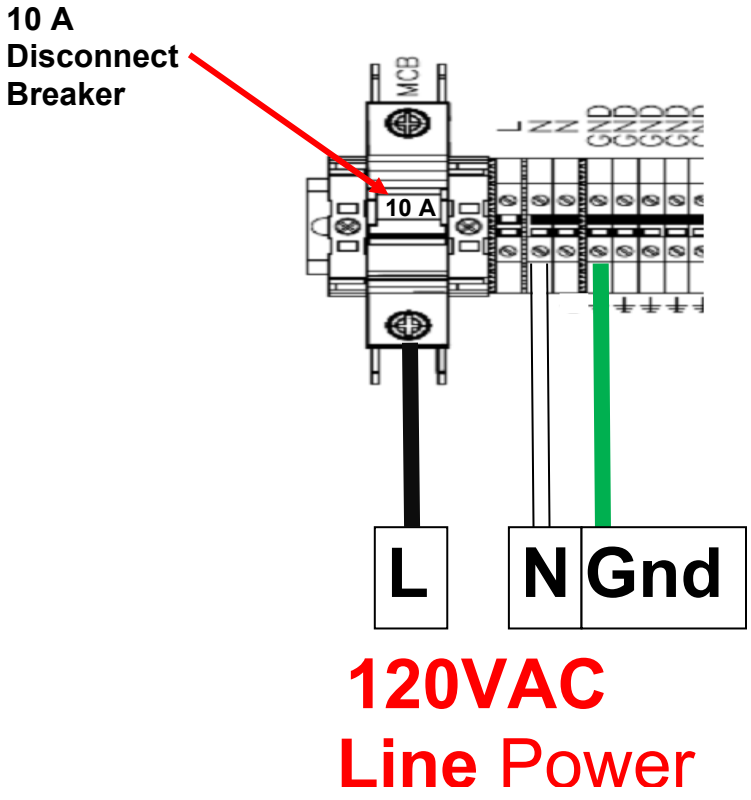


Fig. 3 - AC Power Termination

This circuit should be a dedicated protected 10 Ampere 120VAC branch circuit.
Note: All wiring should be done in accordance with local electrical codes and/or applicable National Electrical Code (70E) by a qualified person.

⚠ WARNING

Hazard of Electric Shock. Any installation involving this Station Controller must be effectively grounded in accordance with the National Electrical Code to eliminate any possible shock hazard.

⚠ WARNING

Hazard of Electric Shock. Disconnect all power before installing Station controller.

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Station Controller I/O connections.

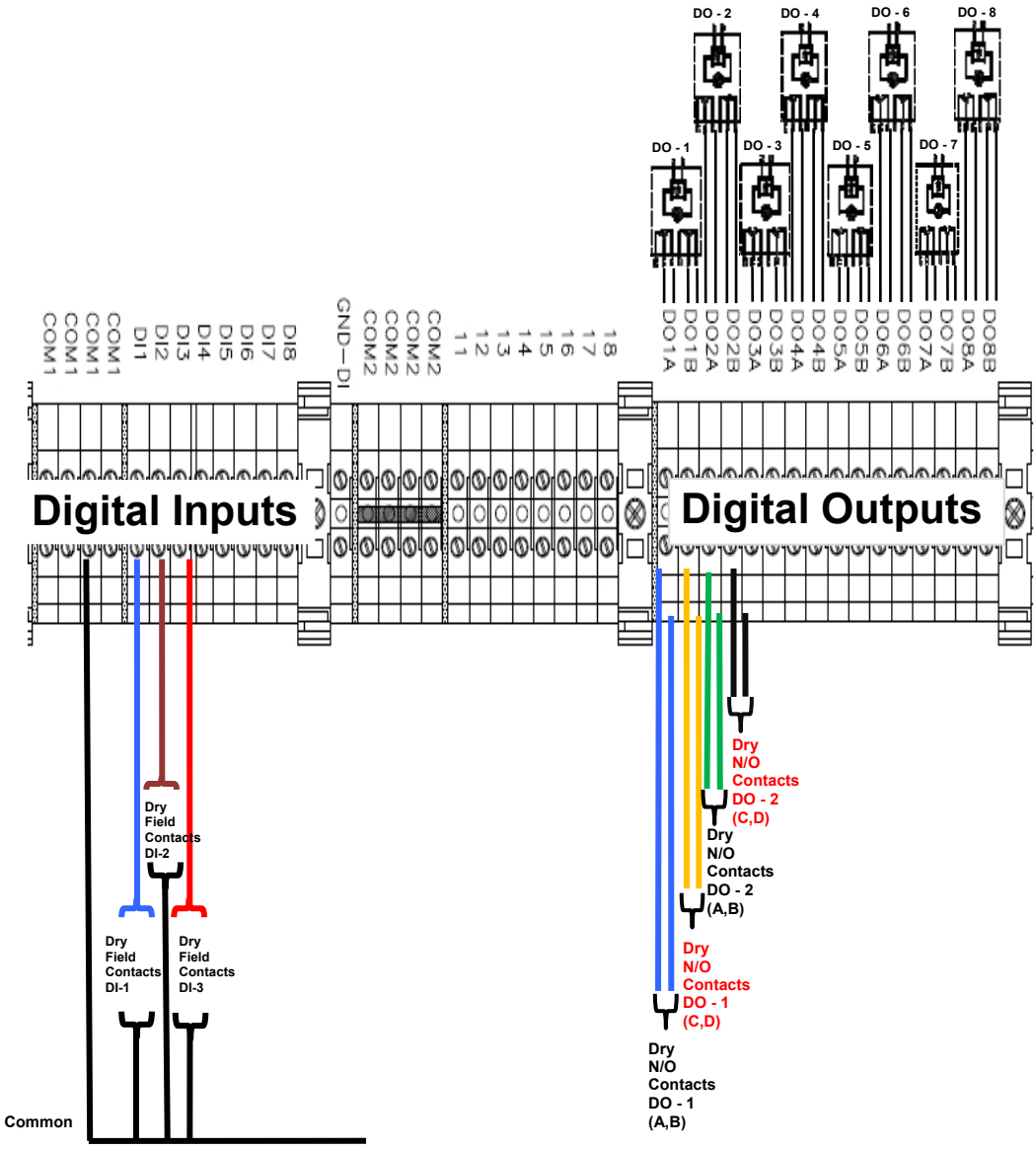

Fig. 4 - Station Controller digital Inputs and Outputs block terminations".

Station Controller Digital Input connections shown on the left must be dry contacts. Switches or devices monitored for contact closure are connected here.

Station Controller Digital Outputs shown on the right are two (2) dry N/O or N/C relay contacts rated for 125VAC or DC @ 6 amps per Digital output.

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MACH Alert FSAA Station Controller typical Digital Output wiring sample.

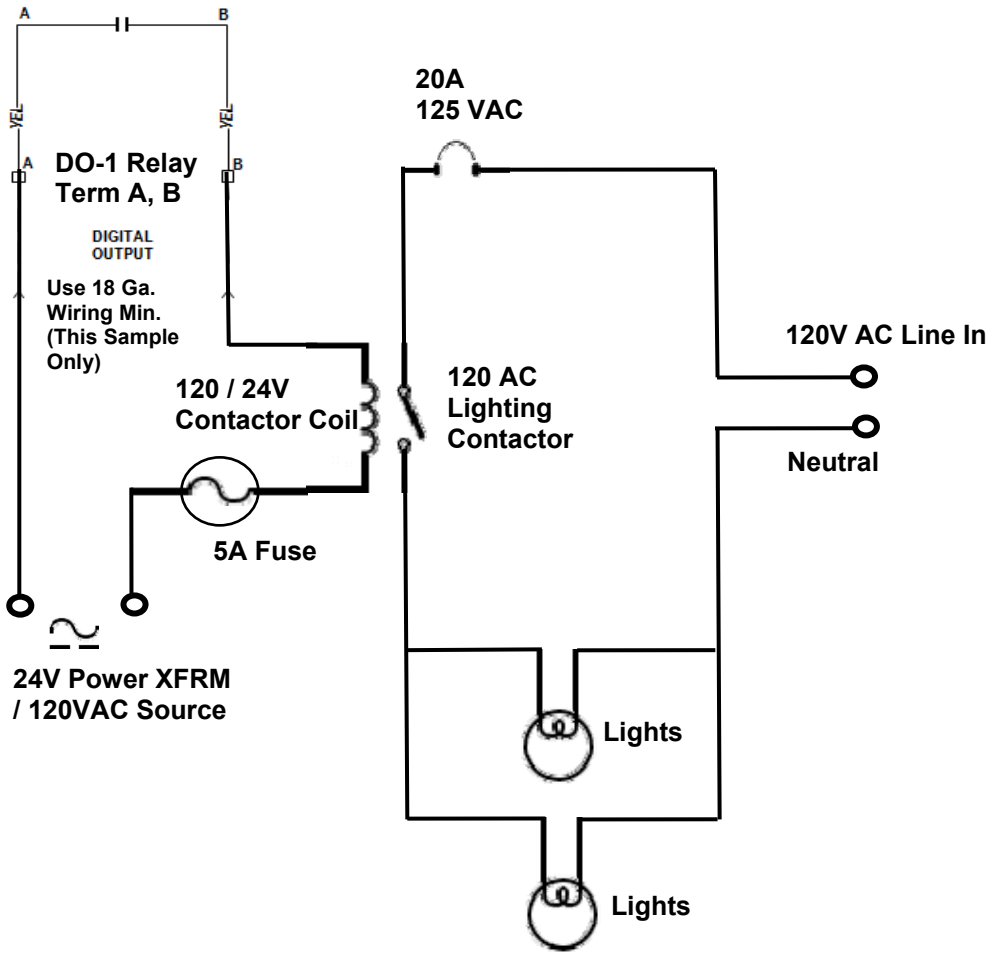

Fig. 5 - Station Controller Digital Outputs wired as a "Station Alert lights".

Note: All wiring should be done in accordance with local codes and applicable National Electrical Code (70E) by a qualified person.

⚠ WARNING

Hazard of Electric Shock. Any installation involving this Station Controller must be effectively grounded in accordance with the National Electrical Code to eliminate any possible shock hazard.

⚠ WARNING

Hazard of Electric Shock. Disconnect all power before installing Station controller.

MACH Alert FSAA Station Controller typical digital Input wiring sample.

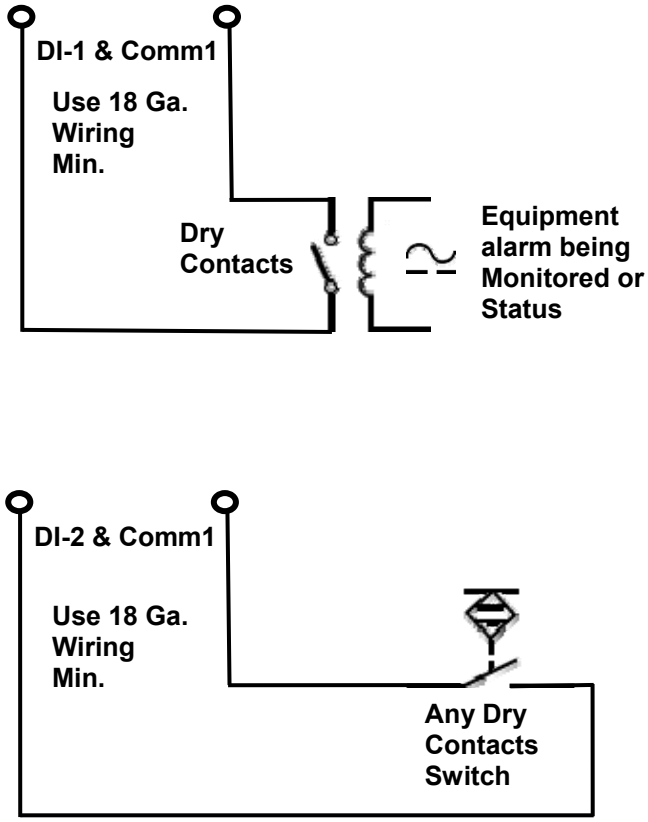

Fig. 6 - Station Controller Digital Inputs Samples.

Station Controller Digital input wired as a station equipment being monitored for “fault alarm” such as a generator equipment. Second sample is a “Mushroom push button” for “Last Man Out” (LMO), also used for station “Turn-Out Timer”.

⚠ WARNING

Hazard of Electric Shock. Any installation involving this Station Controller must be effectively grounded in accordance with the National Electrical Code to eliminate any possible shock hazard.

⚠ WARNING

Hazard of Electric Shock. Disconnect all power before installing Station controller.

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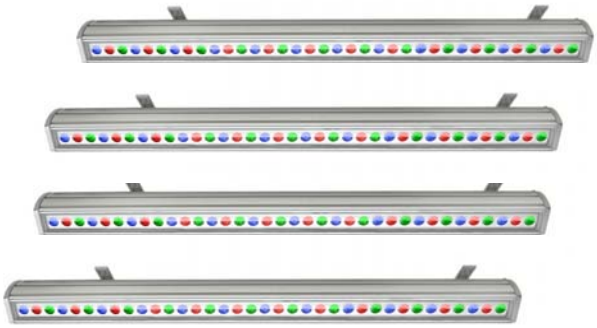
The MAI-produced *MACH Alert FSAA* Station Controller. Shown in a NEMA-rated wall mount cabinet.

Zone selection switches which mount in standard wall switch boxes

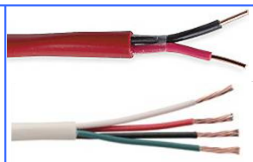
Optional

Lighting Controllers mounted in various Fire Station areas for control of LED light strips



LED Lighting Bars which can display varying color for different alerts.

<u>Existing</u> or new Audio Equipment for Fire Station alerts



18 Gauge Plenum Cable and wiring accessories

CAT 5 Cable with RJ45 Jacks

RJ45 Splitters for LED lighting distribution

Fig. 7 - Accessories

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4. Typical System Wiring

The following diagram shows typical Fire Station Alerting Equipment Interconnection.

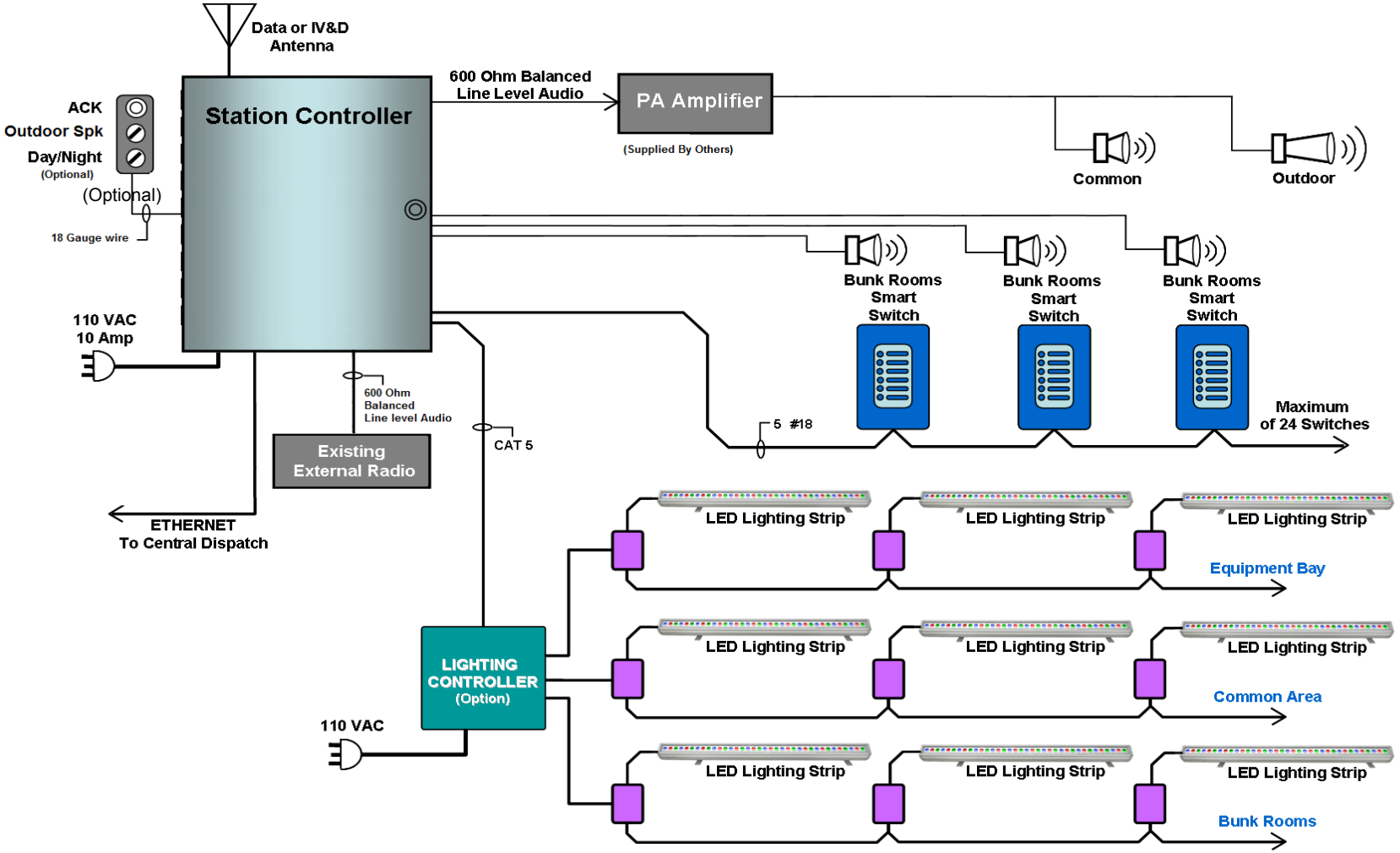


Fig. 8 – Sample System Wiring

5. Equipment Placement

The following diagram shows typical **Equipment Placement**.

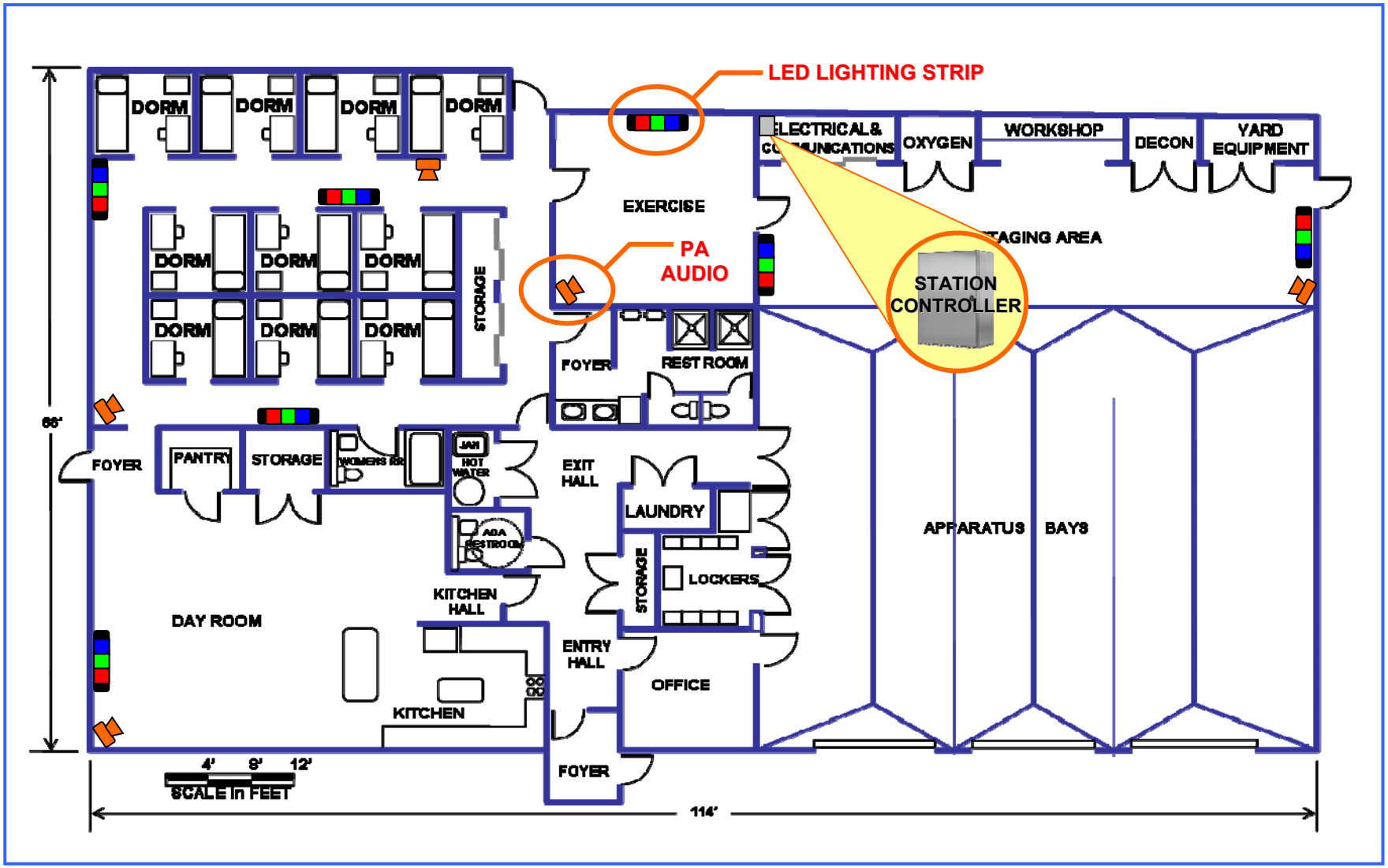


Fig. 9 – Sample Equipment Placement

Appendix A - Station Controller Specifications

Enclosure	
Dimensions	34”H x 30”W x 10”D
Color	White
Mounting	Wall Mount
Rating	NEMA Type 1
Power	
SC Requirements	120VAC, 60HZ, 10 Amp Service
Communications	
Hard wired	Existing TCP/IP Network
Radio	Minimum 2: One Radio for ACE PLC, One Radio for Audio
ACE System	
Power Supply	Includes Battery Back-up System (6.5 Ah)
Processor	Integrated Ethernet Port, Radio Port, Radio/Ethernet Port, RS-232/RS-485 Port
Mixed I/O Card	32 Point DI/DO Configurable Input/Output Card
Barix Module	Custom Tone Audio Generator & (Optional) Text-To-Speech Modules
Radio	Customer Specific
Lighting Control	(Optional) Modbus-DMX Controller. Requires external Luminarc Power/Data Module.
Audio	
Type	Balanced Line Out
Impedance	600Ω Balanced, 300Ω Unbalanced
Output Level	1.227V-rms (+4dBU) In, Output 1.227V-rms (+4dBU) (+7dBU Max)
Controls	Four Input Knobs with Security Covers, One Output knob With Security Cover
Discrete I/O	
Connection	Terminal Block
Discrete Input	8 User Inputs, FET Isolated Sink to common
Output	12 User Outputs, Rated @ dual 6 Amp 125VAC/DC Form C (Dry Contact).
Zone Switches	
Type	Touchplate Smart switch
Dimensions	4”H x 3”W x 2”D
Connection	5 wire, Daisy Chain (up to 8 per link).
Distance	Cable Runs Up To 500 Feet.
LED	Pilot Color And Intensity for each button is system configurable by "Alert" zone.

Appendix B - SC - Station Controller considerations

POWER. Ideal location is near the PA amplifier and 120 VAC 10A branch power source.

Wires - Cables:

1) Installer will need to run 18/2 twisted pair (Shielded) cables to the amplifier from the SC. (600 Balanced audio in or use a Bogen, WMT1A Matching Transformer Balun transformer),
2) Audio from external radio (If used) to the XLR Audio in to the SC. Most System installations use a Motorola internal audio Radio. (600 Balanced audio out (Discriminator out - Preferred) or use a Bogen WMT1A Matching Transformer Balun transformer).
3) INTERCOM / PA. 70V systems: 18/2 twisted pair (Shielded) from the PA Speaker 70V Line audio out for "Zones" (if installed) also consider running a separate home run from each "Zoned" speakers area to the SC, 120VAC lighting contactor (relay) with associated wires for alert lights or low Voltage with appropriate customer provided power source (Consult a qualified Electrician).
4) INTERCOM / PA Valcom systems: CAT 5 cable from the Station Controller Line audio out for "Zones" (if installed) also consider running a separate home run from each "Zoned" speakers area to the SC “Line out”, lighting contactor (relay) with associated wires for alert lights or low voltage with appropriate customer provided power source. (Consult a qualified Electrician).
5) 18/5 cable for Zone Smart Switch plates (Daisy-chained - 24 Maximum per run and total Maximum of 24 Smart Switches per system).
6) 18/2 Minimum for connections to input of SC DI's for Sensing (NEC requirement)
7) Follow NEC 70E recommend practice for controlling SC DO controlled devices which may include 120VAC alert Lighting, Klaxon horns, Gas Shut-off. Always consult a qualified electrician before attempting to wire devices.
8) Plenum 18/2 wires must be used where Plenum cable is a requirement.
9) Always follow local applicable building code for building wall penetrations. Apply appropriate fire stop where required.
10) ETHERNET. A CAT5 cable will need to be run for Ethernet communications (RJ45) from the Network switch to the Station controller's 5 port internal switch. (If the IDB (Incidental display Board) Option is purchased, a separate Ethernet cable will be required to run from the IDB computer to the Network switch.)
11) Some Cable runs may require conduit, consult with a Qualified Electrician before attempting to install wires in a Fire Station house.

Appendix C - Grounding Practices

All device return lines should be installed in a STAR configuration back to a single termination point for Grounds and 24 Volt Power. Earth ground for 24 Volt DC control systems should be isolated from the I/O power supply common return lines.

Avoid “Sneak” return paths by using a STAR configuration as shown below.

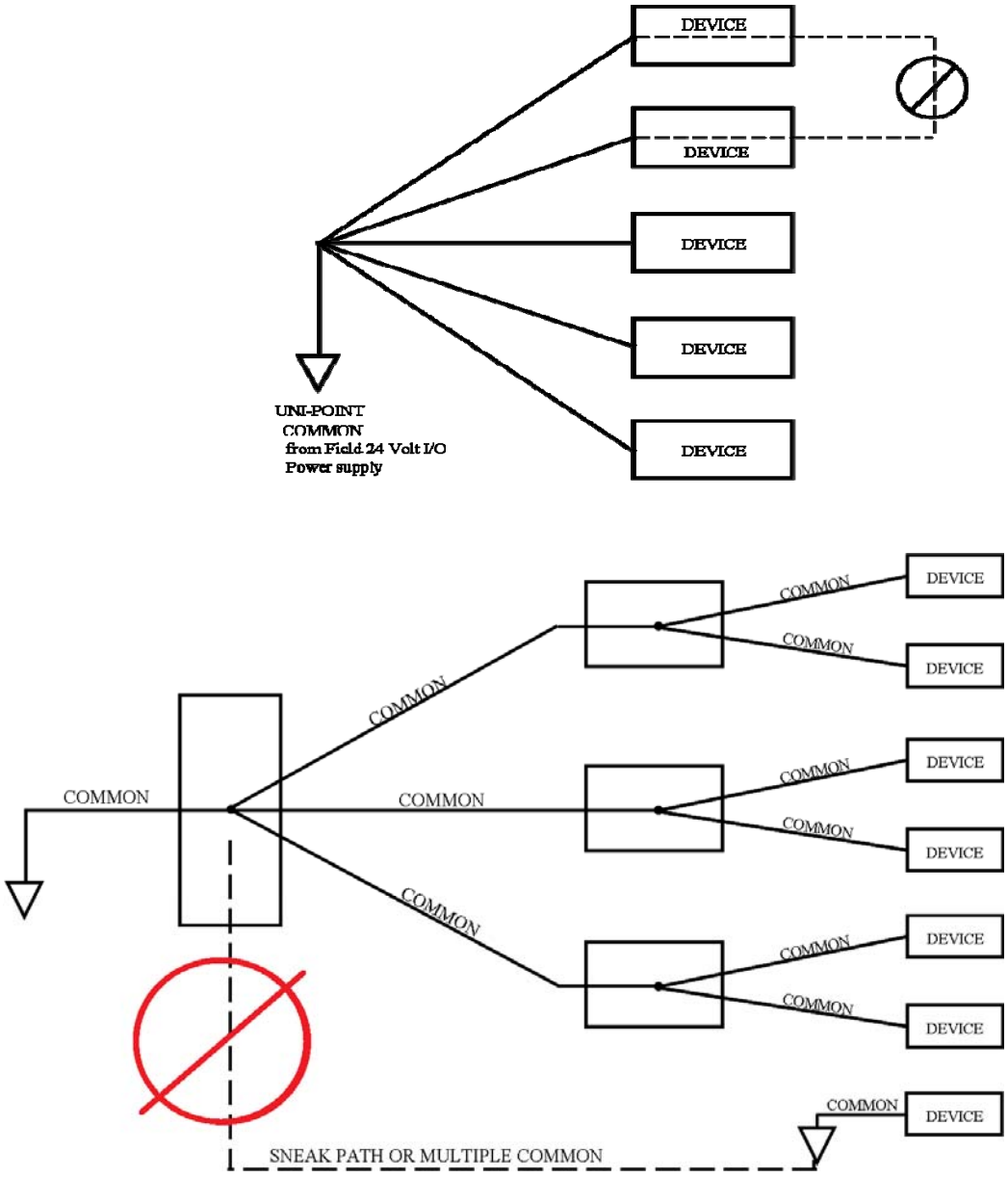


Fig. 10 – Grounding Examples

Appendix D – Audio Connection to PA System

The Station Controller accepts one external audio input into an internal audio mixer located within the enclosure.

The Station Controller also generates its own alerting tones and verbal commands.

Audio Relays are contained within the Station Controller to allow switching and routing of audio to various Fire Station areas such as bunk rooms, common areas and vehicle bay areas. (Optional)

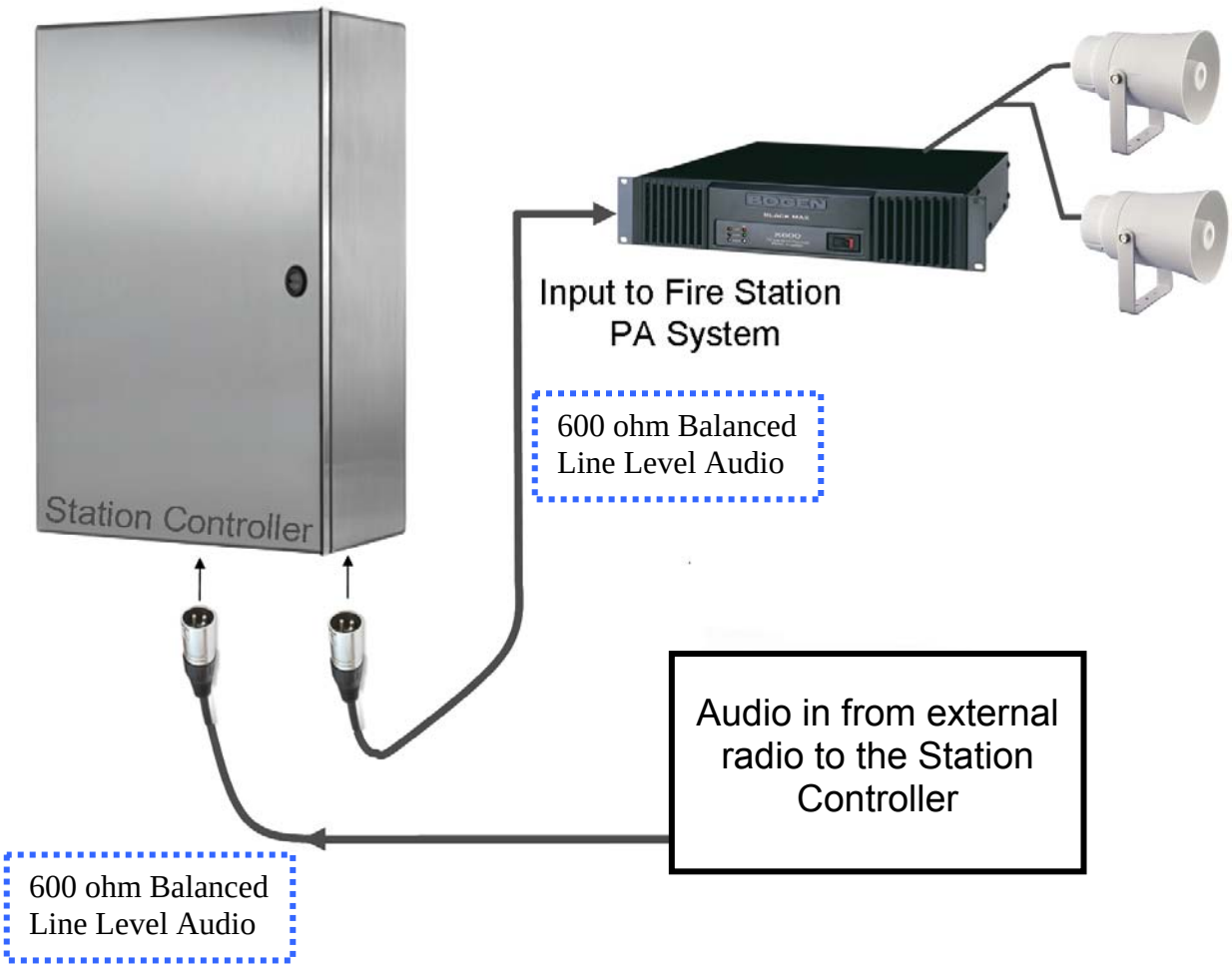
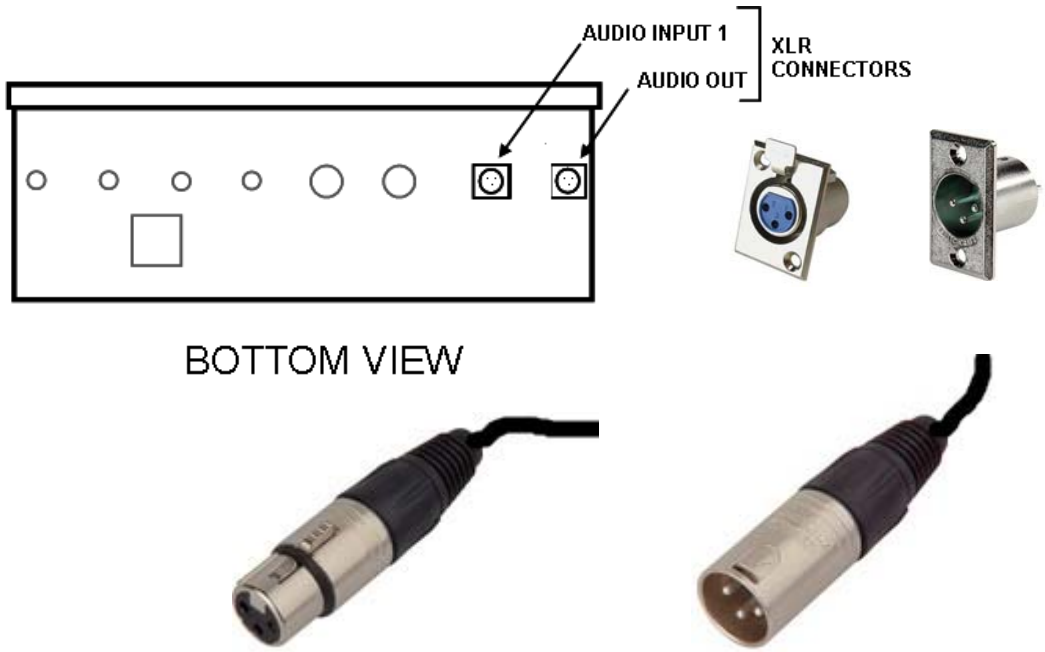


Fig. 11 – Audio Connection to PA System

Appendix E - Audio Connections and Wiring

There are three XLR connectors at the bottom of the Station Controller Panel



XLR Panel Mount and Jacks

Figure 12 - XLR Connectors required

SPEAKER WIRING

- All wiring should be done with Plenum rated cable for use in free air (above ceiling) in bays. For outdoor locations, all wire must be in conduit and weatherproof boxes (NEMA 4R - Rated for weather)
- All common areas can be daisy-chained together but always parallel wiring to 70V line transformer (or 300 Ohm Balanced VALCOM) of the speaker assembly. (DO NOT jump one speaker to another directly. This will impair performance and could damage the PA amplifier). All outdoor speakers must be on their own separate 18/2 cable from the outside common back to the SC cabinet (Option - may be “Muted” at night).
- All speakers that have a separate zone (bunk rooms) must have their own 18/2 cable run back to the SC cabinet. Note that some of the bunk rooms with attached bathrooms and/or offices can be jumped together on the 70V line (or 300 Ohm Balanced VALCOM) first.
- If a Fire Station has any alert lighting, make sure all audio cabling is separate and not bundled with lighting (120VAC 60Hz) as this could cause induced noise (hum) into the audio.

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Appendix F - Typical 70 Volt Line Audio

The majority of Fire Station audio systems use 70 Volt line audio distributed with shielded plenum wire throughout the station. Local speakers can contain transformers to step-down the voltage to appropriate levels (Watt tap) at each speaker or horn speaker.

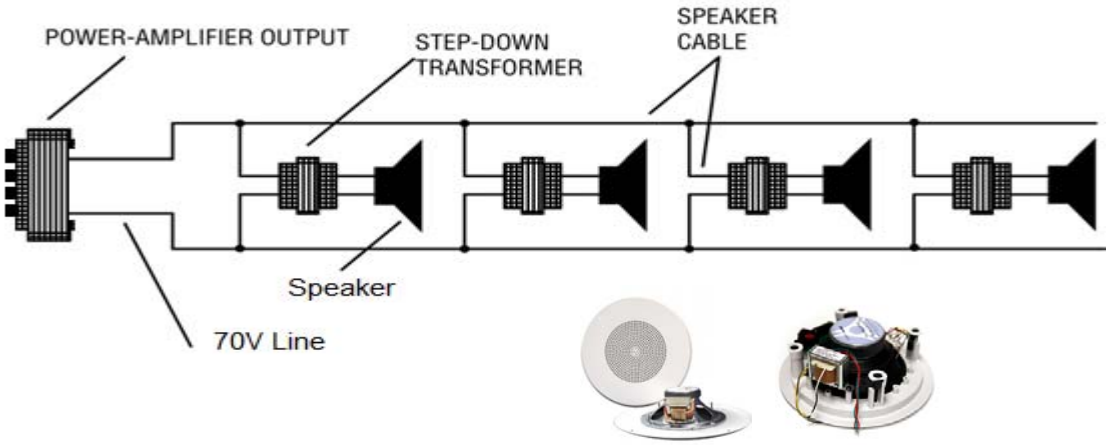

Figure 13 - 70V Line Speaker Sample

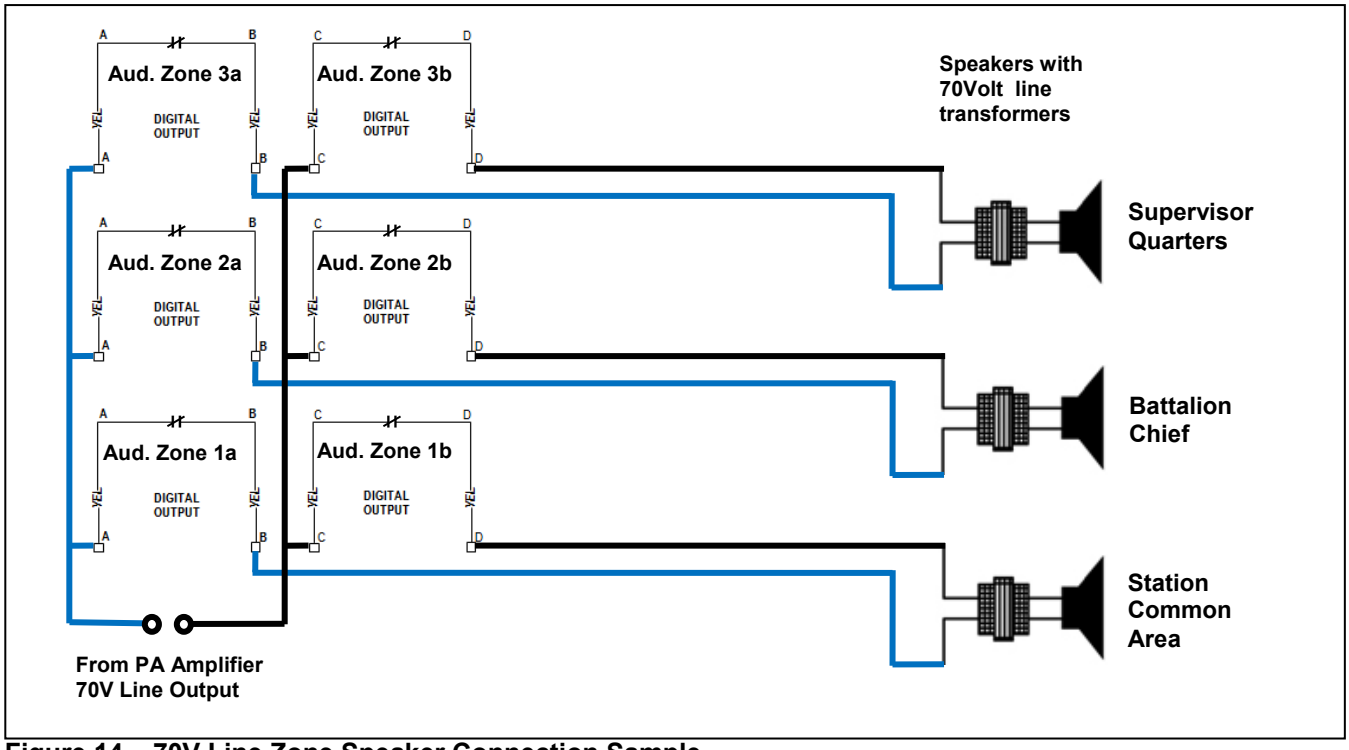

Figure 14 – 70V Line Zone Speaker Connection Sample

Appendix G - Typical VALCOM Audio system

Some of the newer Fire Station audio systems use VALCOM audio distributed with CAT-5 plenum wire throughout the station. Local speakers assembly will have a -24VDC driven amplifier attached to the speaker (see Figure 10) to step-up the audio line input signal (>600 Ohm Balanced) to 45 Ohms voltage drive to appropriate levels (Volume tap) at each speaker or horn speaker.

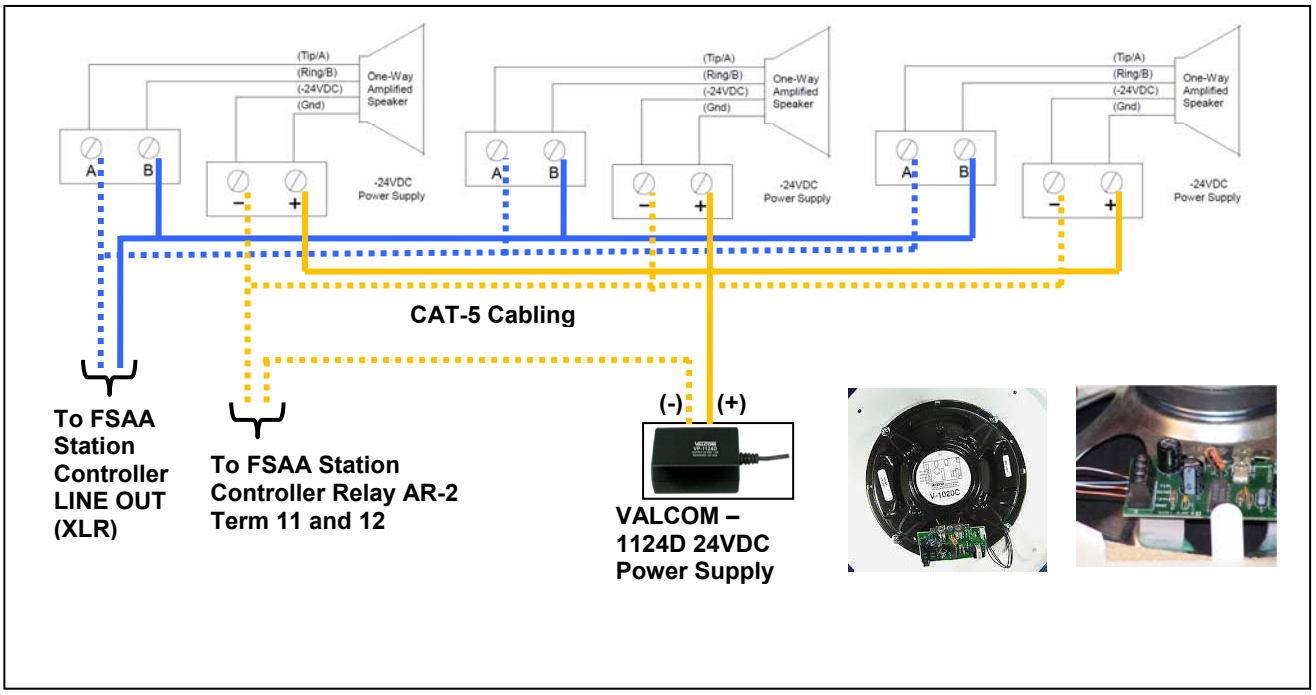

Figure 15 - VALCOM Line Level Speaker Sample

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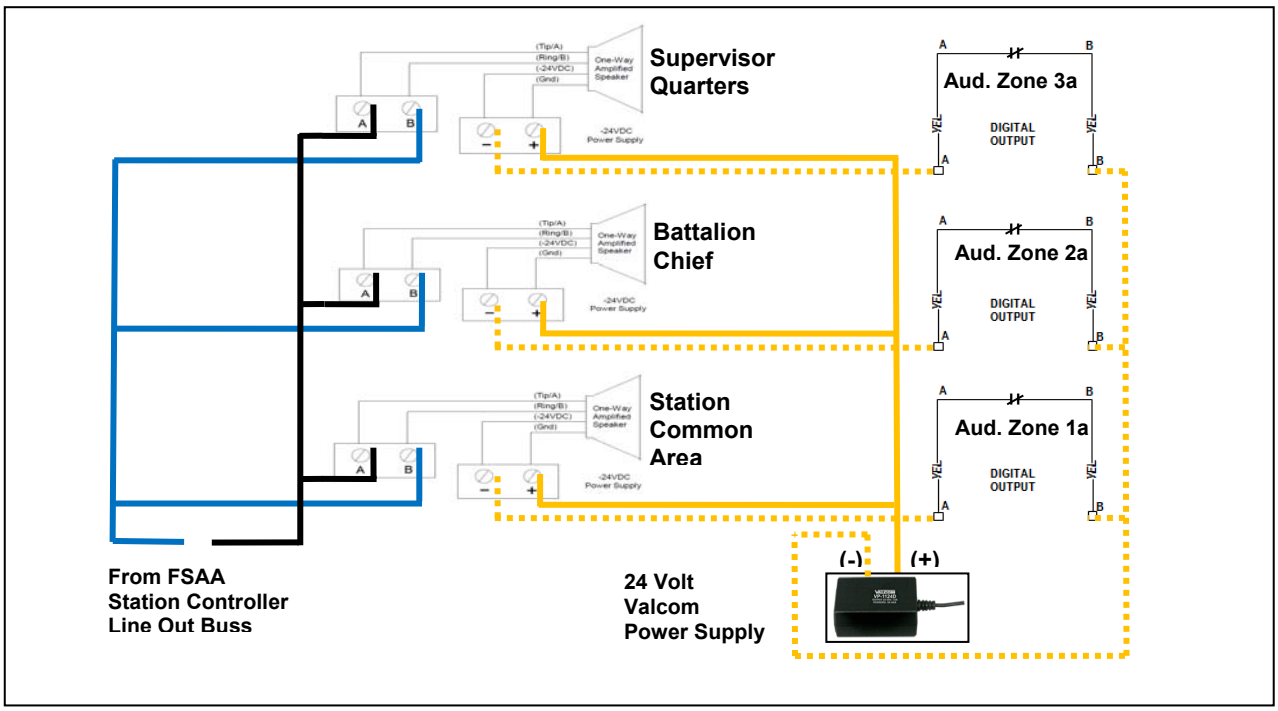

Figure 16a – Option 1
Sample VALCOM Speaker Zones wiring. Station Zone Controlled by 24V power.

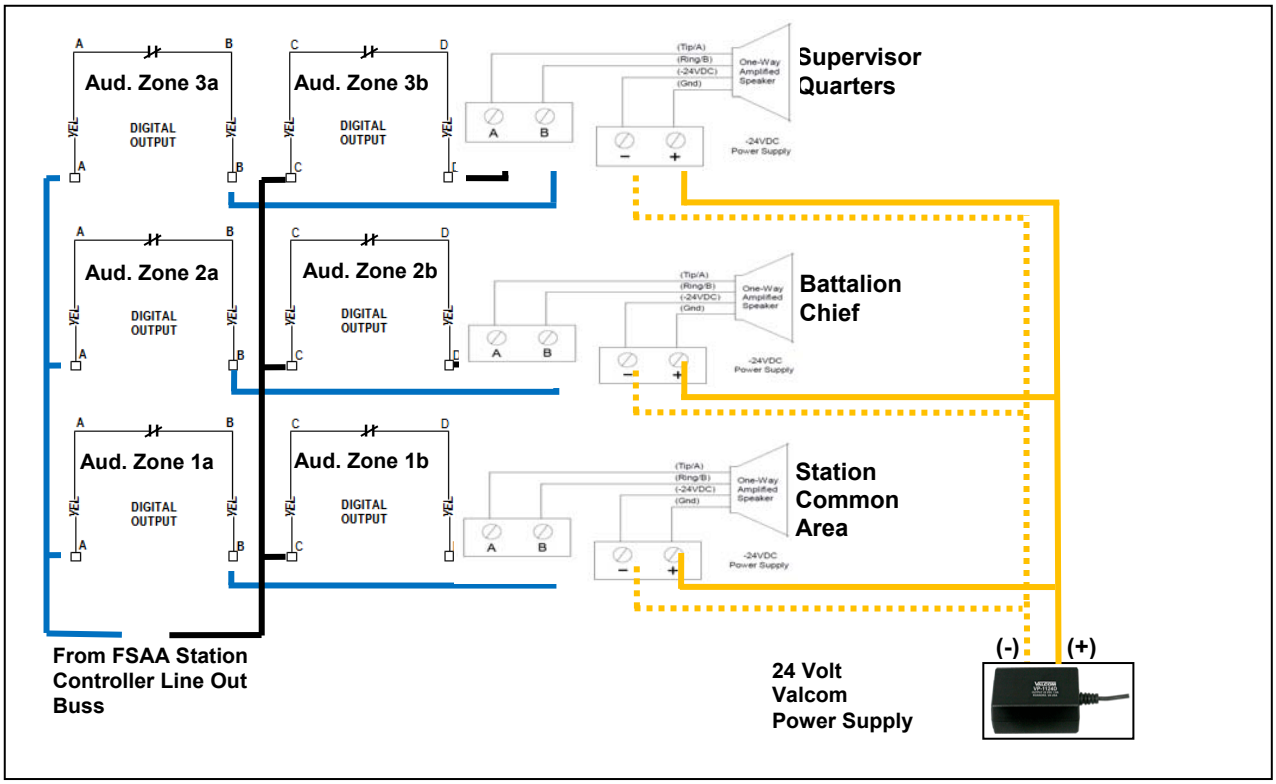

Figure 16b – Option 2
Alternate Method if local phone paging system is used. Station Zone Controlled by Audio source.

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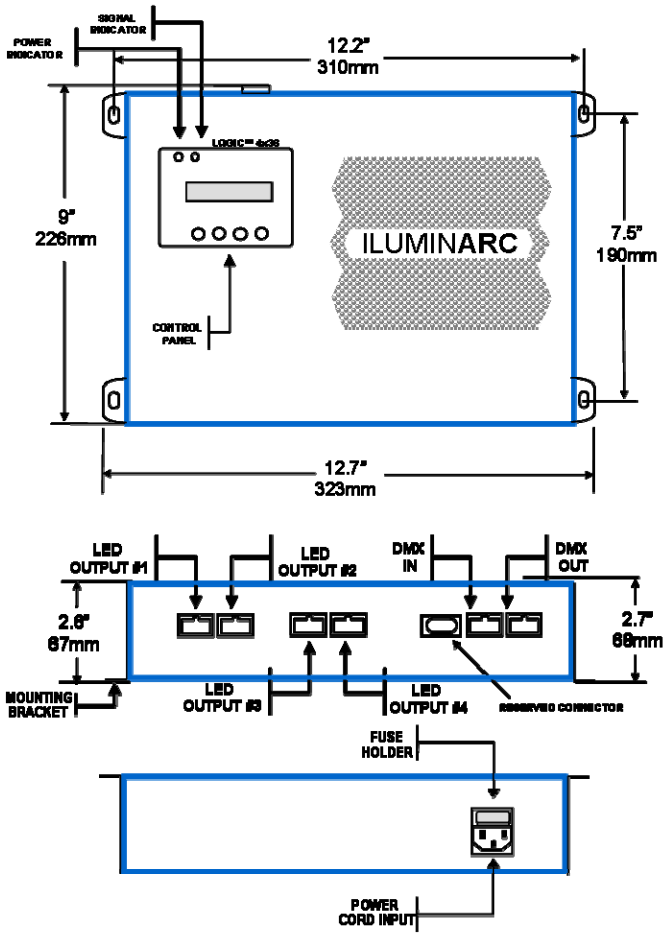
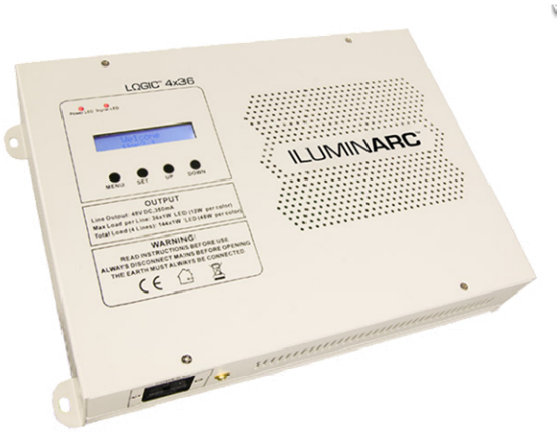
Appendix H - Lighting Controller ILUMINARC (Optional)

LΩGIC™ 4x36
Item Number: 34x36001





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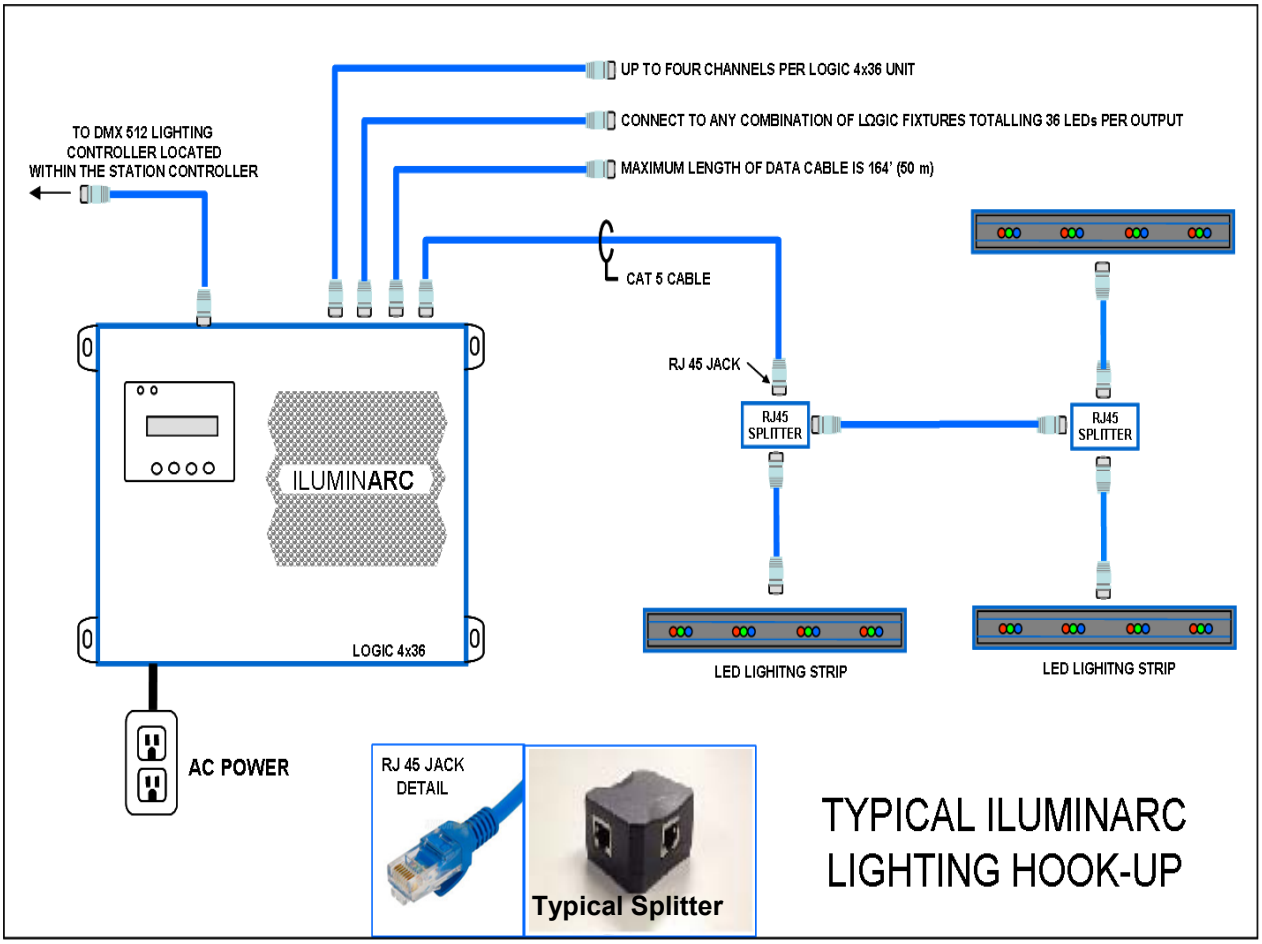

SPECIFICATION

- 1, 2, 3, 4, 6, 9, 12 or 15 channel DMX control
- RGB or SpectraWhite mixing with or without outboard DMX controller via integrated command LCD display
- White effects mixing with or without DMX controller
- Recall custom programs via master/slave or DMX
- Upload software over RS-232 connection
- Schedule playback with time clock functions
- Master/slave over RJ-45 connections

Construction
Color: Beige powder coat
Housing: Steal
Protection rating: IP20

Control protocol: USITT DMX 512

Installation Orientation: Any

Connections Power cable entry-IES
Power cable: 60in (1524mm)
Data cable entry: RJ-45
Data cable: Data in: RJ-45 to 3 pin M.
Data out: RJ-45 to 3 pin female

Electrical
AC power:100 ~ 240 V, 50/60 Hz
Power supply: Internal, auto-ranging, multi-voltage

Power and current
120 V, 60 Hz: 180 W, 1.5A operating
230 V, 50 Hz: 161 W, 0.7 A operating

Thermal Cooling:
Convection via integrated cooling
Maximum ambient temperature 40°C

Approvals **ETL**

Included items 1 x L□GIC™ 4x36

1 x RJ-45 to 3 pin DMX male adapter (input)
1 x RJ-45 to 3 pin DMX female adapter (out)
4 x RJ-45 barrel connector
1 x IEC power cable with plug: 60in 1524mm)

Warranty Card
User QSG

Illuminarc
5200 NW 108th Ave Sunrise FL, 33351
877-932-3680 WWW.ILUMINARC.COM

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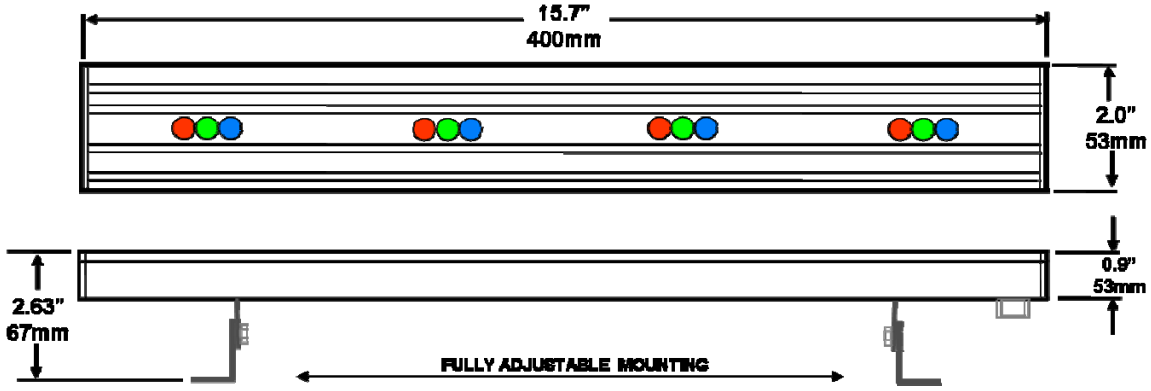
Appendix I - Ilumiline LΩgic 12 RGB Lighting Strip

The Ilumiline LΩgic 12 RGB lighting strip is compatible with LΩgic Controllers. LED lighting strips which are activated and controlled in various colors and sequences to alert station personnel of conditions and warnings. Features:

- RGB Color Mixing
- High power 1 Watt, 350 mA LEDs
- Extruded aluminum housing
- Input power of 1050mA@48VDC

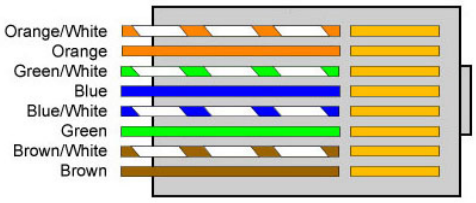
LED Lighting Strip

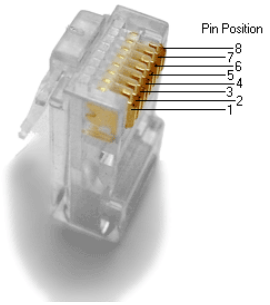


ILUMILLINE LΩgic 12 RGB Lighting Strip

WIRING

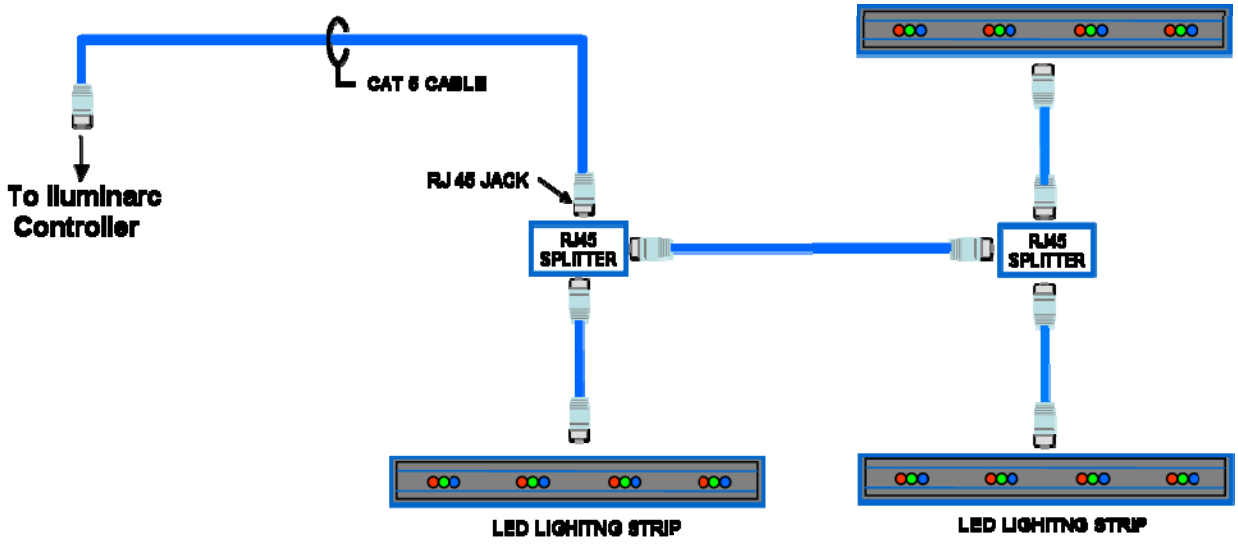
This product comes with a 79 inch (2M) long CAT 5 cable, terminated with an RJ 45 plug to connect to a ILUMINARC LΩgic Controller. If using the included splitter or if making an extension of the product's cable, you must use plenum-grade CAT 5/6 wire. The RJ connector pin-out is as shown below. (Straight 586B)





PIN	WIRE COLOR	FUNCTION
1	White/Orange	Red LED+
2	Orange/White	Green LED +
3	White/Green	Blue LED+
4	Blue/White	Not Used
5	White/Blue	Red LED -
6	Green/White	Green LED -
7	White/Brown	Blue LED-
8	Brown/White	Not Used

- **DO NOT** use splitters as couplers.
- **All cables** must be terminated to a product.



Appendix J - Zone Selection Switches

Wall switches may be provided as an option, allowing each bunkroom (or Zone) to select the type of alert, or combination of alerts, to be directed to that bunkroom. Fire or EMS personnel can use any bunkroom and select their specific alert(s) to be directed to that room. LED indicators on the wall switch indicate which alerts have been selected, or no alerts.

Selector Switch Wiring

These are used for bunkroom lighting. All selector switches can be installed with low voltage cut-in boxes on the wall by the bunk or door entrance. The wiring should be done with **18 gauge, 5 conductor** plenum rated cable and can be daisy-chained together with up to 24 switch panels per string (limited by MACH Alert software), then run on cable back to the cabinet. Always parallel switches in cut-in boxes. The cables for the selector switches can be brought back to the cabinet with the lighting, but not the audio. (Keep the audio and lighting cable separate).

Example Zone Selection

More than one zone can be selected such as BC & Rescue

- **Rescue- This room will receive Rescue, All Call, & Announcement**
- **Engine- This room will receive Fire, All Call, & Announcement**
- **Assistant Chief (AC)- This room will receive Assistant Chief, All Call, & Announcement**
- **Battalion Chief (BC)- This room will receive Battalion Chief, All Call, & Announcement**
- **Light- This Rooms Night light will be on when lighting controller is in Night Light Mode**
- **Vacant- This room will not receive any Calls**

Note: If no Zones are selected Room will receive every call

If the FSA system includes Zone Switches as shown above, the typical set-up is to wire all switches in parallel, noting the polarity of wires, which run to the MODBUS gateway located in the Station Controller.

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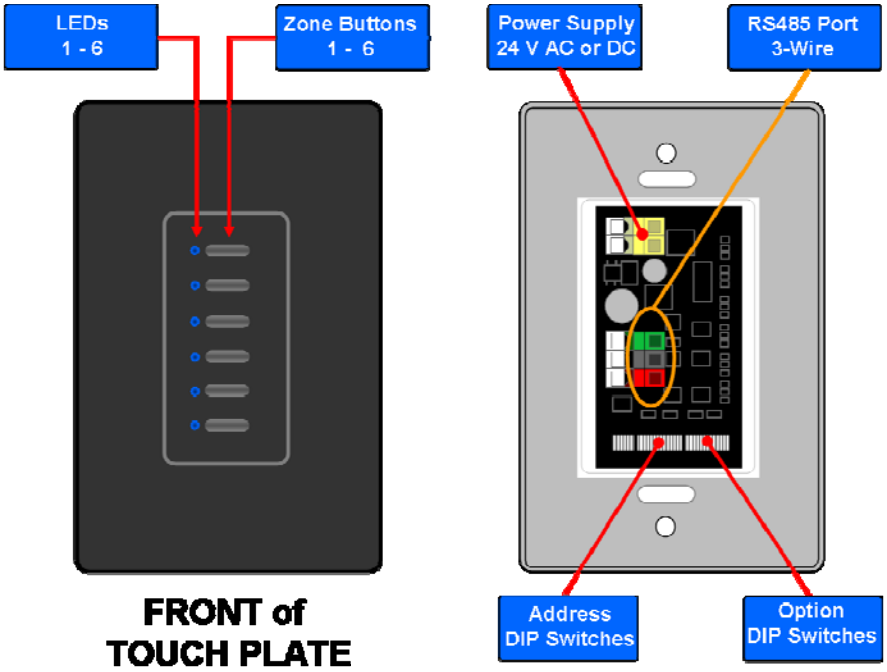
Introduction to the Ultra 5-Wire Touch Plates

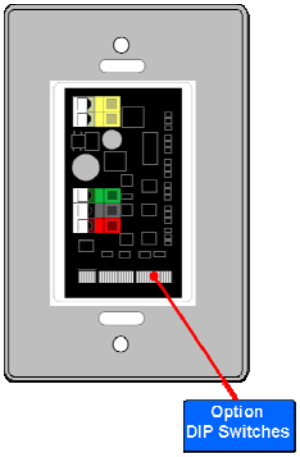
The Ultra 5-Wire Touch Plate works with a control unit contained in the MACH Alert Station Controller. The system is configurable for intensity and LED colors via DIP switch selectors on rear side. LED intensity and color change is possible via software when used with Modbus Gateway that sends digital data via serial ports.



The Option Dip Switches are for color and intensity. Use the table to make changes as desired.

NOTE: The controller unit located in the MACH Alert Station Controller will control the color and intensity and override the Option Dip Switch settings.

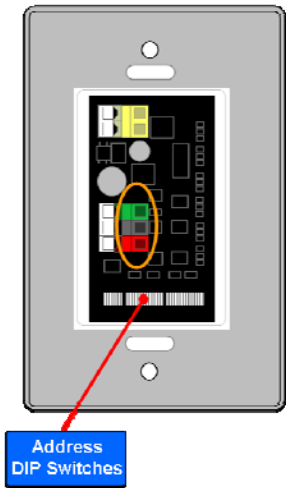
LED INTENSITY DIP SWITCH			NUMBER OF BUTTONS DIP SWITCH				LED COLOR DIP SWITCH			
1	2		3	4	5		6	7	8	
OFF	OFF	LOWEST	OFF	ON	OFF	2B	OFF	OFF	OFF	OFF
ON	OFF	LOW	OFF	OFF	ON	4B	ON	OFF	OFF	RED
OFF	ON	MEDIUM	OFF	ON	ON	6B	OFF	ON	OFF	GREEN
ON	ON	HIGH					ON	ON	OFF	BLUE
							OFF	OFF	ON	YELLOW
							ON	OFF	ON	PURPLE
							OFF	ON	ON	CYAN
							ON	ON	ON	WHITE



Ultra 5-Wire Address Dip Switches

The Address Dip Switches are used to set the Smart Switch Address. Normally, these Dip Switches come from the factory pre-programmed. Make sure you do not duplicate addresses, each control station must have its own unique address.

Do not change values unless directed by Touch-Plate. DIP SWITCH #8 ALWAYS STAYS ON.



Address	1	2	3	4	5	6	7	8
1	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	ON	OFF	OFF	OFF	OFF	OFF	ON
3	ON	ON	OFF	OFF	OFF	OFF	OFF	ON
4	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON
5	ON	OFF	ON	OFF	OFF	OFF	OFF	ON
6	OFF	ON	ON	OFF	OFF	OFF	OFF	ON
7	ON	ON	ON	OFF	OFF	OFF	OFF	ON
8	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON
9	ON	OFF	OFF	ON	OFF	OFF	OFF	ON
10	OFF	ON	OFF	ON	OFF	OFF	OFF	ON
11	ON	ON	OFF	ON	OFF	OFF	OFF	ON
12	OFF	OFF	ON	ON	OFF	OFF	OFF	ON
13	ON	OFF	ON	ON	OFF	OFF	OFF	ON
14	OFF	ON	ON	ON	OFF	OFF	OFF	ON
15	ON	ON	ON	ON	OFF	OFF	OFF	ON
16	OFF	OFF	OFF	OFF	ON	OFF	OFF	ON
17	ON	OFF	OFF	OFF	ON	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF	OFF	ON
19	ON	ON	OFF	OFF	ON	OFF	OFF	ON
20	OFF	OFF	ON	OFF	ON	OFF	OFF	ON
21	ON	OFF	ON	OFF	ON	OFF	OFF	ON
22	OFF	ON	ON	OFF	ON	OFF	OFF	ON
23	ON	ON	ON	OFF	ON	OFF	OFF	ON
24	OFF	OFF	OFF	ON	ON	OFF	OFF	ON
25	ON	OFF	OFF	ON	ON	OFF	OFF	ON
Through Address 96 - Use the table below to calculate Smart Switch Address								

Valid addresses are from 1 to 50. Addresses are set using the eight Address Dip Switches, which each have a value noted in the chart below.

Address Dip Switch	1	2	3	4	5	6	7	8
Value	1	2	4	8	16	32	64	128

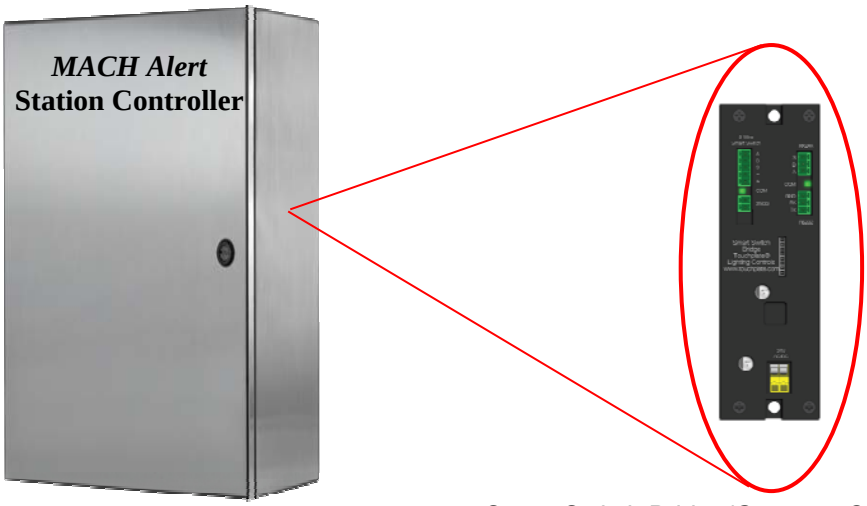
The values of all switches in the ON position are added together and the total is equal to the address. See the examples below:

- Smart Switch Address 1: Turn on switch 1 only, and leave all other Address switches off.
- Smart Switch Address 13: Turn on Address Dip Switches 1, 3 and 4. c The values of those switches is 1 + 4 + 8 = 13.

Mach Alert, Inc.
503 E. Jackson Street, Suite 149
Tampa, FL 33602

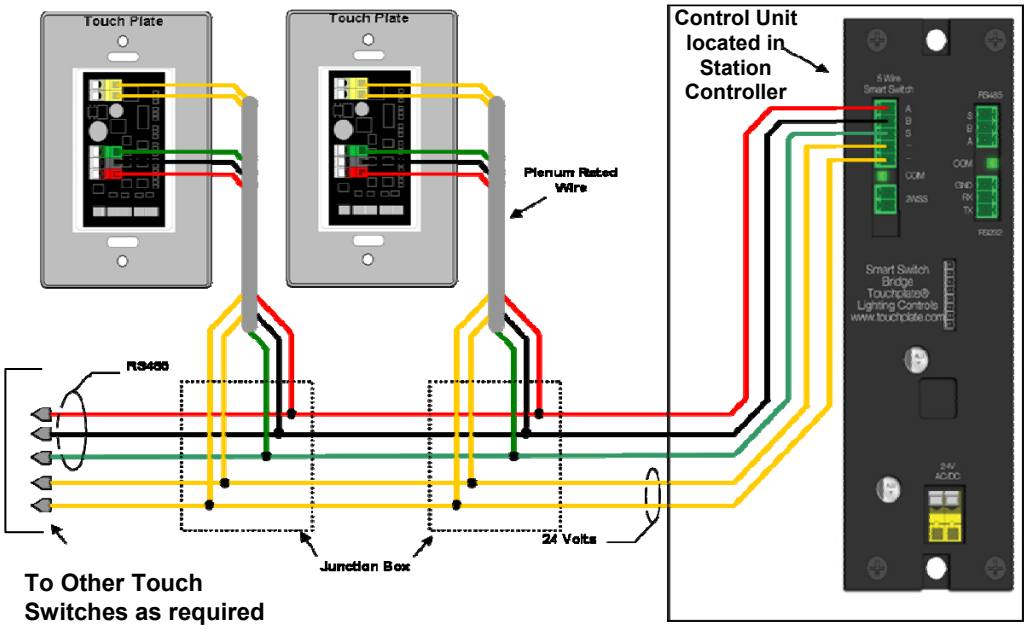
Modbus Controller to Touch Plate Wiring

The Control Unit for the Touch Plate Zone Switches is located inside the MACH Alert Station Controller enclosure.



Smart Switch Bridge/Gateway Controller for Wall-Mounted touch plates is located inside the MACH Alert Station Controller

Wiring is done in parallel to each Touch Plate



Baud Rate (SW2) (Under the Cover) set at 57600. 1- Off, 2 – Off, 3- On, 5 - 8 - Off.